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State of the Indian Renewable Energy Sector: Drivers, Risks, and Opportunities

Report | September 2018

MANU AGGARWAL AND ARJUN DUTT

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About CEEW

The Council on Energy, Environment and Water (CEEW) is one of South Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain – and change – the use, reuse, and misuse of resources. The Council addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with wider public.

In 2018, CEEW once again featured extensively across nine categories in the '2017 Global Go To Think Tank Index Report', including being ranked as South Asia's top think tank (14th globally) with an annual operating budget of less than USD 5 million for the fifth year in a row. In 2016, CEEW was also ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks as per the ICCG Climate Think Tank's standardised rankings. In 2013 and 2014, CEEW was rated as India's top climate change think-tank as per the ICCG standardised rankings.

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Image: unsplash

About the Authors

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Manu is a Programme Associate at CEEW. As a climate and energy expert, Manu works on the efficient allocation of risks and well-functioning markets to drive the energy transition. He has a keen interest in leveraging actuarial and risk science, and big data techniques to improve governance and deepen markets. His current research interests lie at the intersection of development policy, finance, and institutions.

At The Council, Manu's work involves designing market-transformative insurance products, and restructuring regulatory and commercial contracts to de-risk renewables. He is currently assessing risks in emerging economies in Asia and Africa and developing means of advancing regulatory ease in the renewable energy sector. Manu closely monitors the non-UNFCCC negotiations on emissions due to international transport and leads The Council's work on international aviation emissions. Manu has been actively involved with the Women in Sustainability initiative at The Council since its inception.

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Arjun is a Programme Associate at CEEW. Arjun holds a keen interest in finance, renewable energy, public policy, and technology. At The Council, his research is geared towards enhancing the flow of affordable finance to the renewable energy sector. This includes the analysis of risks constraining renewable energy investments, particularly in underserved market segments, and the development of suitable interventions aimed at de-risking the renewable energy sector. He is actively engaged with an array of public and private sector stakeholders to design and develop specialised institutional mechanisms such as green banks as well as financial instruments aimed at risk mitigation.

Arjun holds an undergraduate degree in Electronics and Communication Engineering from the Delhi College of Engineering and an MBA from the Management Development Institute, Gurgaon.


Image: iStock

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Abbreviations

ADB	Asian Development Bank
ADD	anti-dumping duties
C&I	commercial and industrial
CAPEX	capital expenditure
CEA	Central Electricity Authority
CEEW	Council on Energy, Environment and Water
CERC	Central Electricity Regulatory Commission
CLEAN	Clean Energy Access Network
CRMM	Common Risk Mitigation Mechanism
DFI	development finance institution
DGTR	Directorate General of Trade Remedies
FDI	foreign direct investment
FIT	feed-in tariff

Abbreviations

GDP	Gross Domestic Product
GHG	greenhouse gas
GIG	Grid Integration Guarantee
MDB	multilateral development bank
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
MSME	Micro, small and medium enterprise
NBFC	non-banking financial company
NDC	nationally determined contributions
NTPC	National Thermal Power Corporation
OPEX	operating expenditure
PE	private equity
PPA	power purchase agreement
PSA	power sale agreement
PSM	payment security mechanism
PSU	public sector undertaking
PV	photovoltaic
RE	renewable energy
REMC	Renewable Energy Management Centre
RPO	renewable purchase obligation
SAARC	South Asian Association for Regional Cooperation
SECI	Solar Energy Corporation of India
SERC	state electricity regulatory commission
SLDC	state load dispatch centre
SNA	state nodal agency
SRISTI	Sustainable Rooftop Implementation for Solar Transfiguration of India
T&D	transmission and distribution
UDAY	Ujwal DISCOM Assurance Yojna
UNFCCC	United Nations Framework Convention on Climate Change
VGF	viability gap funding

