Chapter 11
Renewable Energy in India: Policies to Reduce Greenhouse Gas Emissions

Neeru Bansal, V. K. Srivastava and Juzer Kheraluwala

Abstract The demand for energy is rising continuously, and the reasons are—economic development, urbanization, rising standard of living and increasing population. In India, 65% of the energy demand is currently met through power generated from fossil fuels, especially from coal-based power plants. These power plants are the highest contributor to the total greenhouse gas emissions in the country. The share of renewable energy is only 15%, excluding the hydropower. There are many countries in the developed world, which are aiming to become 100% reliant on renewable energy. Indian government is aiming to increase the contribution of renewable energy to honour the country's commitment to reducing intensity of greenhouse gas emissions. Solar energy is being considered as one of the main components of the renewable energy basket as the country receives 300 days of good solar radiation. This chapter focusses on the global discussion to reduce greenhouse gas emissions followed by the policies of the central government and the state governments in India to promote renewable energy, especially solar energy, to reduce its greenhouse gas emissions. There are some states, which have actively engaged in renewable energy initiatives, and an analysis of the policies of these states is highlighted. The country-specific policy initiatives for those having a major share of renewable energy have been included in the chapter.

Keywords Greenhouse gas emissions · Renewable energy · Solar energy Policies

N. Bansal (✉)
CEPT University, Ahmedabad, Gujarat, India
e-mail: bansal.neeru@cept.ac.in

V. K. Srivastava
Sankalchand Patel University, Visnagar, Gujarat, India
e-mail: drvks9@gmail.com

J. Kheraluwala
Ernst & Young LLP, New Delhi, India
e-mail: juzer50@gmail.com

N. Shurpali et al. (eds.), *Greenhouse Gas Emissions*, Energy, Environment, and Sustainability, https://doi.org/10.1007/978-981-13-3272-2_11

11.1 Introduction

The energy demand across globe has been rising, as it happens to be the prime driver for development. The reasons for escalating demand are economic development, population growth, urbanization and an increasing standard of living. The existing demand for energy is mainly met by fossil fuel-based power generation. Pollution and release of greenhouse gases (GHGs) and the resultant climate change are major environmental concerns associated with the conventional fossil fuel-based power generation. The issue of climate change is gaining global attention and is at the centre stage of global discussion. The effort is to produce low-carbon or carbon-free energy. This becomes especially important in the light of the Paris Agreement, 2015 where nations have committed to reducing their carbon footprint. This has made discussion on renewable energy, an important one, as it is the key to the sustainable energy future. The policies of the Indian government are aiming to increase the share of renewable energy to honour the country's commitment to reduce intensity of GHG emissions. Solar energy is being considered as a major alternative to generate renewable energy due to the country's geographic location as many parts of the country receive 300 days of solar radiation.

This chapter focusses on the renewable energy initiatives at global level to reduce GHG emissions, followed by the policies of the central government and the state governments in India to promote renewable energy, especially solar energy. The policy initiatives of the states in India which have actively engaged in renewable energy initiatives have been discussed. The policy initiatives by other countries having a major share of renewable energy have been included in the chapter.

11.2 Global Initiatives on Climate Change

11.2.1 The Paris Agreement, 2015

The Paris Agreement builds upon the United Nations Framework Convention on Climate Change (UNFCCC). On 12 December 2015, 195 countries assembled in Paris to chart out the world's first universal climate treaty, the Paris Agreement, aimed at mitigating the effects of rising global temperatures. It is the first comprehensive agreement on climate change, bringing all the nations towards a common cause. Under Kyoto, developing countries were not required to reduce their emissions, but in the Paris Agreement, even they have been made a party and are required to undertake and publish targets for a less carbon-intensive development. The Paris Agreement is officially ratified by 144 countries and entered into force in record time in November 2016. The treaty aims at cutting emissions and keeping global temperatures from rising more than 2 °C above pre-industrial levels, while striving to limit them to 1.5 °C. The treaty aims to strengthen the capacity of all

parties to deal with the impact of global warming; to initiate a modern and superior technology and an enhanced capacity building framework, to provide transparency of support and action through a more vigorous transparency framework.

In order to help developing countries, developed nations are supposed to contribute $100 billion annually to developing countries by 2020. This would help the poorer countries combat climate change and foster greener economies. The individual countries are tasked with preparing, maintaining and publishing their own GHG reduction targets. The targets are to be revised every 5 years. The Paris Agreement has set a target of achieving a carbon-neutral world sometime after 2050 but not later than 2100. This entails a commitment to limiting the amount of GHGs emitted by human activity to the levels that trees, soil and oceans can absorb naturally.

Following the announcement by the President of the USA in 2017 that the USA will cease to participate in the Paris Agreement, the confidence of the parties to the Paris Agreement has suffered a setback. India has still taken a bold decision to spearhead the campaign against global warming and climate change. India being the third largest emitter of greenhouse gases has pledged to follow a low-carbon footprint model of development.

11.2.2 India's Commitment to the Paris Agreement

India has committed to reducing its carbon footprint by 33–35% from its 2005 levels by 2030. This means that the country will have to adopt multi-prolonged policies. Simultaneously, the country will have to transform the power sector, in order to shift the current energy sources more significantly towards renewable energy to reduce volumes of emissions per unit of gross domestic product (GDP), as 70% of GHG emissions in the country are from energy sector (Government of India 2015a).

