CHAPTER-6

POLICY INTERVENTIONS

To boost the deployment of solar thermal energy technologies in India, the government needs to support industry partners through different measures; feed-in tariffs (FIT) reflecting the value of CSP, risk cover for innovative designs, project demonstrations, and financial incentives. This chapter discusses the current policies of various states focusing on solar energy and presents a state-wise analysis of renewable purchase obligations (RPOs) and renewable energy certificates (RECs). Further, suggestions have been provided to promote the integration of solar energy with thermal power plants to augment the power output of the existing plant. This chapter also provides future recommendations for promoting solar thermal power in India through appropriate policy enablers.

6.1 Introduction

The main emphasis of multifaceted climate mitigation discussions after the Kyoto Protocol in 1997 has been to curb the increasing carbon emissions from developing countries like China and India. A recent study showed that India and Bangladesh, and Mozambique have a high climate risk compared to Australia, the United Kingdom, and Canada (Alves et al. 2020). The largest source of greenhouse gas emissions in India is the electricity sector. India's power sector has the highest potential for emission reduction. It has been estimated that through the use of commercially available clean energy technologies, India could reduce carbon emissions by 30 to 50 percent by 2030 (McKinsey&Company 2009). The development and global adoption of low-carbon technologies is a demanding priority that has drawn increased attention to renewable energy sources that offer enormous potential for meeting the world's

energy needs with negligible carbon emissions (Ummadisingu and Soni 2011). India focuses on the transition from a fossil fuel-based burning economy to a low-carbon economy through increased use of renewable energy sources. To achieve this aim, India has set a colossal target of 175 GW of renewable energy capacity by 2022, one of the world's most extensive renewable programs. Financial hurdles will be crucial in achieving this mammoth target of 175 GW. Such a step change would require enormous implications for sustainability.

After Electricity Act 2003 and National Tariff Policy (NTP), 2006 came into force in India, clean energy deployment is predicted to be the best effective alternative to meet international agreement on climate change, to adopt a low-carbon energy pathway, expand energy access and ensure energy security. In order to expand renewable energy capacity and generation, several policy assistance instruments such as FIT, RPO, and REC have been introduced by the Government of India (GoI). The power utilities made power purchase agreements (PPA) to procure renewable energy at FIT. Still, the amount of electricity supplied from renewable sources is not yet equal to the potential of renewable energy in India (MNRE 2009). In addition to this, the fiscal constraints involved in integrating renewable energy into a conventional energy system make RPO targets an economic burden for electric utilities. However, RPO policy interventions' positive influence in enhancing the portion of low carbon supply was observed, with large-scale integration of clean energy sources in the Greek power sector (Voumvoulakis et al. 2012). Contaldi et al. evaluated green-certificates policies in Italy and deduced RECs' sustainability (Contaldi et al. 2007). Amrutha et al. studied the impact of RPO and REC policies on the total electricity supply portfolio and REC purchase portfolio in the Indian context (Amrutha et al. 2017).

Altenburg and Engelmeier (2013) explored how the Government of India (GoI) allots rents to boost generation through solar energy and addressed government failure and political capture. This study examined India’s solar energy policies from a rent management

perspective, particularly its National Solar Mission (NSM). Thapar et al. (2018) carried out an analysis of solar auctions in India and identified key determinants such as solar targets, utilities' credentials, and bid subscription level. Another study reviewed and discussed the drawbacks of the existing solar policy structure of sixteen major states of India and identified the solar sector's hurdles for achieving the targets (Tarai and Kale 2018).

To avert the impending climatic crisis, the growth of clean and sustainable energy technology is highly imperious. One of the most earnest investment alternatives is CSP technology that can provide about 7% of total projected electricity needs for the world by 2030 and 25% by 2050, considering high-energy saving and high-energy-efficiency scenario (Salvador et al. 2010). The only study of hybrid fossil-solar thermal plants for energy policymaking was performed by Bernardos et al. (2013) and concluded that parabolic trough collectors with molten salts could be used for hybridization with Brayton cycles.

Lilliestam et al. (2018) emphasized that CSP technology is one of the renewable energy technologies that can deliver large-scale dispatchable electricity and stated that unless expansion of this technology gains pace and cost reduction, the industry may downfall. The world may lose an essential technology for climate change mitigation. A recent study underlined major challenges in China that might hinder the future growth of solar energy (Li and Huang 2020). Musonye et al. (2020) stated that decision-makers will need to implement climate mitigation, techno-economic, environmental, and efficiency policies to curtail GHG emissions.

The above literature suggests that several studies have been performed which discuss policies related to solar PV, but the studies focused on policies regarding CSP technology are very scarce in the literature. There is only one study in the literature about energy policy related to hybrid fossil-solar thermal plants. Therefore, this chapter will discuss initiatives and policies regarding the use of solar energy taken by GoI and try to identify the policies

dedicated to solar thermal energy utilization to promote CSP technology. In addition to this, this chapter will also analyze state-wise RPO and REC policies and provide future recommendations for encouraging the utilization of CSP technologies to achieve India's low carbon energy goals.

6.2 Indian Power Sector Scenario

In India, both the central government and the state government have the authority to frame electricity-related legislation. The center and state governments have created electricity regulatory commissions to regulate the power sector. The total installed generation capacity as of 28th Feb, 2021 was 379 GW, with about 61.5% from conventional thermal sources followed by renewable (24.5%) and hydro (12.2%) sectors, as shown in Table 6.1. Power generation through these resources for May 2020 is also given in Table 6.1.

Figure 6.1 shows the distribution of grid-connected renewable power capacity installed in India as of 28th Feb 2021. The solar energy installed capacity (42.04%) is the highest, followed by the solar wind energy sector (41.72%), bio-power including waste to power (11.09%), and small hydropower (5.14%). The installed capacity of grid-connected solar energy at the end of March 2016 was 15.82%, while it has increased about 2.6 times by the end of 28th Feb 2021. To exploit the enormous solar potential, GoI came out with solar energy-specific policy mechanisms which are discussed in detail in the next section.

Figure 6.2 shows the structure of energy policy for solar energy in India. GoI has been encouraging renewable energy in the country through various policy enablers. The State Electricity Regulatory Commissions (SERCs) under the Electricity Act 2003 are required to provide apposite ways for grid connectivity and define remunerative tariffs to promote renewable energy technologies.

Table 6.1:

Source-wise total installed capacity and power generation in India (CEA 2021)

Energy Source	Installed Capacity (MW)	Generation (MU)
Coal	201084.50	69664.14
Lignite	6620.00	2991.19
Gas	24956.51	5227.27
Diesel	509.71	11.16
Nuclear	6780.00	3797.54
Hydro	46209.22	14026.13
RES (MNRE)	92970.48	13573.90
Total	**379130.41**	**109291.33**

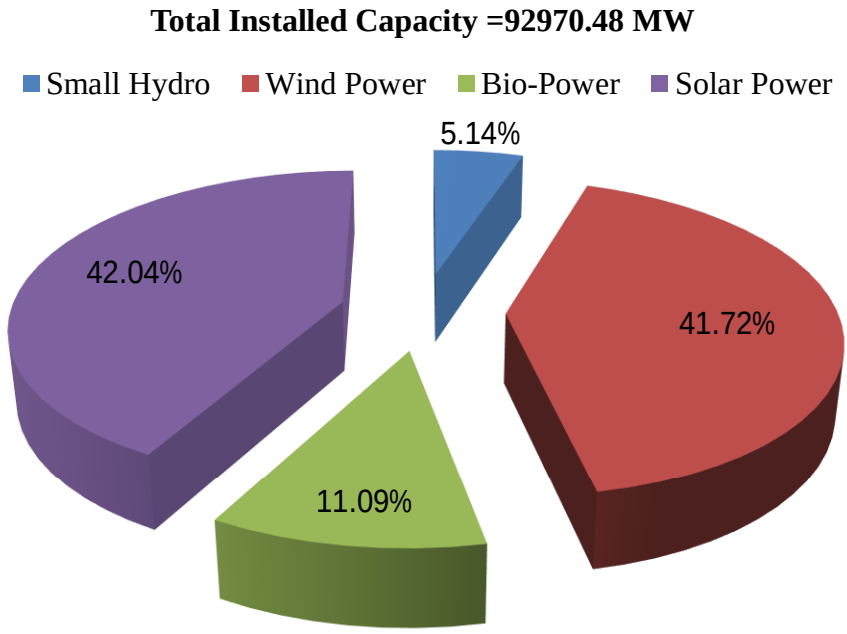

Figure 6.1: Distribution of India's grid-connected renewable power capacity in MW as of 28th Feb 2021 (CEA 2021).