1. Introduction and Motivations

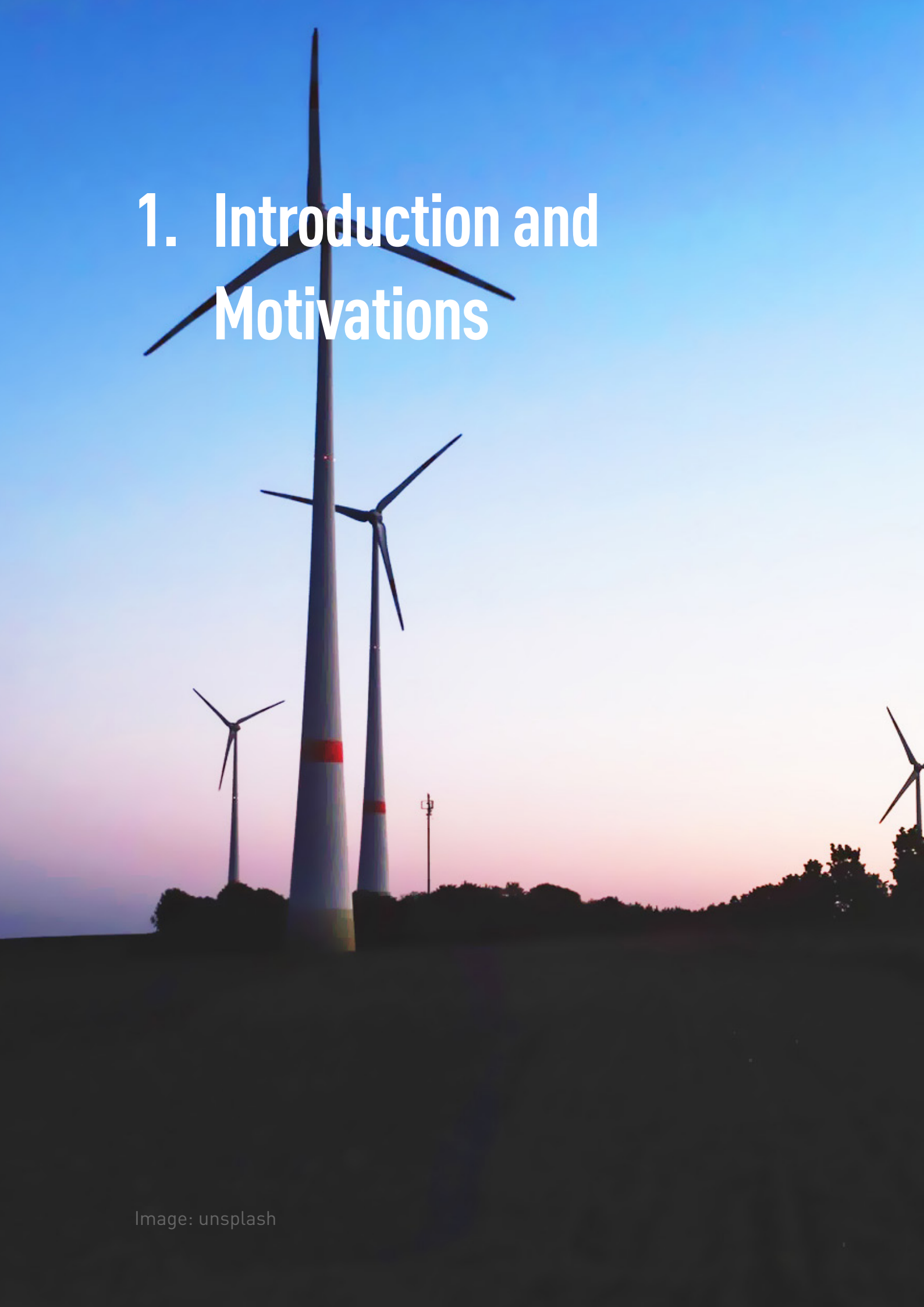


Image: unsplash

India has emerged as one of the champions of the global energy transition. At the end of 2017, India represented the world's fourth largest wind installed capacity and the sixth largest solar installed capacity.[1] Investment flow into the renewable energy (RE) sector in India is the second highest among developing countries.[2] India's RE ambitions are lofty – it targets 175 GW of RE installed capacity by 2022,[3] including 100 GW of solar energy and 60 GW of wind energy.[4,5] In its Nationally Determined Contributions (NDC) under the Paris Agreement,[6] India has committed to achieving a 40 per cent share of non-fossil-fuel-based sources in its installed capacity by 2030.