11.3 Global Renewable Energy Scenario

The summits of the Parties to the Convention (COP)[1] over the past 25 years have resulted in strong commitments towards carbon-free or low-carbon energy generation. The boom in renewable energy began in Europe and Asia with Germany, France, Italy and Japan leading the way in the early 2000s. Their extensive commitment to developing renewable energy, especially solar power, has resulted in these countries having the highest installed solar capacity. The next stage of solar power development came after 2006, where Australia, China, the USA, the UK

[1]The 197 countries that have ratified the UNFCCC are called Parties to the Convention (COP).

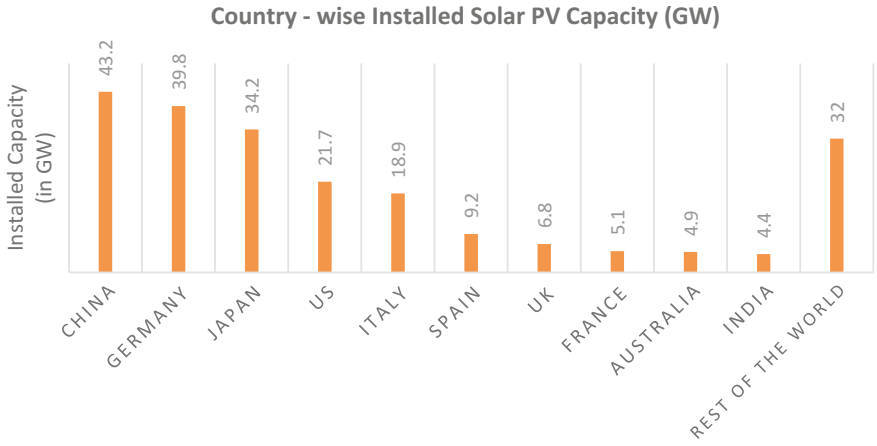

Fig. 11.1 Country-wise installed solar PV capacity (GW). *Source* IEA, 2017 based on 2015 data

began their advent in solar power generation. The top five countries in solar PV in 2016 are—China, Japan, Germany, the USA and Italy, respectively. China is the leader with a world share of 25.8% and has a total installed capacity of 78,100 MW. The details for the countries having a major share in the solar PV are shown in Fig. 11.1 (Hill 2017).

The country-specific policy initiatives by the major leaders in solar power generation are discussed in the following paragraphs.

11.4 Country-Specific Initiatives for Renewable Energy

11.4.1 China

China is the front runner in installed capacity of solar PV systems in the world. The Renewable Energy Law of China was formulated in 2006 and amended in December 2009. The country has been able to install more than the targets every year. The country used to have almost negligible solar PV systems till 2010, but since then, it has started setting massive installations every year.

The total installed capacity has increased from 2 GW in 2011 to around 130 GW in 2017 (Fig. 11.2). In the year 2017, it has added a massive capacity of 52.4 GW of solar PV systems. The policy follows a mechanism of feed-in tariff (FIT). This has resulted in tremendous annual growth every year in solar PV capacity addition. After witnessing the growth in 2017, the Chinese government has reduced the FIT by 12–15% since January 2018. The Renewable Energy Law has divided the country into Class-1, Class-2 and Class-3 regions based on solar resources. The

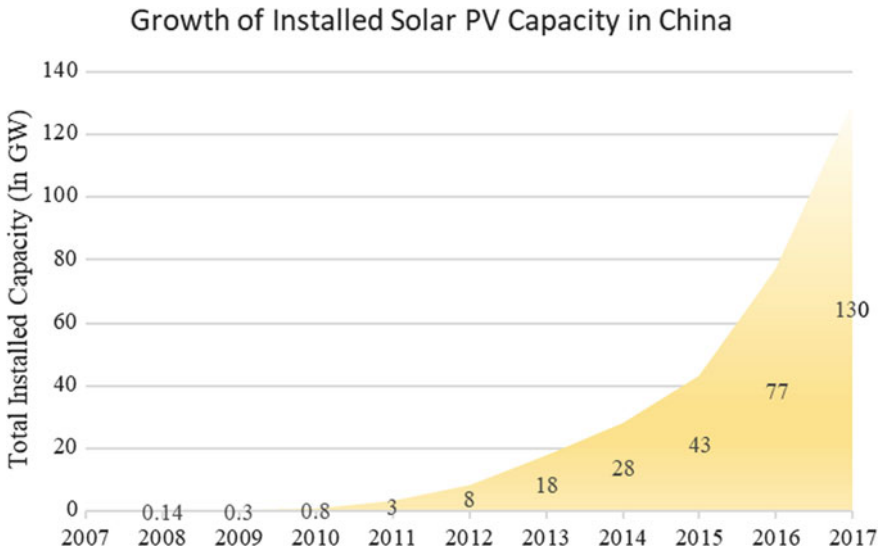

Fig. 11.2 Growth of installed solar PV capacity in China

revised FIT for 2018 is as follows: Class 1—CNY 0.55/kWh (Rs. 5.62); Class 2—CNY 0.65/kWh (Rs. 6.65) and Class 3—CNY 0.75/kWh (Rs. 7.67).

A direct visible impact of the push for renewable energy has resulted in reduced coal consumption in China since 2014. It is projected that renewable energy sources would contribute to 20% of China's total power consumption by the year 2030 (Greenpeace 2017).