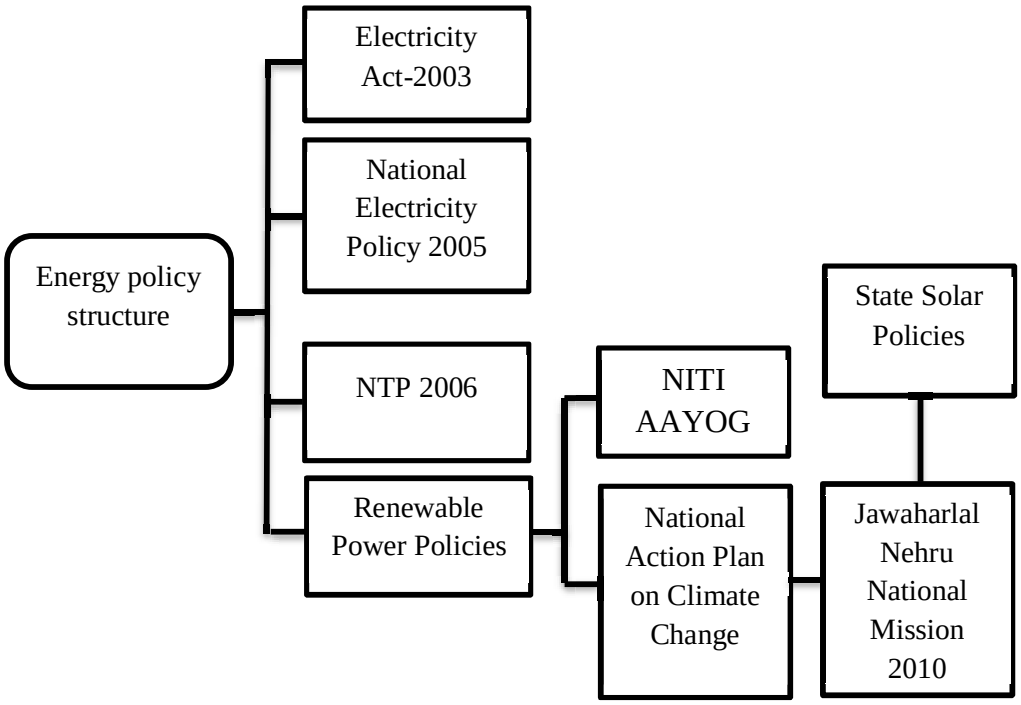

Figure 6.2: Structure of energy policy for solar energy in India (Tarai and Kale 2018)

According to NTP 2006, SERCs are required to fix a definite least percentage of electricity to be obtained from clean energy sources (IBP Inc. USA 2008); the acquiescence can be in terms of the actual procurement of renewable power or by the way of renewable energy certificates.

Solar energy potential based upon land availability and solar radiation in India has been assessed to be around 750 GWp (MNRE 2020). Table 6.2 shows state-wise details of estimated solar energy potential, cumulative installed capacity (as of 31st March 2019), and estimated cumulative solar capacity addition by 2022 (Energetica India 2016). Figure 6.3 shows the top 10 states with the highest solar installation capacity as of 31st March. With a solar potential of 24.7 GWp, Karnataka has the highest aggregate installed capacity of 6.09 GWp, followed by Telangana, which has 20.41 GWp of solar potential and installed capacity of about 3.59 GWp. Rajasthan despite having the highest solar potential of 142.31 GWp in the country, holds 3rd position with an aggregate installed capacity of 3.22 GWp in the state.

Table 6.2

State-wise estimated solar potential and solar capacity addition by 2022 in India (MNRE 2020)

S. N.	State/UT	Solar Potential (MWp)	Cumulative Capacity till 31-03-2019 (MW)	Capacity Addition by 2022 (MW)
1.	Andhra Pradesh	38440	3085.68	9834
2.	Arunachal Pradesh	8650	5.39	39
3.	Assam	13760	22.40	663
4.	Bihar	11200	142.45	2493
5.	Chhattisgarh	18270	231.35	1783
6.	Delhi	2050	126.89	2762
7.	Goa	880	3.89	358
8.	Gujarat	35770	2440.13	8020
9.	Haryana	4560	224.52	4142
10.	Himachal Pradesh	33840	22.68	776
11.	Jammu & Kashmir	111050	14.83	1155
12.	Jharkhand	18180	34.95	1995
13.	Karnataka	24700	6095.55	5697
14.	Kerala	6110	138.59	1870
15.	Madhya Pradesh	61660	1840.16	5675
16.	Maharashtra	64320	1633.54	11926
17.	Manipur	10630	3.44	105
18.	Meghalaya	5860	0.12	161
19.	Mizoram	9090	0.50	72
20.	Nagaland	7290	1.00	61
21.	Odisha	25780	394.73	2377
22.	Punjab	2810	905.62	4772
23.	Rajasthan	142310	3226.79	5762
24.	Sikkim	4940	0.01	36
25.	Tamil Nadu	17670	2575.22	8884
26.	Telangana	20410	3592.09	-
27.	Tripura	2080	5.09	105
28.	Uttar Pradesh	22830	960.10	10697
29.	Uttarakhand	16800	306.75	900
30.	West Bengal	6260	75.95	5336
31.	UTs	790	70.26	1078
	Total	**748980**	**28180.66**	**99534**

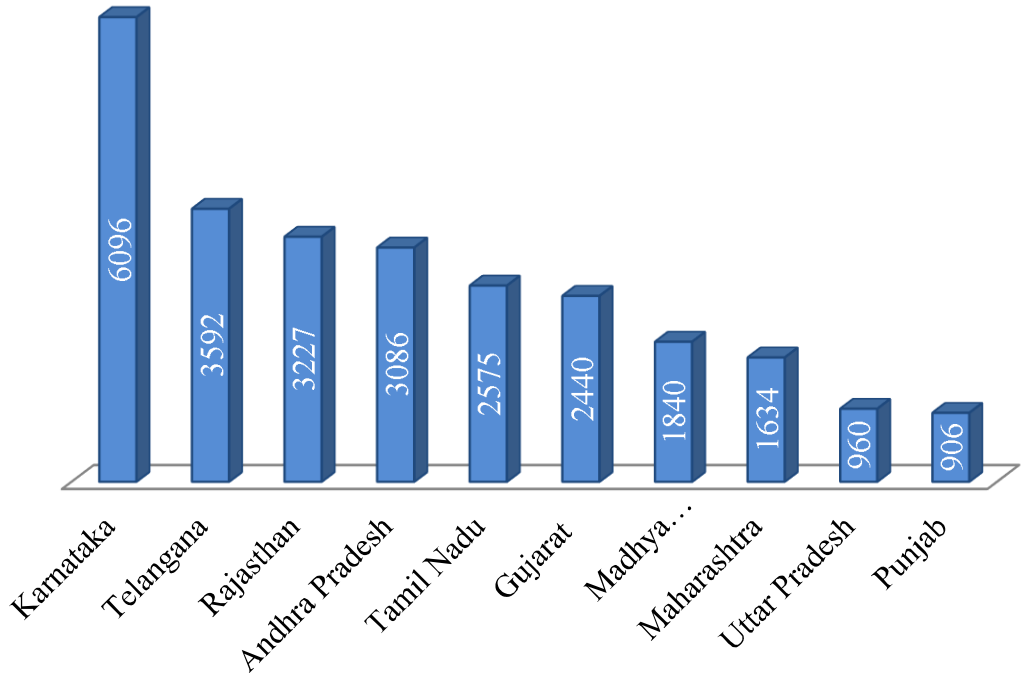

Figure 6.3: Top 10 States in solar installation, capacity in MW as of 31-03-2019 (MNRE 2020)

6.3 Government Initiatives for Renewable Energy: Policy Interventions in India

GoI has been promoting renewable energy through various policies and initiatives. In 1982, the Ministry of Energy created a separate Department of Non-Conventional Energy Sources to look after all the aspects of new and renewable energy. After a decade in 1992, the Department was upgraded into a separate Ministry of Non-Conventional Energy Sources and was renamed as the Ministry of New and Renewable Energy (MNRE), in October 2006. Recently, renewable energy has started playing a progressive role in increasing the grid power, providing energy access, plummeting consumption of fossil fuels, and assisting India to pursue its low carbon development path. Delineating the country's post-2020 climate actions ahead of COP 21; India submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change. India's INDC builds on its target of installing 175 GW of renewable power capacity by 2022. India has set a

target of increasing the country's share of renewable-based installed electric capacity to 40% by 2030. By 2030, the INDC also promises to reduce India's GHG emissions intensity per unit gross domestic product by 33 to 35% below 2005 levels (MNRE 2021).