India has instituted several policy measures to support RE deployment, but actual capacity addition is contingent upon how these policy measures are able to address the various risks plaguing the sector. It is important to take stock of how the interplay between risks, policies, and market developments has shaped capacity addition so far and to identify gaps that need to be addressed. This would help various stakeholders – policymakers, regulators, developers, and investors – assess the extent of the consistency between the current state of the RE sector and India's clean energy ambitions and identify the course corrections required to further the energy transition. Given the primacy of solar and wind energy in India's RE ambitions, this report focuses on these two sectors.

[1]Press Information Bureau, Government of India, "Year End Review 2017 – MNRE", http://pib.nic.in/newsite/PrintRelease.aspx?relid=174832, Accessed on 16-6-2018

[2]UNEP BNEF, Global Trends in Renewable Energy Investment, 2018

[3] As per government projections, India's installed RE capacity could exceed this target and reach 227 GW by 2022 – Sourced from The Economic Times, "Renewable energy target now 227 GW, will need $50 billion more in investments", https://economictimes.indiatimes.com/industry/energy/power/india-will-add-225-gw-renewable-energy-project-capacity-by-2022-r-k-singh/articleshow/64461995.cms, Accessed on 30-7-2018

[4] Ministry of Finance, Government of India, Key Features of Budget 2015-16, 2015

[5] Remaining 15 GW comes from Biomass and Small-hydro sectors

[6] UNFCCC, "India's Intended Nationally Determined Contribution", http://www4.unfccc.int/ndcregistry/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf, Accessed on 16-6-2018

2. The Indian Renewables Market: A Snapshot

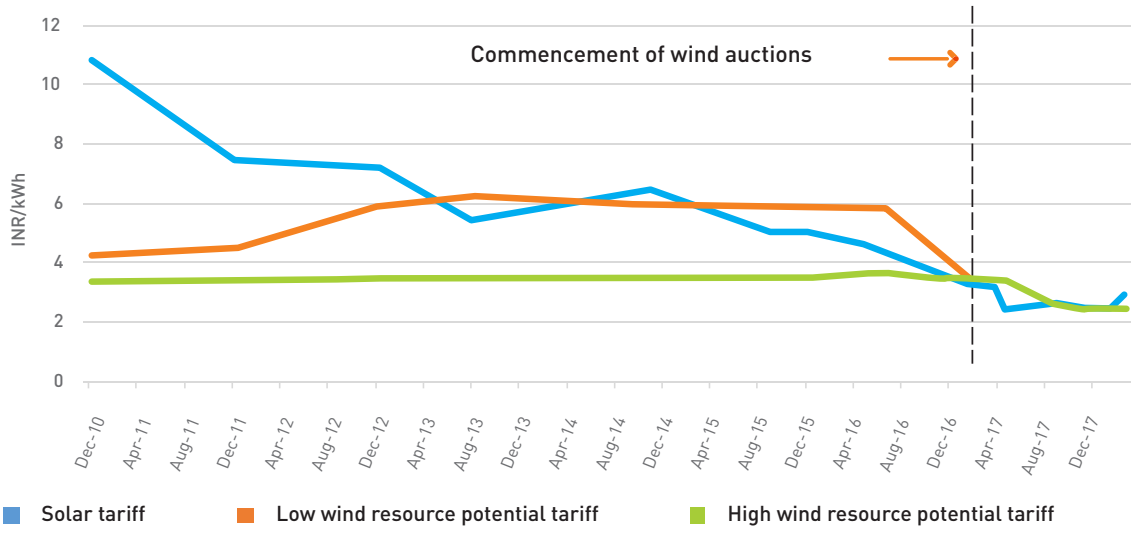
Image: unsplash

The Indian RE sector has exhibited varying degrees of success in terms of tariff reduction, capacity addition and investment flows over the years. Solar and wind tariffs have declined considerably and installed capacity and investment flows have reflected the increased competitiveness of RE tariffs. However, installed capacity is characterised by considerable variations across regions and RE segments. Similarly, investment flows and the pace of capacity addition have varied considerably in recent years. The actions of a number of players in the RE ecosystem have either contributed towards the pattern of deployment or have been affected by it - ranging from policy makers, regulators, and power sector intermediaries to developers, financiers, offtakers, and consumers.