11.4.2 Germany

The growth of the renewable energy sector in Germany started in the year 1991 under Electricity Feed Law (1991–2000). In 1991, the country initiated the "1000 solar rooftop" scheme. This scheme was followed by another rooftop solar PV programme, launched in 1999, known as the "100,000 solar rooftop programme". The programme provided financial assistance to systems greater than 1 kW at low interest rates with repayment options up to ten years. The programme targeted to install 300 MW by the year 2003 and was able to achieve 261 MW (Energiewende Team 2015).

During the "100,000 solar rooftop programme", in 2000, the Electricity Feed Law was superseded by the Renewable Energy Sources Act (EEG). The EEG has been quite effective since its inception. The period 2000 to 2004 saw an increase in the electricity generated from renewable sources from 1.48 to 3.98 GW. The share

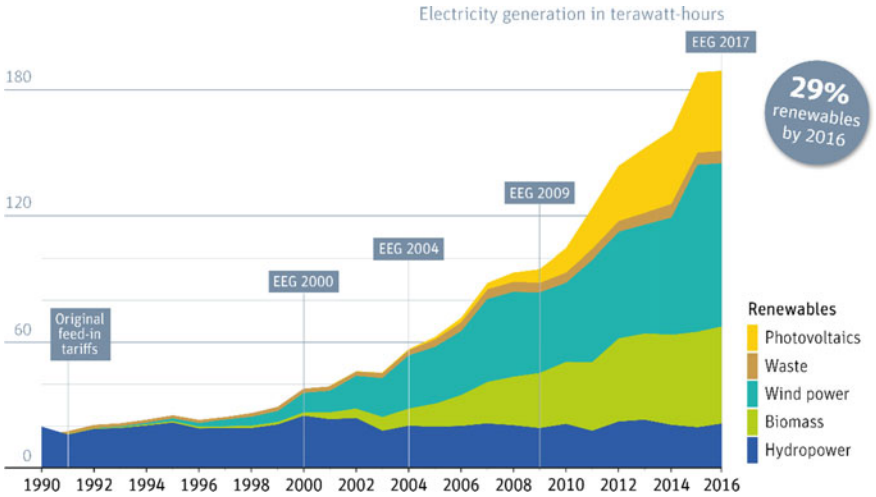

Fig. 11.3 Policy change and the growth of renewable energy in Germany

of wind and biomass increased two times and that of photovoltaic (PV) systems experienced a ninefold increase. In 2014, renewable energy contributed close to 30% of power generated in Germany with few peak days contributing close to 80% of peak power demand at specific times of the day (Morris and Pehnt 2016). As of 2017, the total power generation through solar PV systems in Germany is 43 GW, contributing to 7.2% of net energy consumption including grid losses.

Germany has set a yearly expansion plan of 2.4–2.6 GW up to 52 GW from solar PV systems. The energy generation from solar PV systems is largely driven by the residential sector. The major driver for increased installations has been gradual decline in the cost of solar PV systems. The latest amendment of the EEG Act in 2014 has shifted focus towards market-driven mechanism for fixing prices through bidding and auctions from the conventional system of FIT mechanism. This has resulted in reduction of feed-in tariff from 19 ct/kWh (Rs. 15) to a range of 9.2 to 13.1 ct/kWh (Rs. 7.37–Rs. 10.43), based on the size of the PV system. The timeline for the evolution of the Renewable Energy Law (EEG) in Germany from 2000 to 2017 along with the share of renewable energy from different sources is presented in Fig. 11.3 (https://www.iea.org/policiesandmeasures/pams/germany/name-21000-en.php).

11.4.3 Japan

Japan ranks at number three in terms of installed solar capacity. The country had invested heavily in research and development (R&D) for grid-connected solar rooftop programme under its Sunshine and New Sunshine Projects since the 1970s.

Table 11.1 Procurement prices for solar energy in 2012 (DLA Piper 2012)

Electricity generated	More than 10 kW	Under 10 kW	Under 10 kW (solar cogeneration)
Procurement price	JPY 42p/kWh	JPY 42p/kWh	JPY 34p/kWh
Procurement term	20 years	10 years	10 years

Japan had promoted solar energy by providing fiscal incentives to small generators through capital subsidy as well as by buying power through FIT mechanisms. The FIT mechanism being in force in Japan since 1 July 2012 had been the most generous one in the world. It mandated utility companies to purchase power from renewable energy generated at a price approved by Japan's Ministry of Economy, Trade and Industry (METI), at a rate shown in Table 11.1.

The country had set a modest target of 400 MW in 2000 and raised it to 4.6 GW by 2010. By 2016, the installed solar capacity in Japan was approximately 43 GW and accounted for 4.3% of the total electricity production. The Japanese government is currently projecting solar power generation to meet around 10% of total energy demand by 2050.

The Japanese FIT regime has been amended recently in April 2017 into the Renewable Energy Act. The main objectives of this Act are—achieve better growth of renewable projects, particularly solar; increase competition and improving the cost-effectiveness of renewable projects; promote gradual independence from the FIT regime; reduce renewable electricity costs for the public and introduce auction process for solar projects with a capacity greater than 2 MW. The intent of this auction system is to promote greater competition among solar developers which finally lead to a reduced electricity price for consumers. The shift from a FIT regime to a competitive auction process for large-scale solar projects is predictable, as these projects have attracted the bulk of investment in the renewable energy sector in Japan.