6.3.1 Regulatory reforms and policy initiatives

Electricity Act-2003

The Electricity Act-2003 was the first comprehensive legislation in the new regulatory framework for developing renewable resource-based electricity in India. In addition to establishing laws for generation, transmission, and sharing utility of electricity, this act aims to promote and rationalize electricity policies and tariffs in the nation, introduce competition, protect consumer's interests, and provide power for all. This act paved the path for building captive renewable power plants and third-party sales, and it created specific policy mechanisms, including preferential tariffs or FITs, RPOs, and tradable RECs. This Act mandated the SERCs to grid connectivity of electricity generated from renewable sources through tariff regulations and to specify the minimum purchase obligation of renewable power (Sawhney 2013). Keeping in view the need for the country's energy security, the policy framework of GoI also focuses on the encouragement of renewable energy sources (CERC 2010).

National Electricity Policy (NEP) 2005

The NEP was formulated in 2005 to supply quality and reliable power to the entire household in India at higher efficiency and reduced prices. The NEP stated that the DISCOMs should purchase renewable power through a competitive bidding process. Further, it specified that the relevant commission has the authority to determine preferential tariffs for electricity derived from renewable energy sources to achieve grid parity. In addition to this, the policy

imposes the state electricity boards to specify targets for renewable energy production and installation.

National Tariff Policy (NTP) 2006

In January 2006, the Ministry of Power (MoP) announced the National Tariff Policy (NTP) 2006 with an objective to provide electricity to all consumers at a reasonable and competitive price by promoting competition in efficiency and improvement in the quality of supply operations. The latest amended version of NTP in 2016 promotes the generation of electricity from renewable sources. The revised NTP has a provision of 8% of solar RPO by 2022 (MNRE 2020).

National Action Plan on Climate Change (NAPCC) 2008

The NAPCC was released on 30th June 2008 to focus on future policies and programs for climate change, adaptation, and mitigation. To promote India's sustainable development objectives, the NAPCC has identified eight core national missions (Faith 2020). The NAPCC proposed a target of 5% renewable energy purchase for 2009-10 with an increase of 1% each year for ten years to reach a target of 15% of renewable energy by 2020 (Government of India 2008).

Besides the larger context of the Electricity Act, policies targeting specific renewable energy sources such as solar, wind, biomass, and small-hydro are functioning at both center and state level. The primary emphasis in subsequent sections of the paper will be confined to the policies related to solar energy exploitation.

Jawaharlal Nehru National Solar Mission (JNNSM) 2010

The GoI launched JNNSM in January 2010 to encourage the development of solar energy for grid-connected and off-grid power generation. The primary objective of JNNSM is for solar

power to achieve parity with coal-based thermal power by 2030 and overall grid parity by 2020. The mission plans to achieve its objectives which spans over three phases: Phase I (2009-12), Phase II (2012-17), and Phase III (2017-20). The goal under JNNSM for 2030 is 100 GW of solar capacity which would constitute 10-12% of total power generation (Sawhney 2013).

` Other supporting policies under the National Solar Mission (NSM) include fiscal investment incentives, generation-based incentives, and subsidies. For example, a ten-year tax holiday will be provided to utility-scale solar plants set up by 2020 to encourage solar power capacity installation. Another vital goal of JNNSM is to make India a global leader in solar energy by increasing confidence in power developers, stimulating manufacturing in solar sectors, and installing large-scale solar projects with a suitable policy framework. Solar Energy Corporation of India and NTPC Vidyut Vyapar Nigam Limited (NVVN) are the executing bodies for JNNSM (Kaladharan 2016).

National Institution for Transforming India (NITI) Aayog

NITI Aayog was established on 1st January 2015, replacing Planning Commission with the aim to achieve sustainable development goals with cooperative federalism by fostering the involvement of State Governments of India. NITI Aayog aims to design strategic plans for long-term policy, program framework with initiatives, and monitor progress and efficiency. For the implementation of programs and initiatives throughout the country, NITI Aayog focuses on technology up-gradation and capacity building (Faith 2020).

Solar Parks and Solar Cities

The government has taken another initiative to develop solar parks and solar cities to promote solar power projects. The scheme for the development of Solar Parks and Ultra Mega Solar

Power Projects was released on 12th Dec. 2014 with a cumulative capacity of 20 GW. Further, this capacity was increased from 20 GW to 40 GW on 21st March 2017 to set up at least 50 solar parks by 2021-2022. Solar projects of cumulative capacity 5835 MW have been commissioned inside various solar parks till March-2019 (MNRE 2020).

The initiative for the development of solar cities across the country was taken in the year 2013-14. A total of 60 cities are proposed to be developed as solar cities. The objectives of this program are to empower the local government to address the energy challenges at the city level, to estimate future demand, to create awareness among people about solar energy, and to involve stakeholders in the planning process (Rathore et al. 2018). The role of central and state government agencies in policy development, regulation, and promotion of renewable energy is presented in Table 6.3.

6.3.2 Comparison of state-wise solar policies in India

The major initiative towards the development of a large-scale solar power sector is the launching of a web-based portal known as solar guidelines. It is a web-based platform designed for easy access to the information by local and international solar power investors. This initiative is taken jointly by MNRE and the German Ministry of Environment, Nature Conservation, and Nuclear Safety. This platform is for the growth and development of solar power projects in India. Its main objective is to create a single-window clearance system regarding policy framework, contracts, government approval, and any other bottleneck formality that delays the power project's commissioning (Rathore et al. 2018).

Table 6.4 (a, b, c) provides a comprehensive comparison based on important parameters of state government policies for solar power (IREDA-Government of India 2015). For CSP technologies, the support among solar state policies is negligible.

Table 6.3

Role of central and state government agencies in policy growth (Kaladharan 2016)

Level	Central Government	MNRE	CERC
Central	▪ Develop national electricity tariff policies which include renewable energy ▪ Provides fiscal incentives to promote renewable energy	▪ Develops national renewable energy laws ▪ Sets technical standards for renewable energy ▪ Conducts resource assessment and supports R&D in clean energy technologies ▪ Promotes effective use of information technology for renewable energy, manages database ▪ Reviews clean energy programs to comprehend their usefulness and competence	▪ Sets guidelines for FIT design for different clean energy technologies ▪ Controls the regional electricity corporation mechanism ▪ Controls inter-state open access and third party sales
	State Government	**State Nodal Agency**	**SERC**
State	▪ Develops state-level renewable energy policy ▪ Provides financial incentives for promoting renewable sources within the state	▪ Conducts resource assessment for various renewable energy sources ▪ Assigns renewable energy projects and monitors progress ▪ Assists clearances and land procurement ▪ Raise consciousness and educates the masses about the use of renewable energy ▪ Keep up renewable energy sources database	▪ Determines FIT for different clean energy technologies ▪ Determines RPOs and enforcement mechanisms ▪ Sets regulations on intra-state wheeling, open access, and third-party sale

6.3.3 Institutional framework/policy structure for concentrated solar thermal (CST) in India

CST technologies exploit solar energy to generate thermal energy or electrical energy for use in industry, residential, and commercial sectors. According to MNRE annual report, a total of 318 CST projects are under various phases of execution, representing an area of 73764 m^2, and the completed projects occupy an area of 55578 m^2. The total energy generation potential of completed projects is 39 $MW_{th,}$ and the roadmap targets the further implementation of 161 MW_{th} by 2022 (MNRE-UNIDO 2017).

Table 6.5 shows the status of CSP projects sanctioned in JNNSM phase-I, Batch-I which includes total of ten projects. The last three projects in Table 6.5 are migrated under JNNSM Phase-I through the Migration scheme (Bhushan et al. 2015). Out of these ten projects, only three projects have been commissioned with full capacity so far. While one project ACME Solar is functioning with reduced capacity. The remaining CSP projects are at different stages of execution and are far behind schedule.

In Phase-II, MNRE has decided to reduce the share of CSP to 30% because of poor performance in JNNSM Phase-I. In the backdrop of recognized societal benefits attached to CST technology, GoI has constantly been promoting the deployment of this technology. In this regard, the two crucial initiatives comprise Accelerated Depreciation (AD) in the income tax (IT) Act and the reimbursement of subsidy from MNRE.

Depending on the technology implemented, the subsidies provided by MNRE are 30% of the project costs. In a special category state like Uttarakhand, Himachal Pradesh, and North-East states, there is an additional subsidy of 30%. Under the provision of AD benefits, the system beneficiaries can avail AD of up to 40% per annum on systems implemented.