2.1 Trajectory of solar and wind tariffs

The Indian RE space is characterised by the competitiveness of its tariffs, with the record-low utility-scale solar and wind bids registered in 2017 being among the lowest in the world (Figure 1). These tariffs have started stabilising at under INR 3/kWh in recent months. However, in the case of solar, the projected decline in module prices could start a sharp decline in tariffs towards the INR 2/kWh mark.[7] The projected decline is based on a global over-supply situation, caused by a reduction in feed-in tariffs (FIT) and subsidy support for new solar generation in China.

Figure 1: Utility-scale solar and wind tariffs are stabilising at under INR 3/kWh in India



Source: CEEW analysis, Central Electricity Regulatory Commission (CERC) Tariff Orders

Note: Low (and high) wind resource potential tariffs refer to FIT in wind zones with, respectively, the lowest (and highest) resource potential. With the recent adoption of the reverse auction regime for wind, tariff trends are reflected by extending the high wind resource potential trajectory.

2.2 Installed RE capacities

The pace of capacity addition for both solar and wind energy picked up after 2014–15, which reflects the impact of an enhanced policy push for RE deployment in the wake of the announcement of the revised 175 GW target by 2022 in 2015 (Figure 2, Page 5). Accelerated depreciation benefits were reinstated for wind energy in the second half of 2014, and that further

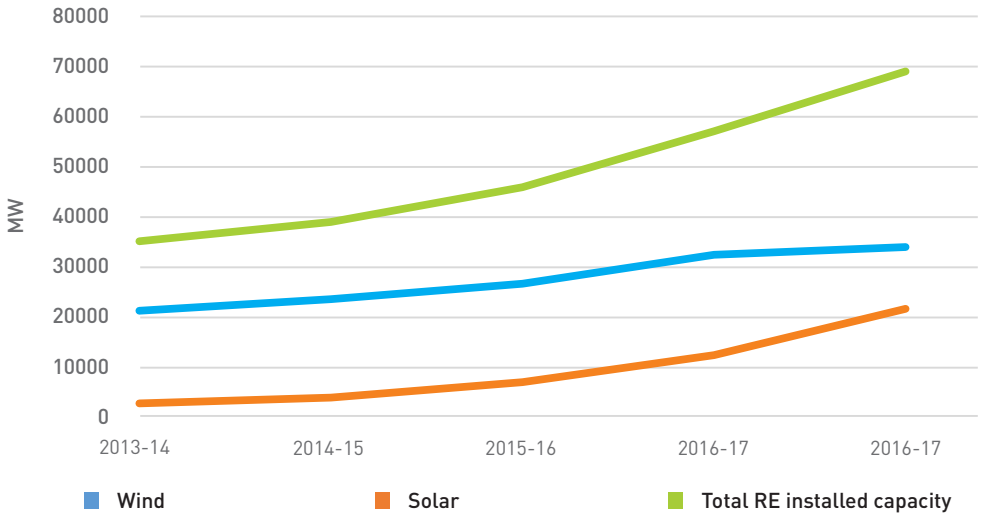
[7]Financial Times, "China's solar desire dims", https://www.ft.com/content/985341f4-6a57-11e8-8cf3-0c230fa67aec, accessed on 17-6-2018

facilitated capacity addition. Capacity addition was given additional impetus by other market-related factors – such as declining module and wind turbine costs, and improving terms of finance for utility-scale projects – that translated into declining tariffs and increased the attractiveness of RE to offtakers. In the second half of FY 2016–17, there was a transition from the earlier FIT regime to competitively determined wind tariffs. This transition, compounded by weak tendering activity, led to a decline in wind capacity addition in 2017–18.

2.2.1 Utility-scale solar and wind

India's RE deployment is not uniform but concentrated in certain states. This is a function of the attractiveness of that state for RE investments, based on RE resource potential, the availability of land and supporting infrastructure (including evacuation infrastructure), and the ease of regulatory processes and clearances. Tables 1 and 2 illustrate the major states by installed solar and wind capacity.