11.4.4 The USA

The USA has installed a total of 52 GW of solar energy as on 31 December 2017 as per the statistics released by the USA Energy Information Administration (EIA) in 2018. The solar energy accounts for almost 25% of all new power plants installed in the USA in 2017. Nearly 60% of installed solar capacity in the USA is in the form of large, utility-scale plants consisting of both solar PV and solar thermal. Similar to other countries, the national government has offered several incentives to promote and encourage the growth of solar power in the country. Coupled with this are the incentives offered by the respective state governments. Considering the massive

size of the country and the federal nature of the government, each state has its own unique policy towards solar energy, although having certain common policy instruments. Some of the policy instruments are discussed in the following paragraph (http://theconversation.com/the-state-of-the-us-solar-industry-5-questions-answered-90578).

The Renewable Portfolio Standards (RPS) mandate utilities to purchase certain percentage of their power generation from renewable sources. Twenty-five out of the 50 states have mandatory RPS obligations to be met. However, there are 14 states in the USA which do not have RPS obligations; this includes Arizona which otherwise is in the list of top ten solar power states. Another important policy instrument in the USA is "net metering", and this has been adopted by nearly 37 states. A few states like Arkansas, California, Colorado, Louisiana do not have any restrictions on their net metering policies. The state of Arizona has recently restricted their net metering policy to only large-scale power projects and has recently excluded residential installations from the purview of this policy. Investment tax credit (ITC) also known as federal tax credits is another policy instrument to promote renewable energy. It is provided in the form of tax deductions equivalent to 30% of the total cost of the solar power system. This was introduced in 2005 and was initially promoted only for a period of two years. But after considering the positive response from consumers, it has been extended till 2021. Certain states have added additional tax credits to the ITC for installation of solar systems (https://www.solarpowerrocks.com/2017-state-solar-power-rankings/#propexemption).

11.4.5 New Entrant in Solar Energy—Saudi Arabia

The Kingdom of Saudi Arabia is the latest entrant in introducing renewable energy component in the conventional energy basket. The country which currently ships the largest quantity of crude oil in the world now plans to shift away from fossil fuel-based power. It has a yearly solar irradiance of more than 5.75 kWh/m^2 (Pazheri 2014). Saudi Arabia has launched the National Renewable Energy Programme (NREP) as part of Vision 2030 and National Transformation Programme (NTP). The NREP has two phases—0.45 GW of renewable energy generation by 2020 in phase 1 and a cumulative capacity of 9.5 GW by 2023 in phase 2. This will account for 10% of the country's total power requirement. Recently, in January 2018, Saudi Arabia has awarded 300 MW of utility-scale solar PV plant. There are plans to award an additional 620 MW by the end of 2018. However, rooftop solar PV projects in the country are not being given a major push; reason being the dusty climate conditions would demand higher maintenance costs for the small generators.

11.5 Power Sector and Emission of Greenhouse Gases in India

The energy demand in India is mainly met by fossil fuel-based power generation. In February 2018, India's total installed power capacity was 334 GW which includes 62.85 GW of renewable energy, and this makes the share of renewable energy to be approximately 15%, after excluding electricity generated from hydropower (Central Electricity Authority 2018). The installed capacity of thermal power plants, mostly coal-based plants, has continued to grow at a high growth rate of 16% during the period 2011 to 2017. However, in 2017, for the first time, the capacity addition of renewable energy was more than the conventional energy sources, wherein, 12.5 GW of renewable energy was added against 10.2 GW of conventional energy power.

The figures in Table 11.2 highlight that country is still majorly dependent on fossil fuels for meeting its energy requirements. Due to the nature of energy mix, almost 70% of the GHG (amounting to 1,510,120 Gg CO_2 equivalent) emitted into the atmosphere are from across the energy sector categories in 2010 (Government of India 2015a). India is the third largest GHG emitter in the world, though the per capita emissions are very small. The need is, therefore, to shift from conventional energy sources to new and renewable energy sources (Fig. 11.4).

In Paris Agreement, India has committed to reducing GHG emissions intensity by 33–35% of 2005 levels by 2030. Since energy sector is the major contributor to GHG emissions, many policy initiatives have been directed towards promoting renewable energy and specifically solar energy. These are discussed in the subsequent section.

Table 11.2 Total installed power capacity in India—2017 versus 2011

Source type	Type of generation	Total installed capacity (in GW)		% split	
		2017	2011	2017 (%)	2011 (%)
Conventional energy sources	Coal	192.97	93.84	58	54
	Nuclear	6.78	4.78	2	3
	Gas	25.15	17.46	8	10
	Diesel	0.84	0.00	–	–
Renewable energy sources	Hydro	49.35	40.32	15	23
	Wind	32.70	13.18	10	8
	Solar	14.77	0.03	4	0.02
	Biomass	8.30	2.67	3	2
Total installed capacity (in GW)		331	172	100	100