Table 6.4a:

State government policies for solar energy (IREDA-Government of India 2015)

Description	Andhra Pradesh	Assam	Bihar	Chhattisgarh	Delhi	Goa	Gujarat	Haryana	Himachal Pradesh
	Solar Policy	Solar Policy	Renewable Energy Policy	Solar Policy	Solar Policy	Solar Policy	Solar Policy	Solar Policy	Solar Policy
Order Date	Jan., 2019	Jan., 2018	Feb., 2017	2012	Sept., 2016	Feb., 2019	Aug., 2015	March, 2019	Jan., 2016
Nodal Agency	NREDCAP	AEDA	BREDA	CREDA	EE&REM	GEDA	GEDA	HAREDA	HIMURJA
Operative Period	5 Years	3 Years	5 Years	5 Years	5 Years	7 Years	5 Years	5 Years	7 Years
Target (in MW)	5000	590	1000	1000	1000			3200	700
Registration Fee	₹ 1000 (≤ 5 kWp) ₹ 5000 (5-100 kWp) ₹ 10000 (100 kWp-1 MWp) ₹ 25000 (> 1 MWp)	₹ 1000 (≤ 5 kWp) ₹ 3000 (5- 100 kWp) ₹ 12000 (100-500 kWp) ₹ 18000 (500 kWp-1 MWp) ₹ 25000 (> 1 MWp)	₹ 100 per kWp, Min. - ₹ 2000/Project, Max. - ₹ 10000/Project					No fee for captive use power plants under net-metering systems	₹ 5000 (1 MWp) ₹ 25000 (5 MWp-5 MWp)
Incentives	COD -10 Years								
Electricity		Exempted		Exempted			Exempted		

Description	Andhra Pradesh	Assam	Bihar	Chhattisgarh	Delhi	Goa	Gujarat	Haryana	Himachal Pradesh
Duty		within state for 3 Years		within state					
Wheeling		Not applicable within state	Not applicable	As per CSERC	As per DERC	As per JERC	As per GERC	Exempted for 10 Years	
Cross-Subsidy		Exempted within state for 3 Years	Exempted within state	As per CSERC	As per DERC		Exempted	Exempted for captive use	
T&D Charges	Exempted within state	Not applicable within state	Exempted	As per CSERC	As per DERC		As per GERC	Exempted for 10 Years	
Open Access Charges	As per APERC				Exempted			As per HERC	
Supervision Charges				Exempted, If developer lay evacuation					
Banking Charges at the point of Drawing	5%		2%	As per CSERC				only for captive/third party sale; Charges-2%	
Land	Project developer to acquire land; Land cost revenue-10% of market value till 10	As per SPGs	Project developer to acquire land	Project developer to acquire land		2% of usable area; Max. area - 200 m^2/MW	Project developer to acquire land	Rent/Lease for 30-Years;	Max. land-per MW capacity shall be 2.5 Hectare

Description	Andhra Pradesh	Assam	Bihar	Chhattisgarh	Delhi	Goa	Gujarat	Haryana	Himachal Pradesh
	Years								
Tenure of PPA		25 Years		25 Years	25 Years	25 Years		25 Years	
Residential		8 MW (Goal)						3% to 5% of connected load ≥ 500 Square Yard	
Subsidy						50% of capital cost			
Rooftop Solar System Capacity		Min. – 1kWp Max. – 1000 kWp			≥ 1 kWp		1 kW to 1 MW		Net-metering, Min.-1 kW, Max.-1 MW

— Commercial Operation Date (COD), Transmission and Distribution charges (T&D) charges, Solar Power Generators (SPGs)

— NREDCAP - New & https://nredcap.in/PDFs/Pages/AP_Solar_Power_Policy_2018.pdf)

— AEDA - https://www.aegcl.co.in/06022018Gazette-Solar_Policy.pdf)

— BREDA - http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Bihar/1-RE%20Policy%20BREDA/1%20Summary%20Bihar%20renewable%20Energy%20Sources%20Policy%202017%20BREDA.pdf)

— CREDA - http://www.ireda.in/writereaddata/CompendiumStatePolicyRE/Data/CH4.pdf)

— EE&REM - Energy Efficiency and Renewable Energy Management Centre http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Delhi/1%20Summary%20Delhi%20Solar%20Policy%202016.pdf)

— GEDA - http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Goa/1-Solar/Goa%20Solar%20Policy%20New.pdf)

— GEDA - https://geda.gujarat.gov.in/Gallery/Media_Gallery/2gujarat_solar_power_policy_2015.pdf)

— HAREDA - *Haryana Renewable Energy* Development Agency http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Haryana/March2019/Haryana%20Solar%20Power%20Policy%20Summary.pdf)

— http://himurja.hp.gov.in/wp-content/uploads/2018/08/SPP-2016.pdf)

Table 6.4b:

State government policies for solar energy (IREDA-Government of India 2015)

Description	Jammu & Kashmir	Jharkhand	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Manipur	Mizoram	Puducherry
	Net - Metering	Solar Policy	Solar Policy	Solar Policy	Solar Policy	Renewable Energy Policy	Solar Policy	Solar Policy	Solar Policy
Order Date	Feb., 2017	Aug., 2015	Nov, 2018	Nov., 2013	2012	July, 2015	Dec., 2014	Feb., 2017	March, 2016
Nodal Agency	JAKEDA	JREDA	KREDL	ANERT	MPNRED	MEDA	MANIREDA	ZEDA	REAP
Operative Period	10 Years	Until modified	7 Years	Until modified	Until modified			Until modified	
Target (in MW)	450	2650	6000	2500		7500	5	80	
Registration Fee	₹ 100 per kWp, Max. - ₹ 10000		₹ 1000 (5-50kWp) ₹ 2000 (> 50kWp)		As per MPNRED		₹ 500 per kW; Max. - ₹ 50000/project		
Incentives		COD-10 Years							
Electricity Duty	As per gov. of J&K	Exempted for 10 Years		Exempted	Exempted for 10 Years	Exempted for 10 Years		Exempted	
Wheeling	Exempted	4%	As per KERC	Exempted for captive plants	As per MPERC	As per MERC			Exempted
Cross-Subsidy	Exempted	Exempted	As per KERC			As per MERC		As per JERC	Exempted
T&D Charges		Exempted for Distribution		Exempted for captive plants	As per MPERC				

Description	Jammu & Kashmir	Jharkhand	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Manipur	Mizoram	Puducherry
		Losses for projects injecting at 33 kV or below							
Open Access Charges		Clearance for 25 Years	Exempted within state	No charges		As per MERC			Exempted
Supervision Charges			5% reduction	Exempted, If developer lay evacuation		Exempted			
Banking Charges at the point of Drawing	Exempted	2%	As per KERC	Available only for captive Generators	2%	As per MERC			Exempted
Land			Project developer to acquire land	Deemed conversion of land for SPPs	4 Hectare of land for the grid connected SPP up to 4 MW Capacity			Maxi. 5 acre/MW for 30 Years for Solar Park, otherwise on lease basis	
Tenure of PPA		25 Years							
Residential				2000-3000 square ft.- 100 liter Solar Water					

Description	Jammu & Kashmir	Jharkhand	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Manipur	Mizoram	Puducherry
				Heater					
Subsidy	As per gov. of J&K Rooftop	As per JREDA					Applicable		
Rooftop Solar System Capacity	Net-Metering, Min. – 1 kWp, Max. – 1000 kWp	Min. Size - SPV-1MW; Rooftop SPV-1kW				Min. - 1 MW	Min. - 1 kW, Max. – 500 kW	Min. - 1 kWp	

- JAKEDA - http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Jammu%20&%20Kashmir/1-Net%20Metering/2%20Order%20Solar%20Rooftop%20Policy%20(JAKEDA)%20approved.pdf)
- JREDA - http://www.ireda.in/writereaddata/CompendiumSolar2016/Data/Jharkhand.pdf)
- KREDL - http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Karnataka/1-Solar/Kranataka%20SP%20Summary%20.pdf)
- ANERT - Agency for Non-conv https://www.anert.gov.in/sites/default/files/inline-files/go_20131125_pd-49-p_solarenergypolicy2013.pdf)
- MPNRED - Madhya Pradesh New and Renewable Energy Department http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Madhya%20Pradesh/1-Solar/1%20Summary%20MP%20Solay-Policy%202012.pdf)
- MEDA - https://www.iea.org/policies/6217-maharashtra-renewable-energy-policy-2015?country=India%2CUnited%20States&topic=Renewable%20Energy)
- MANIREDA - **Manipur Renewable Energy** http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Manipur/1-Solar/1_Manipur%20Solar%20Policy-2014.pdf)
- ZEDA - Zoram Energy Development Agency http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Mizoram/MizoramSolarPolicy/Solar%20Power%20Policy%20of%20Mizoram-2017%20OO.pdf)
- REAP - Renewable Energy Agency Puducherry http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Puducherry/1%20Summary%20Puducherry%20Solar%20Energy%20Policy-2015.pdf)

Table 6.4c:

State government policies for solar energy (IREDA-Government of India 2015)