Figure 2: Solar and wind capacities grew faster post 2014–15



Source: Central Electricity Authority monthly installed capacity reports

Table 1: List of Indian states by installed utility-scale solar and wind power capacity (as of March 2018)

State	Installed utility-scale solar power capacity (GW) [8]	Installed wind power capacity (GW) [9]
Andhra Pradesh	2.3	4.0
Gujarat	1.4	5.7
Karnataka	5.1	4.5
Madhya Pradesh	1.3	2.5
Maharashtra	1.1	4.8
Rajasthan	2.3	4.3
Tamil Nadu	1.8	8.2
Telangana	3.3	0.1

Sources: Mercom and Indian Wind Turbine Manufacturers Association

[8]Mercom, "India's Top 10 Solar States in Charts", https://mercomindia.com/top-solar-states-charts/, Accessed on 14-6-2018

[9]Indian Wind Turbine Manufacturers Association, "India – Wind Power Capacity Installations FY 2017-18", http://www.indianwindpower.com/pdf/Installed-Wind-Capacity.pdf, Accessed on 14-6-2018

Table 2: List of top Indian states by installed rooftop solar capacity (as of September 2017)[10]

State	Installed rooftop solar power capacity (MW)
Delhi	95
Gujarat	103
Haryana	102
Karnataka	125
Maharashtra	237
Punjab	73
Rajasthan	129
Tamil Nadu	191
Telangana	54
Uttar Pradesh	77

Source: Bridge To India

2.2.2 Rooftop solar

Rooftop solar installed capacity was around 1.6 GW at the end of January 2018.[11] The CAPEX mode of deployment – in which the end consumer pays for the system upfront – accounts for nearly 81 per cent of cumulative installed capacity.[12] The OPEX model, in which the end consumer does not own the system but pays for the electricity consumed, accounts for around 19 per cent of installed capacity. The share of the OPEX model in new installations is rising; it accounted for 30 per cent of the deployments in 2017.[13]

Rooftop solar tariffs under the OPEX model are INR 4–5/kWh, which are far more competitive than C&I grid electricity tariffs of INR 5–17/kWh.

The commercial and industrial (C&I) consumer segments together account for the largest share of rooftop solar installed capacity as the business case for adopting rooftop solar is the strongest for these segments. Rooftop solar tariffs under the OPEX model are INR 4–5/kWh, which are far more competitive than grid electricity (INR 5–17/kWh).[14] States such as Maharashtra and Tamil Nadu, where C&I demand is high, account for the highest shares in rooftop solar installed capacity (Table 2).

There is a mismatch between solar resource endowment and capacity deployment. Rooftop solar deployment in resource-rich states – such as Andhra Pradesh, Madhya Pradesh (neither figures among the top states), and Telangana – is much less than in Delhi, Haryana, and Punjab, which are much less resource-rich. This could indicate greater C&I demand for rooftop solar from these less resource-rich states. The superior implementation of rooftop solar policies in some

[10]Note: As of September 2017, sourced from Bridge To India, India Solar Rooftop Map September 2017

[11] Mercom, "India Reaches 20 GW in Cumulative Installed Solar Capacity", https://mercomindia.com/india-reaches-20-gw-installed-solar-capacity/, Accessed on 16-6-2018

[12] Bridge To India, India Solar Rooftop Map September 2017, 2017

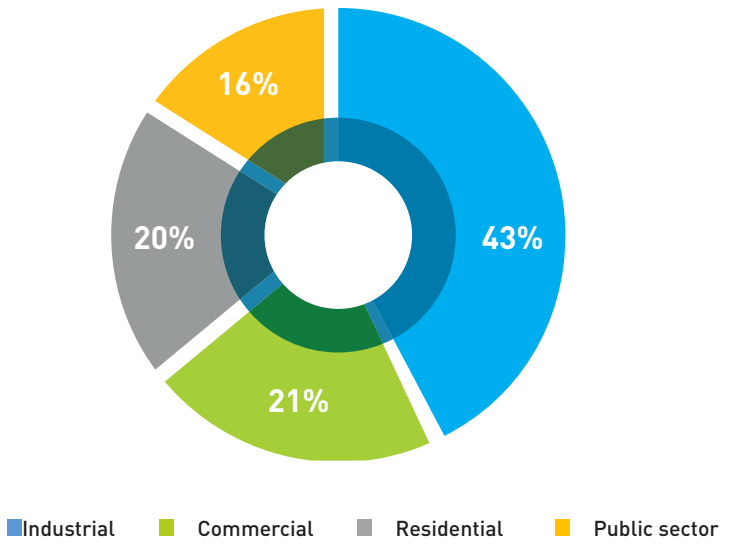
[13] As of September 2017, sourced from Bridge To India, India Solar Rooftop Map September 2017, 2017