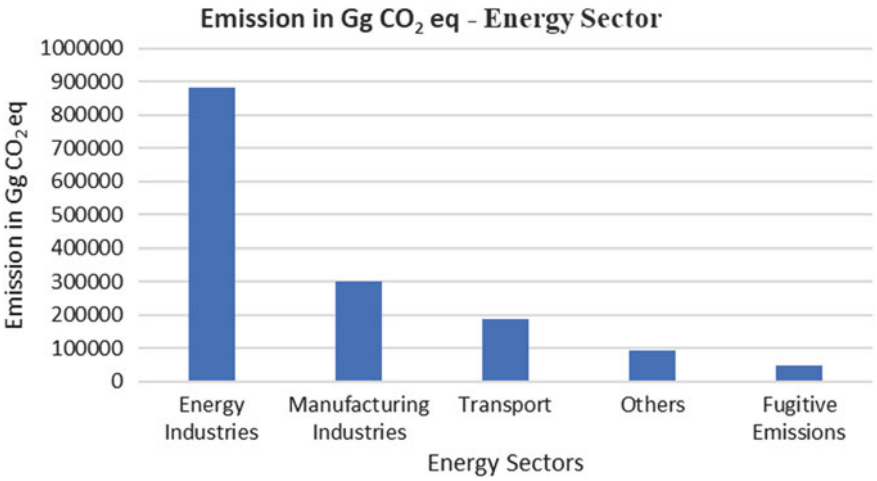

Fig. 11.4 Emission in Gg CO_2 eq from energy sector. *Source* Government of India (2015a)

11.6 National Action Plan for Climate Change (NAPCC) in India

The National Action Plan for Climate Change (NAPCC) was launched in the country in 2008 to tackle the issue of climate change. The objective of NAPCC is "to establish an effective, co-operative and equitable global approach based on the principles of common but differentiated responsibilities and respective capabilities". The NAPCC has formulated eight National Missions, which are fundamental to the National Action Plan for fulfilling the objectives set by the UNFCCC. These Missions are listed as follows.

1. National Solar Mission
2. National Mission on Enhanced Energy Efficiency
3. National Mission on Sustainable Habitat
4. National Water Mission
5. National Mission for Sustaining Himalayan Ecosystem
6. National Mission for Green India Mission
7. National Mission for Sustainable Agriculture and
8. National Mission on Strategic Knowledge for Climate Change.

11.6.1 Jawaharlal Nehru National Solar Mission (JNNSM)

Jawaharlal Nehru National Solar Mission (JNNSM) is one of the missions under NAPCC and was launched on 11 January 2011. The major objective of JNNSM is the development of solar energy; reason being that the country gets abundant sunlight for more than 300 days of the years. Solar is the most secure source of power as it is available in abundance throughout the country. The proximity to the equator also provides high solar radiation between 4 and 7 kWh/m^2/day. The country has a capacity to generate 5500 trillion kWh/year equivalent energy through solar radiation. This provides immense potential for development of solar power as an alternate source of renewable energy to wind, biomass and hydro-electricity. JNNSM has two segments for development of solar power, one through utility-scale projects and the other through rooftop solar PV projects.

Targets of the JNNSM. The mission is divided into three phases spanning from 2010 to 2022. The government will review and evaluate the capacity targets during the mid-term and end of each phase to prevent overexposure of government subsidies and vice versa. The targets for this mission were first set in 2010 and were revised by the cabinet in 2015. The targets under JNNSM are summarized in Table 11.3.

The installed solar capacity for power generation in 2009, prior to the National Solar Mission, stood at a meagre 0.02% (0.03 GW), which has now increased to 5%. The targets of the JNNSM have been revised from 20 to 100 GW of total solar installations by 2021–22. The development and commissioning of large-scale projects have been at the forefront of India's solar energy capacity addition. However, India lacks adequate transmission infrastructure to evacuate power from these large-scale power plants. Therefore, the generation of power at the point of consumption in urban areas has been given importance in the recent JNNSM policy amendment, through the implementation of rooftop solar PV systems. As per the revised government resolution of July 2015, the government aims to add 60 GW through medium and large-scale solar power projects like solar parks and another 40 GW of grid-connected solar rooftops on residential, commercial, institutional and industrial buildings (Ministry of New & Renewable Energy 2015; Goel 2016). In order to facilitate and promote the rooftop solar plants, Ministry of New and Renewable Energy (MNRE), India, has introduced another programme called Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI), the details of which have been discussed in the next section.

Table 11.3 Targets of JNNSM

Phase	Year	Rooftop solar	Utility-scale solar plants	Total targets (in GW)		Target achieved
				2010 resolution	2015 revised resolution	Commissioned capacity (in GW)
I	2010–2013	No separate distinction		1.1	Not applicable	0.87 (PV, CSP, migration)
II	2013–2015	No separate distinction		3.0–10.0	Not applicable	3.74 up to 2015
	2015–16	0.20	1.8		2.0	3.0
	2016–17	4.80	7.2		12.0	2.89
III	2017–18	5.0	10.0	≥ 11.0	15.0	5.53 up to 30 Nov. 2017
	2018–19	6.0	10.0		16.0	
	2019–20	7.0	10.0		17.0	
	2020–21	8.0	9.5		17.5	
	2021–22	9.0	8.5		17.5	
Total revised target		40.0	57.0[a]	Not applicable	97.0[a]	
Total target of JNNSM (in GW)				20	100[b]	

[a]Around 3 MW of solar capacity was installed before the JNNSM was initiated
[b]After the Revision of JNNSM target to 100 GW in 2015, phase wise breakups of targeted capacity have not been released by the government

11.6.2 Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI)

SRISTI programme has been proposed by the MNRE for implementation of rooftop solar PV plants. This programme focusses to ensure that the target of 40 GW from solar rooftops by 2022 is achieved smoothly (Government of India 2015b). The yearly targets for solar rooftops and the break-up based on the type of roof from various sectors like residential, commercial, government, industrial are given in Table 11.4.