Description	Punjab	Rajasthan	Tamilnadu	Telangana	Uttar Pradesh	Uttarakhand	West Bengal
	Net -Metering	*Solar Policy*	*Solar Policy*	*Solar Policy*	*Solar Policy*	*Solar Policy*	*Renewable Energy Policy*
Order Date	Nov., 2014	Oct., 2014	Feb, 2019	2015	2017	June, 2013	June., 2012
Nodal Agency	PEDA	RREC	TEDA	TNREDCL	UPNEDA	UREDA	WBREDA
Operative Period				5 Years	5 Years	Until modified	
Target (in MW)	1000		9000		4300	500	500
Registration Fee	₹ 50 per KVA	₹ 50000/MW Max. - ₹ 30 lac/project		₹ 10000/MW Max. - ₹ 2 lac/project			
Incentives				COD - 10 Years			
Electricity Duty			Exempted for 2 Years	Exempted within state	Exempted for 10 Years within state		
Wheeling	Exempted		< 1 MW shall not considered	Exempted within state	Exempted of 50%	As per UERC	
Cross-Subsidy	Exempted			Exempted within state	Exempted	Exempted for open access	
T&D Charges				Exempted within state	Exempted within state	As per UERC	
Open Access Charges	Exempted	As per RERC regulations		As per TSERC		As per UERC	As per WBERC

Description	Punjab	Rajasthan	Tamilnadu	Telangana	Uttar Pradesh	Uttarakhand	West Bengal
Supervision Charges	Max. - 5% of deposit						
Banking Charges at the point of Drawing	Exempted	As per RERC regulations		2%	As per UPERC		As per WBERC
Land		SPV on Crystalline with or without tracker - 3.5 Hect./MW		Price - 5 acres/ MW	As per State Govt.	2.5 Hect./ MW (for agriculture land - Exempted from paying any conversion rate)	
Tenure of PPA	25 Years						
Residential							
Subsidy	As per nodal agency				₹ 15000/kW to a max. limit of ₹ 30000/consumer		
Rooftop Solar System Capacity	Min. – 1 kW, Max. – 80% of sanctioned connected load				Min. – 5 MW for large scale standalone projects		5-10 MW

— PEDA - http://peda.gov.in/main/pdf/notification-net%20metering.pdf)

— RREC - http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Rajasthan/1-solar/1%20Summary%20Rajasthan%20Solar%20Policy%202014.pdf)

— TEDA - Tamilnadu Energy Development Agency http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Tamil%20Nadu/TamilNaduSolarPolicyMarch-2019/Tamil%20Nadu%20Solar%20Policy%20Summary.pdf)

— TNREDCL - Telangana New and Renewable Energy Development Corporation Limited https://www.tssouthernpower.com/ShowProperty/CP_CM_REPO/Pages/Hotlinks/TelanganaSolarPowerPolicy/TelanganaSolarPowerPolicy)

— UPNEDA - Uttar Pradesh New and Renewable Energy Development Agency http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Uttar%20Pradesh/1-Solar/1%20summary%20UP%20Solar%20Policy-2017.pdf)

— UREDA - Uttarakhand Renewable Energy Development Agency http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Uttarakhand/1%20Summary%20Solar%20Energy%20Policy%20of%20Uttarakhand-2013.pdf)

— WBREDA – http://www.wbreda.org/wp-content/uploads/2012/06/policy-renewable-wb.pdf)

Table 6.5:

Status of CSP projects sanctioned in JNNSM Phase-I, Batch-I (Bhushan et al. 2015)

Sr. No.	Project	Tariff Quoted (Rs./kWh)	Size and Technology	State	Status
1.	Lanco Solar "Diwkar"	10.49	100 MW Parabolic trough with 4-hour storage	Rajasthan	Land leveling has been done, looking for buyers
2.	KVK Energy Ventures	11.20	100 MW Parabolic trough	Rajasthan	Under construction
3.	Reliance Power	11.97	100 MW Linear Fresnel	Rajasthan	Commissioned in November 2014
4.	Corporate Ispat Alloy	12.24	50 MW Parabolic trough	Rajasthan	Under construction
5.	Godawari Green	12.20	50 MW Parabolic trough	Rajasthan	Commissioned in August 2013
6.	Aurum	12.19	20 MW Parabolic trough	Gujarat	Land leveling done, orders placed for most equipment
7.	MEIL Green Power	11.31	50 MW Parabolic trough	Andhra Pradesh	Commissioned in November 2014
8.	ACME Solar	13.45	10 MW Solar Tower	Rajasthan	Only 2.5 MW have been commissioned
9.	Entegra	-	10 MW Parabolic trough	Rajasthan	Not even broken ground
10.	Dalmia Cement	19.03	10 MW Sterling Dish	Rajasthan	Still under development

In addition to power generation, CST technologies can also help in saving fuel used for a variety of industrial, commercial, institutional, and residential applications such as community cooking, process heating, and space cooling, water desalination, etc. (Wang et al. 2020). Industries such as food processing, dairy, chemicals, textiles, pharmaceuticals, fertilizers, and rubber show vast potential for implementing CST technologies. To promote and commercialize CST technologies, MNRE provides financial support through subsidy and has launched several projects in association with United Nations Development Programme and United Nations Industrial Development Organization. These projects have been implemented through financial support from MNRE. Some successful selected projects under this scheme include; Salem Dairy in Tamil Nadu uses concentrating solar steam for milk pasteurization, Nareshwadi Learning Centre in Maharashtra uses solar concentrator for a community kitchen, Unique Biotech Ltd. Hyderabad, a pharmaceutical industry uses CST for medicine preparation and sludge drying, Goodricke tea plant in West Bengal uses CPC based system for drying application and 100 TR capacity solar steam based air conditioning system at Muni Seva Ashram near Vadodra, Gujarat. The industries have benefited from government policies for installing CST projects (Sun Focus 2016). The financial initiatives from MNRE include payment of subsidy and allowance of AD in income tax. The 40% depreciation benefit is allowed for the first year and 40% benefit on the remaining value for subsequent years.

The umbrella of institutional framework for the development of industrial CST technologies in India includes MNRE as the central Ministry with the accountability of policymaking and administration. Flowchart shown in Figure 6.4 describes overall institutional framework with both accredited and autonomous technical, project implementation, policy level, and financing agencies that support the growth of CST technologies in India.

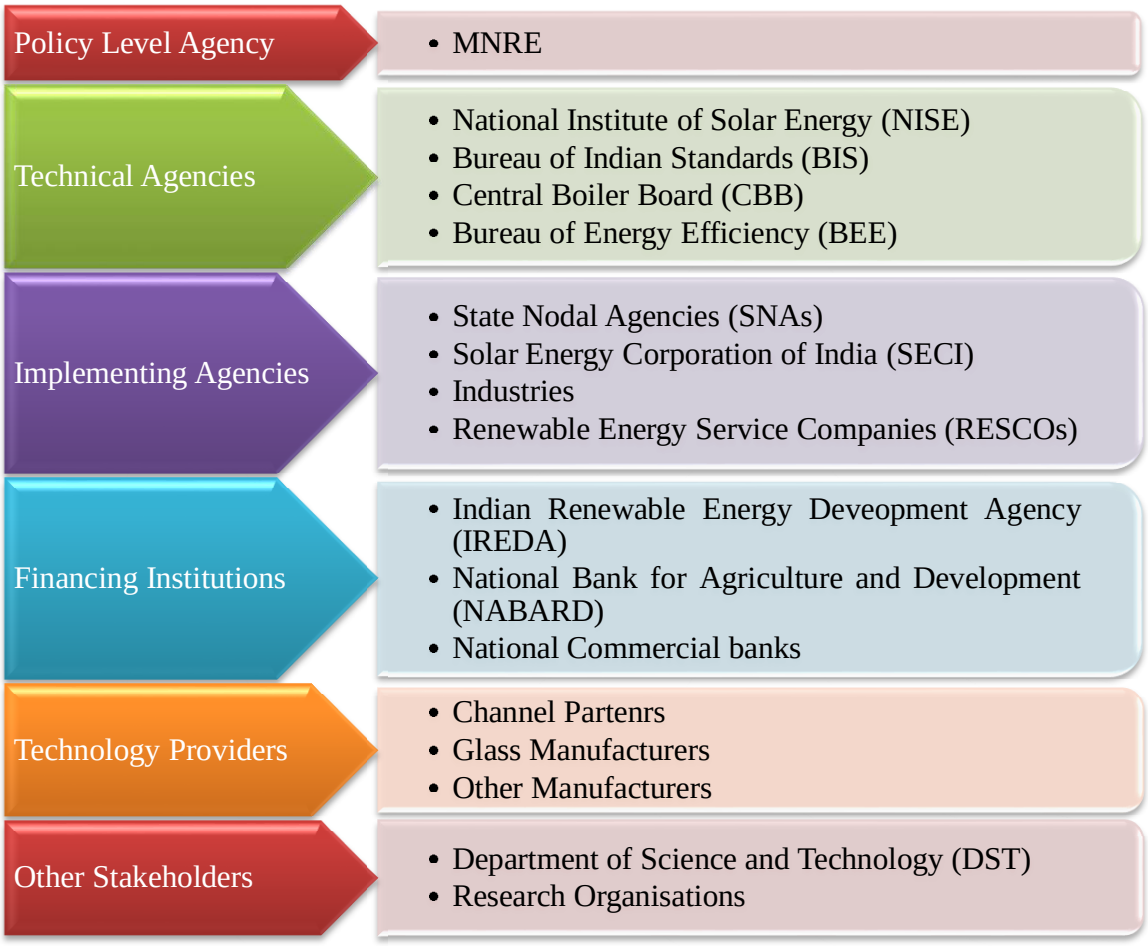

Figure 6.4: Institutional framework for the development of CST technologies (MNRE-UNIDO 2017)