[14] Based on data for commercial and industrial segments for the states mentioned in table 2 sourced from CEA, Electricity Tariff & Duty and Average rates of electricity supply in India, March 2016. The Uttar Pradesh (Rural) region is an outlier, for which commercial tariffs stood at INR 3.48/kWh.

states (with Delhi being among the leading states) could also have contributed to the deployment pattern.[15]

Residential consumers, particularly small residential consumers (in terms of units consumed), have a lower share in rooftop installed capacity (Figure 3). Grid tariffs are subsidised for small residential consumers; so, they have less of an incentive to adopt rooftop solar. Moreover, unit capital costs for small, residential rooftop solar systems are higher than for larger C&I systems[16] and residential consumers have a lower capacity to pay the upfront costs of these systems. Small, residential rooftop solar systems are also characterised by lower consumer awareness. These factors hinder the uptake of rooftop solar in the residential segment.[17] Surprisingly, the uptake of rooftop solar among government/public sector undertakings (PSUs) has been sluggish, despite the availability of a capital subsidy (Section 3.1.2).

Figure 3: Commercial and industrial (C&I) consumers account for the majority of rooftop solar installations



Source: As of September 2017, sourced from Bridge To India, India Solar Rooftop Map September 2017

2.3 Investment flows

The power sector accounts for 3.52 per cent of the total foreign direct investment (FDI) received in the form of equity since 2000.[18] One area within the power sector that has caught the attention of foreign investors is RE generation. The percentage of FDI in RE generation has almost doubled from its average value of 1.7 per cent since 2000 to 3 per cent in the first nine months of FY 2017–18 (Figure 4).

The percentage of FDI in RE generation has almost doubled from its average value of 1.7 per cent since 2000 to 3 per cent in the first nine months of FY 2017–18

[15] Bridge To India, "Poor implementation of net-metering policies poses a major challenge for rooftop solar", http://www.bridgetoindia.com/poor-implementation-net-metering-policies-poses-major-challenge-rooftop-solar/, Accessed on 30-7-2018

[16] Neeraj Kuldeep, Selna Saji, and Kanika Chawla, Scaling Rooftop Solar: Powering India's Renewable Energy Transition with Households and DISCOMs (CEEW, 2018)