The SRISTI programme has been formulated after considering the key learnings from the phase 1 of JNNSM. The prime focus is to reduce the complexities involved in the process of setting up rooftop solar systems. Accordingly, it has proposed to integrate the distribution companies (DISCOMs) as the primary implementation agency. The DISCOMs are likely to incur additional costs due to their responsibility towards capacity building, awareness programmes, etc. Therefore, performance-linked incentives will be provided to DISCOMs as a measure of compensation. It may be in the form of every MW capacity of solar energy added from rooftops (except for residential sector) into their distribution network. The residential sector is excluded as separate set of subsidies that have been announced for this sector. It is proposed that the funds linked to incentives will be released on a quarterly basis. This is an enabling policy instrument to ensure that

Table 11.4 Yearly targets for rooftop solar systems

Year	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	Total
Target (in MW)	200	4,800	5000	6000	7,000	8,000	9,000	40,000
Sector-wise targets (SRISTI programme)								
Commercial and industrial sector				20,000 MW				
Government sector				5,000 MW				
Residential sector				5,000 MW		Central financial assistance available per kW		
Institutional sector				5,000 MW				
Social sector				5,000 MW				

Note The sector-wise targets maybe modified based on the demand in respective sectors

DISCOMs take an active part in promoting and implementing rooftop solar systems.

Central Financial Assistance (CFA) Scheme for residential sector: As per the provisions of the Central Financial Assistance (CFA) for the residential sector, the consumers in the residential sector shall be eligible for a 30% subsidy (CFA) per kW with a limit of 50 kW. The CFA will be released directly to the DISCOM either on a bimonthly or quarterly basis. An advance amount of up to 30% of the total CFA can be availed by government-owned DISCOM. In the case of private DISCOMs, the same will be provided on submission of a bank guarantee. This amount will then be passed on by the DISCOMs to the channel partners. The financial impact of the SRISTI programme is estimated at Rs. 23,450 crores to the exchequer.

11.7 State-Specific Solar Policies in India

In accordance with the JNNSM, certain states in India have drafted their own solar policies to promote the renewable energy. Based on the solar irradiance, the states of Gujarat, Tamil Nadu, Rajasthan have capitalized on this energy reserve with the support of the central government after the inception of JNNSM in January 2011. The solar power policy of these states is discussed in the following paragraphs. The states have incorporated subsidies, over and above the subsidy given by the MNRE. The states have also embedded other policy instruments like FIT and net metering to promote renewable energy. The following policies have been discussed:

- Tamil Nadu Solar Energy Policy, 2012
- Rajasthan Solar Energy Policy, 2014
- Gujarat Solar Power Policy, 2015.

11.7.1 Tamil Nadu Solar Energy Policy, 2012

Tamil Nadu has a high solar radiation of 5.6–6 kWh/m^2/day with around 300 sunny days a year. The aim of this policy is to install 3000 MW of solar power by 2015. The state has mandated renewable purchase obligation[2] (RPO) starting with 3% till December 2013 and 6% thereafter. The RPO will be administered by Tamil Nadu Generation and Distribution Corporation (TANGEDCO). A target of 3.5 GW by 2022 through rooftop solar PV systems for Tamil Nadu has been set by MNRE (Government of India 2015c). In order to promote rooftop solar PV systems, subsidies and/or incentives have been provided in the policy.

For the residential solar rooftops, a state subsidy of Rs. 20,000 per kW has been provided up to 1 kW plants. This is in addition to the subsidy by MNRE. The surplus power exported into the grid is adjusted over a period of twelve months. Settlement for surplus power is done only up to 90% of the total power consumed from the grid. Any power in excess of this value is considered void and not applicable for any payment. The subsidy provision is applicable only for residential consumers.

The rooftop solar systems installed on industrial and commercial buildings are not eligible for subsidy, but they are given generation-based incentives (GBI) at a rate of Rs. 2 per unit (first two years), Rs. 1 per unit (next two years) and Rs. 0.5 per unit (subsequent two years). For industrial consumers, demand cut exemption to the extent of 100% of the installed capacity assigned for captive use purpose is allowed.

The other enabling mechanisms in the policy are in terms of "single window clearance" guaranteed through TEDA[3] in 30 days, so as to enable commissioning of plants in less than a year. All the solar power developers/producers are also eligible to avail CDM benefits to enhance the viability of the projects. On account of the political change and uncertainty in Tamil Nadu since 2016, the state solar policy has not been revised after its expiry in 2015.

11.7.2 Rajasthan Solar Energy Policy, 2014

Rajasthan has the highest solar radiation in India, ranging between 6 and 7 kWh/m^2/day for more than 325 sunny days a year. The state has a potential to generate 142

[2]The Renewable Purchase Obligations (RPO) has been the major factor in India to promote the renewable energy sector. Under the RPO, states are supposed to achieve certain targets, specified by Central government, by ensuring that their power-share comes from green or renewable sources. In case the states are unable to produce enough renewable due to any-reasons, they buy Renewable Energy Certificates (REC) to compensate for the lag in the target. The State Electricity Regulatory Commissions (SERCs) define their respective RPO Regulations. The 'obligated entities' for RPO are mostly electricity distribution companies and large consumers of power.

[3]Tamil Nadu Electricity Development Authority.