6.4 REC/RPO Policy Implications and Compliance

6.4.1 Renewable energy certificate (REC) framework

In India, the concept of REC was introduced in November 2010. It is based on the REC regulations notified by CERC on January 14, 2010. REC framework is a market-based pan India policy designed in a way to promote renewable energy and facilitate the compliance of RPO by obligated entities. As the renewable energy (RE) sources in India are not uniformly spread across

different states, and the high cost of generation from RE sources restricts the states from complying with their RPOs. The REC framework aims to address the mismatch between the availability of RE sources in the state and the requirement of obligated entities to accomplish their RPOs by purchasing REC. In denomination, one REC is treated as equivalent to one MWh injected into the grid. The REC framework comprises of four main processes viz. Accreditation, Registration, Issuance, and Redemption of RECs and for the detailed procedure about these processes, the readers can refer CERC website. In line with RPO, there are two categories of RECs – Solar RECs and Non-Solar RECs (Baba 2018). This chapter will focus only on solar RECs. CERC notifies the forbearance price and floor price of solar and non-solar RECs from time to time.

Recently, CERC issued a draft regarding the revision of forbearance and floor price of RECs. Under the REC regulations, the proposed forbearance price is ₹ 1000 each for solar and non-solar REC for the year 2020, against 2017's prices of ₹ 2400/MWh and ₹ 3000, respectively. In its proposal, CERC has marked the floor price as zero for the year 2020 against the prices of 2017, which were ₹1000/MWh each for both solar and non-solar REC (Recconect Energy 2020). The technology-wise breakup RECs is shown in Table 6.6. Till date, 6,66,95,499 RECs have been issued since the inception of the REC mechanism in India, and a total of 6,08,81,938 RECs have been redeemed through power exchanges and self-retention. It can be seen from Table 6.6 that neither a single project is registered under REC framework nor a single REC has been issued since the inception of REC mechanism in pan India for solar thermal and geothermal technology.

The details of accredited, registered, number of RECs issued since inception, redeemed (through power exchanges and self-retention), and available for trade with power exchanges for Solar PV technology are also given in Table 6.6. Since the inception of the REC framework, a

total of 376 projects from 12 states with 851.112 MW capacity have been registered under the REC mechanism as of April 25, 2020, the details of the same are given in Table 6.7.

As discussed above CST technologies find vast applications in a variety of industrial processes such as space heating and cooling, water heating, drying, cooking, dairy processing, food processing, and beverages, etc. The industries require a large amount of process heat for different purposes. If this process heat is produced using CST technologies, then such sectors can register for issuance of tradable solar RECs. For including process heat under REC mechanism, it is necessary to find out how much thermal energy input is required to generate 1 unit of electricity. Generally, 1 kW thermal energy is needed to generate 1 kWh of electricity if the conversion has no inefficiencies. Thus, if the process's conversion efficiency is known, then its equivalent electricity generation capacity can be obtained. Based on the units of electricity generated by a process heat industry, the industry can be allowed to issue REC. Similarly, the industries, hospitals, and hotels using solar hot water systems also help in saving conventional fuels and reduce environmental pollution. A 100-liter capacity solar hot water system can save upto1500 units of electricity annually (Solarthermalworld 2015). Indian government should bring process heat collected through solar energy in industries, hospitals, and hotels under REC Mechanism in policies for promoting CST technologies' deployment.

6.4.2 Renewable purchase obligations (RPOs) targets and compliance

RPO is a mechanism under the Electricity Act-2003 and NTP-2006, by which obligated entities are bound to purchase a certain percentage of electricity (as a percentage of the total consumption of electricity) from renewable energy sources. To create demand for renewable energy, RPO is

being implemented throughout the country. RPOs are of two types; Solar and Non-Solar, and the present study will focus only on Solar RPOs. Pursuant to the amendment of the Tariff policy in January 2016 (MoP 2016), the SERCs are required to reserve a minimum purchase of solar energy as 8% of the total consumption of energy excluding hydropower by March 2022. In July 2018, GoI notified the long term growth trajectory of RPOs for Solar as well as Non-Solar, uniformly for all States/Union Territories, setting a target of 21% RPO by 2022, divided equally between solar power (10.5%) and non-solar power (10.5%, mainly wind) (Energetica India 2016). As per RPO targets, the obligated entities such as DISCOMs, Open Access (OA) consumers, and Captive Power Producers (CPP) are enforced to purchase a minimum share of their electricity from renewable sources of energy. The state-wise solar RPO targets from 2016-17 to 2021-22 are shown in Table 6.8 (Energetica India 2016, PEG 2020).

In Mizoram, Nagaland, and Uttar Pradesh, no regulations have been notified regarding RPO by their respective state electricity regulatory commissions. Only a few states like Andhra Pradesh, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Rajasthan, and Uttarakhand have modified the definition of RPO to exclude electricity consumption from hydro sources. Besides these states, Telangana is presently following the existing RPO-related regulations of Andhra Pradesh. Although the target of increasing the RPO to 21% of total energy consumption by 2022 is equally applicable to all states and UTs as per MoP guidelines, some states like Rajasthan and West Bengal have reserved their right to set their own targets according to their supply situations and financial conditions of their DISCOMs. This attitude highlights the center-state differences on ways to accomplish the goal of 175 GW and need for building a consensus.

In India, RPO has been the primary driving force to promote the renewable energy sector. But the SERCs have defined their individual RPO regulations, which may create favorable and

neutral/repellent effects in the growth of the renewable energy sector. One possible policy alternative to help state-level RPOs reflect India's national commitment would be to incentivize resource-rich states to set higher than national-level targets to make up for other states' failure to meet the national RPO target. In case of non-compliance with RPO by the licensee, the regulatory commission may impose a penalty ranging from Rs. 1 to Rs. 5 per unit, by which the licensee falls short of the obligation specified by the commission.

Further, this chapter discusses the compliance status of solar RPOs. According to Minister of Power Shri R. K. Singh, about 27 Indian states and territories failed to achieve 60% RPO compliance (Mercom 2019). Many of the state DISCOMs are not fully complying with their RPO targets due to a dearth of implementation of RPO protocols and the nonexistence of fines in case of non-compliance. The RPO targets are themselves meaningless unless they are strictly enforced. However, MNRE created a compliance cell for RPOs in May 2018. This cell will coordinate with states, CERC, and SERCs to ensure RPO compliance (Mercom 2019). The process of monitoring the compliance of RPOs is given in Figure 6.5. The compliance with solar RPOs of some state DISCOMs for the financial year (FY) 2017-18 is shown in Figure 6.6.

In Telangana, RPO compliance for both the has been calculated from the tariff order for FY 2017-18. Both the utilities purchased more than solar RPO targets in Telangana for FY 2017-18. Tamil Nadu Generation and Distribution Corporation in Tamil Nadu could purchase only 2.34 % as compared to 5% solar RPO target for FY 2017-18. In Rajasthan, all three DISCOMs purchased 4.55%, 4.48%, and 3.9%, respectively, in place of the 4.75% solar RPO target for FY 2017-18. Maharashtra State Electricity Distribution Company Limited failed to comply with the solar RPO target of 2%, and it could purchase only 0.79%. Madhya Pradesh showed compliance with its solar RPO target (1.79% against the target of 1.5%). In Karnataka, all five DISCOMs pur

Table 6.6:

The source-wise breakup of RECs since inception as of April 25, 2020 (REC Registry 2020b)

Source	Accredited (25-04-2020)		Registered (25-04-2020)		RECs Issued Since Inception	RECs Redeemed through Power Exchanges	RECs Redeemed through Self Retention	Closing Balance (25-04-2020)
	Capacity (MW)	No. of Projects	Capacity (MW)	No. of Projects				
Wind	2704	503	2643	487	25004035	21646205	2021668	1336162
Urban/Municipal Waste	0	0	0	0	72892	72892	0	0
Solar Thermal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Solar PV	**866**	**382**	**856**	**379**	**9585368**	**9420593**	**115995**	**48780**
Small Hydro	298	39	250	37	4773593	4714027	6899	52667
Others	4	2	3	1	19892	11588	5010	3294
Geothermal	0	0	0	0	0	0	0	0
DISCOM	NA	NA	NA	NA	8513006	4366311	0	4146695
Biomass	480	44	420	40	10109971	9827396	147549	135026
Bio-fuel cogeneration	828	91	378	54	8616742	8520804	5001	90937
Total	**5180**	**1061**	**4550**	**998**	**66695499**	**58579816**	**2302122**	**5813561**

Table 6.7:

State-wise registered Solar PV projects and Capacity as of April 25, 2020 (REC Registry 2020a)

State	No. of Projects	Capacity (MW)
Andhra Pradesh	14	29.194
Chhattisgarh	1	4.8
Delhi	2	7.84
Gujarat	1	5
Haryana	1	1
Kerala	1	1
Madhya Pradesh	105	211.765
Maharashtra	69	118.11
Odisha	3	5
Rajasthan	108	287.6
Tamil Nadu	59	133.373
Telangana	12	46.43
Total	**376**	**851.112**

chased 13.1%, 5.33%, 3.93%, 3.89%, and 2.89%, respectively, against their solar RPO target of 2.75%.