[17] Based on market intelligence

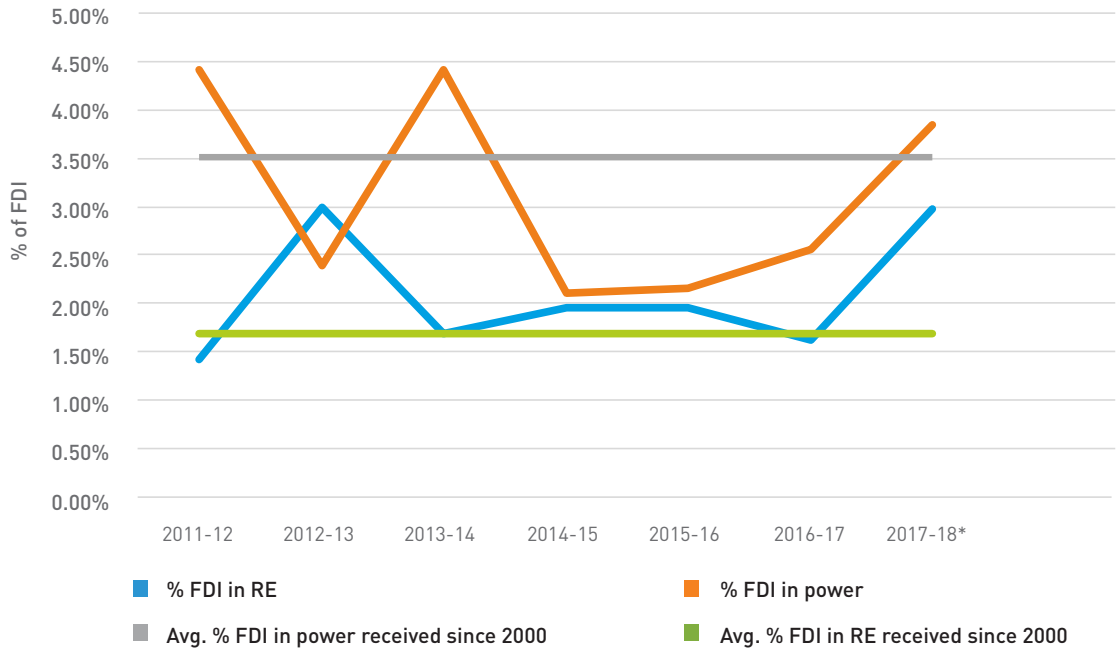
[18] Department of Industrial Policy & Promotion, Ministry of Commerce and Industry. Government of India, Fact Sheet on Foreign Direct Investment From April 2000 to December 2017, 2017

[19] UNEP, Global Trends In Renewable Energy Investment 2018, 2018

[20] Around 2.55 GW capacity was tendered and awarded under competitive wind auctions in 2017

Investment flows into the RE sector (Figure 5) increased sharply in 2016, coinciding with the enhanced policy push for RE after 2015 and other favourable market-related factors (Section 3). In 2017, however, investment flows declined considerably, driven largely by a 41-per-cent year-over-year decline in flows into the wind energy segment.[19] The transition to an auction-determined tariff regime from the FIT regime, and falling tariffs, adversely impacted investment in wind energy. Tendering activity under the auction regime for wind was sluggish in 2017.[20] Sharp declines in the cost of equipment, particularly solar photovoltaic (PV) modules, contributed to the decline in investment flows.[21]

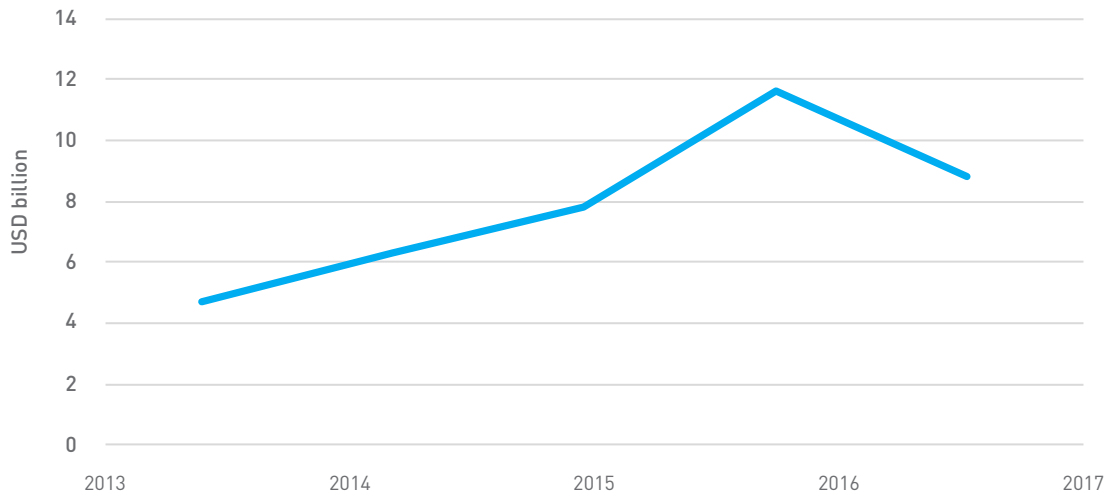
Figure 4: Share of FDI in RE now is twice its long-term average



*Data from April–December 2017

Source: Department of Industrial Policy & Promotion, Ministry of Commerce & Industry; CEEW analysis

Figure 5: Investment flows declined in 2017



Source: United Nations Environment Programme, Global Trends In Renewable Energy Investment 2018

2.4 Political economy of the Indian RE ecosystem

The RE ecosystem in India consists of a variety of actors – policymakers, regulators, power sector intermediaries, offtakers, financiers, and developers.