GW as estimated by National Institute for Solar Energy (NISE). The state solar policy has set an ambitious target of 25,000 MW capacity installation by 2024. The total installed capacity of rooftop solar PV systems in the state crossed 129 MW in September 2017. A major factor which has affected the installation of rooftop systems in Rajasthan is the absence of any subsidy or incentive for the residential sector. Although Rajasthan provides the highest FIT rate (Rs. 3.93/unit) for export of surplus power to the grid, the cost of installation is a big deterrent for consumers. The MNRE has set a target of 2.3 GW by 2022 through rooftop solar PV systems for the state of Rajasthan.

11.7.3 Gujarat Solar Power Policy, 2015

Gujarat was the first state in India to develop a solar policy in 2009, two years before the commencement of JNNSM. This provided Gujarat a head start in generation of renewable energy. The learnings from the 2009 policy have helped to draft the revised policy in 2015. The policy has been formulated in accordance with the Electricity Act-2003 and shall be applicable till 31 March 2020 (Government of Gujarat 2015). Gujarat Energy Development Agency (GEDA) and Gujarat Power Corporation Limited (GPCL) have been the designated as the state nodal and facilitating agency, respectively.

Gujarat is rich in solar energy resources with a high solar radiation between 5.5 and 6 kWh/m^2/day. The state has a potential to generate around 10,000 MW of solar energy. The target set by MNRE for Gujarat for rooftop solar PV systems is 3.2 GW by 2022. The state solar policy has differentiated between projects for the purpose of subsidy and incentives. The different types of solar power projects as classified by the local DISCOMs are depicted in Fig. 11.5.

The policy has set eligibility criteria for availing subsidies and incentives for rooftop solar PV projects. The main highlights of the criteria are as follows:

- The project proponent shall own or be in legal possession of the premises including the rooftop or terrace.
- The project proponent shall be a consumer of the local DISCOM, and the premises shall be connected to the DISCOM's grid.
- The project proponent shall consume all the electricity generated from the solar PV system at the same premises. If unable to consume all the generated electricity, relevant provisions as defined below shall be applicable to the generated surplus electricity.

Subsidy, Incentives and Feed-in Tariffs. The government of Gujarat and the MNRE provide subsidy towards installation of grid-connected rooftop solar PV systems. The benchmark cost set by Gujarat Energy Development Agency (GEDA) for the installation of 1 kW solar PV system is Rs. 69,000 as per the mandated specifications. The specification includes all equipment costs, installation costs and

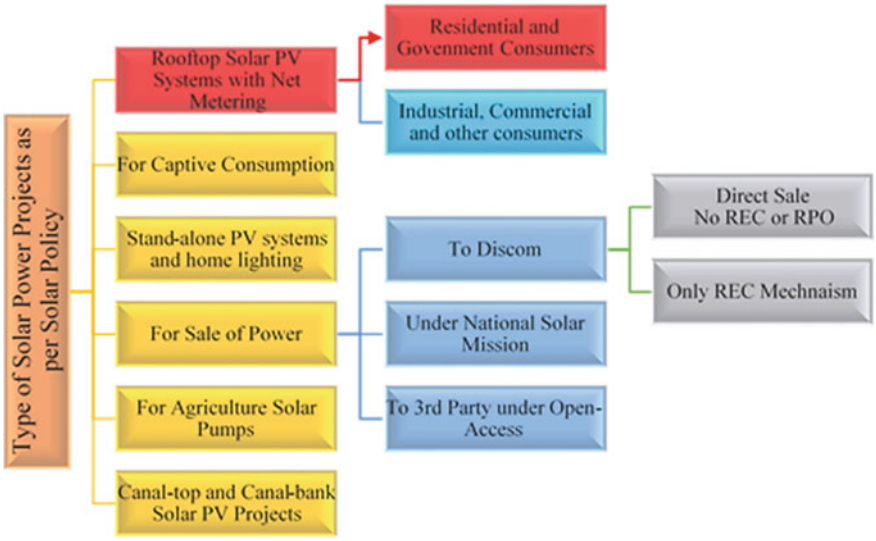

Fig. 11.5 Types of solar power projects in Gujarat. *Source* Adapted from Gujarat Solar Power Policy, 2015

the operation and maintenance (O&M) costs for 5 years. To the residential rooftop solar PV systems, the MNRE provides a subsidy at a rate of 30% of the total cost, amounting to Rs. 20,700 per kW, with a maximum limit of 50 kW. The state also provides an additional subsidy at a rate of Rs. 10,000 per kW, with a limit of 2 kW. The subsidy is directly provided to channel partners. This means that the residential consumer/beneficiary is required to pay only Rs. 38,300 per kW. The subsidies are not provided to commercial, industrial and institutional consumers by the state government and the central government. However, they are provided with the benefits of "accelerated depreciation".

In the case of net export of surplus power into the grid, from a residential rooftop solar PV systems, the DISCOM pays FIT to the household at a rate of Rs. 3.26 per kWh. For other rooftop solar PV systems, the FIT is higher at Rs. 6.61 per unit (in case of appreciated depreciation benefits) and Rs. 7.28 per unit (without appreciated benefits).