Table 6.8:

State-wise Solar RPO targets (%) from the year 2016-17 to 2021-2022 (Energetica India 2016)

Sr. No.	State	2016-17	2017-18	2018-19	2019-20	2020-21	2020-2022
1.	Andhra Pradesh	0.25	3.00	4.00	5.00	6.00	7.00

2.	Arunachal Pradesh	-	4.75	6.75	-	-	-
3.	Assam	-	4.00	5.00	6.00	7.00	8.00
4.	Bihar	1.25	2.25	3.25	4.75	6.75	8.00
5.	Chhattisgarh	-	2.00	3.50	5.00	6.50	-
6.	Delhi	0.35	2.75	4.75	6.75	-	-
7.	Goa	1.15	2.50	3.60	4.70	6.10	8.00
8.	Gujarat	1.75	1.75	4.25	5.50	6.75	8.00
9.	Haryana	1.00	1.25	1.50	2.00	2.50	3.00
10.	Himachal Pradesh	0.25	0.50	0.75	1.00	2.00	3.00
11.	Jammu & Kashmir	2.00	1.25	1.50	1.75	2.00	3.00
12.	Jharkhand	-	3.75	5.50	6.55	-	-
13.	Karnataka	0.75	2.75	6.00	7.25	8.50	10.50
14.	Kerala	0.25	1.50	2.75	0.25	0.25	0.25
15.	Madhya Pradesh	-	1.50	1.75	4.00	6.00	8.00
16.	Maharashtra	-	2.00	2.75	3.50	4.50	6.00
17.	Manipur	-	5.50	8.00	9.00	10.00	10.50
18.	Meghalaya	-	0.43	0.75	1.00	1.25	-
19.	Odisha	-	3.00	4.50	5.50	-	-
20.	Punjab	-	1.80	2.20	4.00	5.00	6.50
21.	Rajasthan	2.50	4.75	6.75	7.25	8.75	10.50
22.	Sikkim	-	4.75	6.75	-	-	-
23.	Tamil Nadu	2.50	5.00	-	-	-	-
24.	Telangana	-	-	5.33	5.77	6.21	7.10
25.	Tripura	1.15	1.50	1.75	2.00	-	-
26.	Uttarakhand	0.30	4.75	6.75	7.25	8.75	10.50
27.	West Bengal	0.25	0.30	0.40	0.50	0.50	0.50
28.	**MoP**	**2.75**	**4.75**	**6.75**	**7.25**	**8.75**	**10.50**

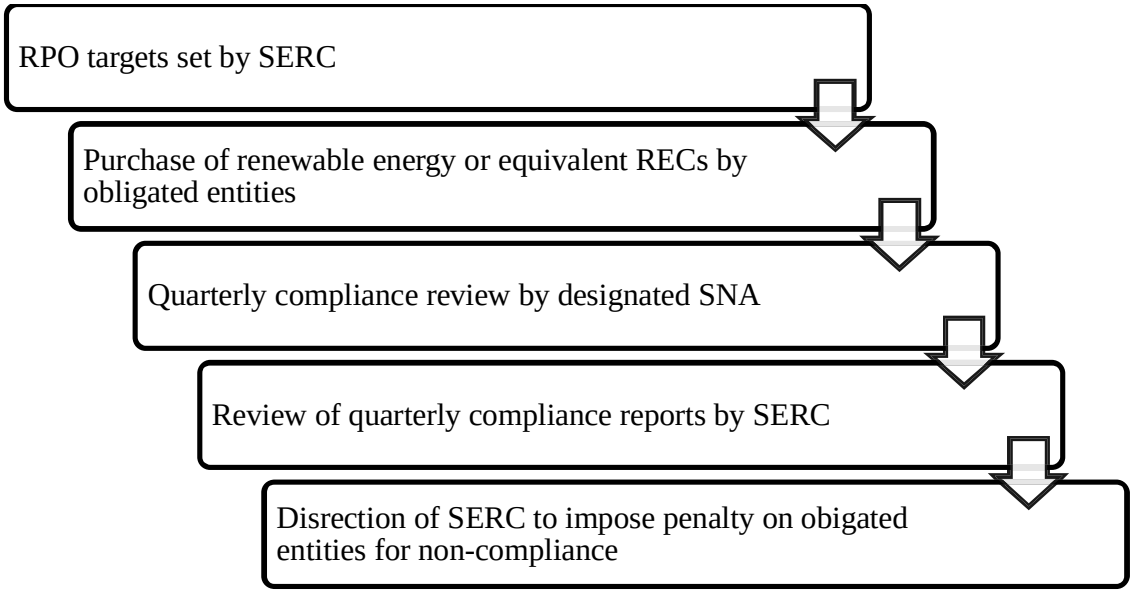

Figure 6.5: Process showing steps followed for monitoring compliance of RPOs (Kaladharan 2016).

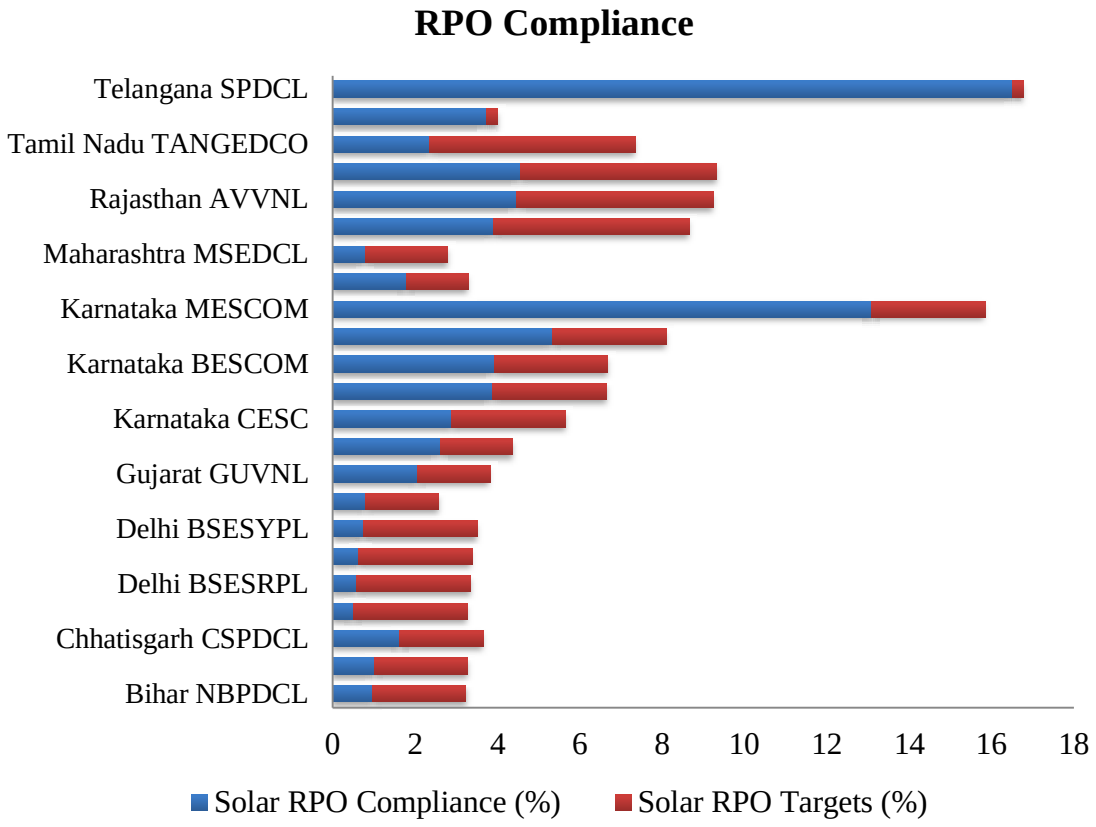

Figure 6.6: Analysis of compliance with solar RPOs of state DISCOMs for FY 2017-18 (PEG 2020).