11.8 Conclusion

There is a global consensus on reducing the emission of GHGs and keeping the rise in temperature under check. The formation of policy and enabling instruments to promote clean energy will have a major impact in reducing pollution levels and decline in GHG emissions. Initiatives have been taken by many countries to

promote renewable energy and reduce their carbon footprint. Worldwide experience indicates that rooftop solar PV installations have played a significant role in increasing the share of solar power installations in Europe and Japan. In 2011, Germany added 60% of all solar generation capacity through rooftop solar PV projects. Today, Germany has more than one million rooftop solar PV installations. Likewise, Japan has seen growth primarily through rooftop solar PV installations and more recently by integrating solar cells into the building façades, sometimes complementing and in many cases completely replacing traditional view or spandrel glass. Some of the key factors supporting the expansion of rooftop solar PV installations are—the sector's ability to thrive under conducive policy and enabling regulatory environments; the non-existent threat of supply of encumbrance free land and the ability of rooftop solar PV projects to meet directly the power requirement, thus reducing transmission and distribution losses and thereby avoiding the expensive infrastructure required for power evacuation.

The global solar PV market grew significantly, by adding around 74.4 GW in 2016 alone. The growth was in spite of the fact that the two major contributors, Japan and Europe, did not add any significant capacity. Asia is ranked first for the fourth consecutive year with around 67% of the global PV market in 2016, up from 60% in 2015. China alone added 52 GW of installed capacity in 2017, and outside of China, the global PV market grew between 35 and 40 GW (IEA 2018).

India has committed to reducing its carbon footprint and has taken initiatives at all levels to promote renewable energy. The renewable energy includes solar energy, wind energy, bioenergy, hydropower. The solar energy has been focused in the chapter; reason being that this is the main focus sector in the National Action Plan for Climate Change. The national policy on renewable energy has set a target of 175 GW of renewable energy generation by 2022, out of which 100 GW is to be generated as solar energy. The generation of hydropower and wind energy is possible only at specific locations, whereas solar energy is available in most parts of the country, with a good radiation intensity, for the most part of the year, due to the country's geographic location. The initiatives to promote solar energy have been taken at all levels—from the central government to the state governments, local DISCOMs and the individual household level. The end users across industrial, commercial and residential sectors have been involved in the process of generating solar energy by offering certain incentives. The incentives have been built as the markets alone cannot solve the problem of GHG emissions related to energy production. The government has supported the shift to renewable energy by providing incentives in the form of subsidies, tax rebates, etc. The proposals like the SRISTI programme are a step in the right direction towards the promotion of grid-connected rooftop solar systems. This new scheme is a step forward in involving the DISCOMs as active participants in the implementation of rooftop solar systems by providing incentives towards the achievement of targets fixed by the MNRE. The continued increase in capacity addition of renewable energy will help the country to meet its international obligation of reducing the emission of GHGs.

References

Central Electricity Authority (2017) All India installed capacity—monthly report: December 2017, p 3

Central Electricity Authority (2018) All India installed capacity—monthly report: February 2018, p 3

DLA Piper (2012) Japan's renewable energy feed-in-tariff regime, Brisbane

Energiewende Team (2015) How is Germany integrating and balancing renewable energy today? https://energytransition.org/2015/02/how-germany-integrates-renewable-energy/. Accessed 02 May 2018

Goel M (2016) Solar rooftop in India: policies, challenges and outlook. Green Energy Environ 1:129–137

Government of Gujarat (2015) Gujarat Solar Power Policy—2015. Gandhinagar

Government of India (2015a) First Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, New Delhi, p 57

Government of India (2015b) SRISTI (Sustainable Rooftop Implementation for Solar Transfiguration of India)—318/331/2017-GCRT. Ministry of New & Renewable Energy, New Delhi

Government of India (2015c) Statewise and yearwise targets for installation of 40,000 MWp grid connected solar rooftop systems. Ministry of New & Renewable Energy, New Delhi

Greenpeace (2017) By 2030 China's wind and solar industry could replace fossil energy sources to the tune of 300 million tonnes of standard coal per year. http://www.greenpeace.org/eastasia/press/releases/climate-energy/2017/By-2030-Chinas-wind-and-solar-industry-could-replace-fossil-energy-sources-to-the-tune-of-300-million-tonnes-of-standard-coal-per-year/. Accessed 25 April 2018

Hill JS (2017) China officially installed 52.83 gigawatts worth of solar in 2017. https://clean-technica.com/2018/01/22/china-officially-installed-52-83-gw-worth-solar-2017-nea/. Accessed 02 May 2018

International Energy Agency (IEA) (2018) Snapshot of global photovoltaic markets—photovoltaic power systems programme. https://www.researchgate.net/publication/324703156_2018_SNAPSHOT_OF_GLOBAL_PHOTOVOLTAIC_MARKETS. Accessed 02 May 2018

International Energy Agency (IEA) https://www.iea.org/policiesandmeasures/pams/germany/name-21000-en.php. Accessed 12 April 2018

International Energy Agency (IEA) (2017) Key world statistics

Ministry of New & Renewable Energy (2015) Resolution No.30/80/2014-15/NSM

Morris C, Pehnt M (2016) The German Energiewende book. Heinrich Böll Foundation, Berlin

Pazheri FR (2014) Solar power potential in Saudi Arabia. Int J Eng Res Appl 171–174 (2014)

Renewables surpass other energy sources in capacity addition in FY17. https://www.livemint.com/Industry/yWPo2ZUyvn4hZPmQhtORoM/Renewables-surpass-other-energy-sources-in-capacity-addition.html. Accessed 23 April 2018

The state of the US solar industry: 5 questions answered. http://theconversation.com/the-state-of-the-us-solar-industry-5-questions-answered-90578. Accessed 30 April 2018

United States solar power rankings (2017). https://www.solarpowerrocks.com/2017-state-solar-power-rankings/#propexemption. Accessed 30 April 2018