In Gujarat, all three DISCOMs showed compliance of 2.61%, 2.06%, and 0.81%, respectively, against the target of 1.75%. None of the DISCOMs in Delhi have met even 40% of their stated solar RPO targets of 2.75% in FY 2017-18. The status of RPO compliance by Chhattisgarh State Power Distribution Company Limited for FY 2017-18 can be found in tariff order 2018-20.

The compliance is up to 1.64% of the stated target of 2%. The regulator North and South Bihar Power Distribution Company Limited (NBPDCL and SBPDCL) have verified RPO compliance for FY 2018 in respective tariff orders for the DISCOMs in 2019-20. As shown in Figure 6.6, the compliance status is 0.98% and 1.01% respectively for NBPDCL and SBPDCL against the RPO target of 2.25% for FY 2017-18. The analysis of RPO compliance in Figure 6.6 shows that only three states Gujarat, Karnataka, and Telangana have met their solar RPO compliance.

6.5 Suggestions for Promoting Solar-Coal Hybrid Power Generation

This chapter has analyzed the policies and initiatives taken by GoI to promote power generation using solar energy. All the policies and initiatives taken by GoI exclusively promote solar PV. Though, there is a scheme being implemented by MNRE as "Off-Grid and Decentralized CST Technologies for community cooking, process heat, space heating, and cooling, for promoting CST projects. This scheme aims to promote CST technologies for off-grid solar thermal applications. In this scheme, MNRE provides central financial assistance of 30% of the benchmark cost for projects in all states and 60% of the benchmark cost for projects in Non-profit making institutions and special category states (MNRE 2019).

Currently, researchers and scientists have shown significant attention towards the application of solar energy for power generation. In this regard, several investigations have been conducted to integrate solar energy with coal-based power plants for power generation (Jamel et al. 2013, Parvareh et al. 2014, Sunil and Soni 2019, Serrano-Sanchez et al. 2019, Juan Wang 2019, Qin et al. 2020, Sunil and Soni 2020). Their outcome shows that the integration of solar energy with coal-based power plants saves a substantial amount of coal (fuel-saving mode), thereby reducing CO_2 emissions and mitigating environmental degradation or augments the power output of the hybrid plant (power boosting mode) thus providing financial benefits. The incorporation of solar energy into the existing thermal power plants in fuel-saving mode will help India to achieve the Paris Agreement target of reducing global climate change (Aggarwal 2019). In power boosting mode, the more power generated using solar energy will help the power producer in meeting their RPO or RGO (Renewable Generation Obligations) targets. If the power producer has surplus power then it can be sold to DISCOMs in form of RECs. For instance, in a particular analysis, it was found that the solar coal hybrid power plant of 210 MW capacity may produce 7 MW more power when operated in power boosting mode (Sunil and Soni 2019). This increase in power output may be obtained by replacing only a single high-pressure feedwater heater energy supply by bled steam with solar thermal energy; this implies that with more solar energy integration, the power output can be substantially increased.

A practical demonstration of the integration of solar energy with coal-based power plant at NTPC Dadri showed encouraging results (Vir 2012). The hybridization of coal-based power plants with solar energy also creates employment opportunities along with environmental and economic benefits. Therefore, looking at the socioeconomic and environmental benefits of solar-coal hybrid technology, the authors strongly recommend that GoI should frame specific policies

for promoting the integration of solar energy with existing coal-based power plants in India. The government should come up with policy initiatives that attract power producers for integrating solar energy into thermal power plants. This will help in compliance of RPO/RGO targets in every state.

6.6 Policy Implications and Summary

India wishes to shift from a fossil fuel burning economy to a relatively low carbon economy through increased use of renewable energy sources because of issues such as climate change and environmental protection. India is facing pressure to control GHG emissions at the international front; therefore, GoI has released JNNSM to install 100 GW of solar energy installations across the country by 2022. In India, the solar energy sector's growth is moderate even when there are several motivational factors like plentiful solar radiation and land availability; due to the absence of a single comprehensive solar policy. To successfully achieve the target, the Indian government has to extend support to the solar industry, especially solar thermal industry, in framing common policy at the central level, implementing the policies at the ground root level, and the single-window clearance system easy and long term financing, and proper infrastructure. For India's solar power sector's growth, besides the above-said steps, GoI needs to invest in improving research and development facilities, manufacturing facilities, and infrastructure. These initiatives will certainly attract national/international investors to invest in the Indian solar power market and provide a favorable environment. With the center targeting 40% renewable sources in the energy mix by 2030, the Indian electricity sector is at the heart of a seismic changeover. These ambitious targets are supported by legislative, regulatory, and policy interventions at the center and state levels. This is also in tune with global trends supporting

green industrial policy for an immaculate and sustainable form of economic growth. The recent focus has shifted to a commitment with the market through the establishment of an assisting policy environment, instead of control over the market. However, there is lucidity at the center level on driving renewable energy reform; there is an apparent apprehension at the state level. For the success of any renewable energy policy, the role of DISCOMs is rudimentary, but the recent perception is that the state DISCOMs are working against the national policy. In the present study, all the government initiatives for promoting the growth of renewable energy sources (especially solar energy) have been discussed in detail. The analysis of state-wise solar policies given in Table 6.4 shows that the government has taken a lot of initiatives for achieving the target of 100 GW solar power by 2022, but the share of CSP technologies seems negligible in these policies. This chapter also deliberates the government's initiative to develop solar parks and solar cities for promoting solar power projects.

To further promote RE, the central government has introduced RPO through CERC for renewable energy in general and solar power in particular. The central government continues to encourage the development of RE sources through several key policies and governing methods. During the FY 2016-17, these measures include notification of RPO targets, waiver of inter-state transmission system (ISTS) charges and losses, reinforcement of the ISTS under the Green Energy Corridor program, and amendments to the CPP rules to provide more lucidity and encourage long-term investments in the sector. The present study discusses in detail the solar RPOs and their compliance. The analysis of state-wise targets of solar RPOs from 2016-17 to 2021-22 is presented in Table 6.8. Figure 6.5 and Figure 6.6 show the monitoring process and compliance status of RPOs in FY 2017-18 by different state DISCOMs. The solar RPO targets set by states differ widely from the MoP solar RPO targets. The lenient enforcement of RPO

policy in India is one of the key reasons for non-compliance with RPO targets (Shrimali and Tirumalachetty 2013). In order to attain India's RE targets, effective implementation of RPO policy is critical. Regretfully, previous years' trend has proved that ensuring RPO compliance is an uphill battle with most of the DISCOMs unable and often reluctant to meet RPO targets. Another government initiative REC policy, is expected to give a push to RE capacity addition in India. Table 6.6 and Table 6.7 provide a technology-wise break up of RECs since inception and state-wise registered projects and capacity under the REC framework, respectively. Obligated entities use the RECs to fulfill their RPO requirements. Tradable RECs are helpful in meeting the solar RPO when there is inadequate solar capacity in a particular state.

Finally, this study deliberates the policy framework of CST technologies to identify the key policy instruments launched by the GoI for the support of CSP projects, which is one of the key objectives of this study. Table 6.5 gives the detail of CSP projects sanctioned in JNNSM phase-I, Batch-I, which includes a total of ten projects. Most of these projects failed to attract new investors in this sector. The total energy generation potential of completed projects is just 39 MW_{th}, while the roadmap targets the further implementation of 161 MW_{th} by 2022. In JNNSM Phase-II MNRE has decided to reduce the share of CSP to 30% because of poor performance in JNNSM Phase-I. The limited growth of CST technology in India is due to a lack of prioritization because the government is providing a maximum focus on solar PV technologies. Therefore, Solar PV technologies have outshined CSP technologies. According to a channel partner, if all the exemptions that are given to solar PV are extended to solar energy as a whole, then the CST sector will definitely grow at a much faster rate. CSP technology has the enormous potential that can be tapped in a much more inexpensive and feasible manner to meet future energy needs and mitigate climate change, but if suitable policy instruments are not put in place to support this

technology, this valuable technology may lose its attractiveness in the market. Although the central government offers subsidies, tax benefits, and funding programs, the policies and guidelines put in place have no primary boosting framework for encouraging CST systems' deployment. Policy support needs to provide competitive pressure for innovation and cost reductions. The deployment policies for CSP should be designed to include key advantages of CSP, i.e., dispatchability and plunging cost pressure, to trigger cost reductions and more efficient plant designs. Such policies are auctions or feed-in tariffs. The CSP policy instrument should include research, development, and demonstration-related support for industry partners. It should also include policies to cover the increased risk of implementing new and innovative components and designs. Implementing such a policy framework could revive the CSP industry with a balance of lucrative profits.