Aggressive top-down target-setting and policy cues characterise India's pursuit of its RE goals. Since there is no legislation to back India's RE ambitions, top-level political commitment is necessary in order to achieve them.

2.4.1 Policymakers and public sector agencies

India's ambitious RE targets were set in the backdrop of a global push towards combating climate change, represented by the international negotiations under the aegis of the United Nations Framework Convention on Climate Change (UNFCCC). There is no legislation to back Indi a's RE ambitions. Therefore, top-level political commitment is necessary to demonstrate the country's commitment to combating climate change, determine its commitments under the Paris Agreement, and realise its stated RE deployment goals. Policymakers at the highest levels of government, including the Prime Minister's Office, are involved. Aggressive, top-down target-setting and policy cues characterise India's pursuit of its energy security and access goals and its climate change commitments.

The Indian RE sector is dynamic, and it is characterised by shifting risks (Section 5). Managing these risks effectively requires policy making to be nimble enough to anticipate and respond to these challenges to accelerate the pace of capacity addition in line with the country's RE ambitions. Within the central government, the Ministry of New and Renewable Energy (MNRE) is the nodal ministry that makes policy on the matters of RE.

Central public sector entities under the administrative control of the MNRE implement its schemes; the Solar Energy Corporation of India (SECI) is the main central sector entity. Created as an entity dedicated to the solar energy sector, SECI has since seen its mandate broadened to include the entire RE domain. Along with National Thermal Power Corporation (NTPC), a central public sector power generation utility, SECI conducts competitive auctions for the award of solar and wind energy generation capacity. These entities make power purchase agreements (PPAs) with developers in central RE tenders; to sell the power, they make power sale agreements (PSAs) with state discoms.

NTPC is the largest state-owned thermal power producer. It could play a leading role in blending RE generation with thermal, permitted under both existing and future PPAs, under the Ministry of Power (MoP)'s scheme.[22,23] That would let NTPC balance variable RE generation with thermal capacity, allow discoms to fulfil renewable purchase obligations (RPOs) under existing PPAs (in case of blended generation for existing contracts) and reduce emissions from its generation activities. State nodal agencies (SNAs) implement RE schemes at the state level and conduct state-level tenders for the setting up of solar and wind generation capacity. The MNRE's schemes are implemented at the state level in close coordination with SNAs.

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[21] Mint, "India's solar power sector is getting commoditized: First Solar", https://www.livemint.com/Industry/7CgFlRqZUhqSQYkvFRtshJ/Indias-solar-power-sector-is-getting-commoditized-First-So.html, Accessed on 18-6-2018

[22] Ministry of Power, Government of India, Flexibility in Generation and Scheduling of Thermal Power Stations to reduce emissions, 2018

[23] Business Standard, "NTPC to back down thermal power at some of its units for more renewables", https://www.business-standard.com/article/companies/ntpc-to-back-down-thermal-power-at-some-of-its-units-for-more-renewables-118041901127_1.html, Accessed on 18-6-2018

Since RE generators are entities involved in power generation, these are subject to the jurisdiction of the MoP. The MoP, which makes power sector–related policy, is an important player from the policy perspective. Regulators under the MoP's jurisdiction create an environment conducive for the enhanced deployment of RE generation by implementing the provisions of the Electricity Act, 2003, the National Tariff Policy, 2016 (and amendments thereafter), and other legislation.

India's solar energy generation is heavily dependent on imported solar PV modules.[24] Therefore, trade-related policymakers are important stakeholders from the RE perspective. The Ministry of Commerce and Industry and the Ministry of Finance have taken measures to curb alleged unfair trade practices by foreign solar PV module manufacturers. These measures have implications for project costs and solar energy tariffs (Section 5.1.3). Besides influencing equipment costs through trade-related measures, the Ministry of Finance is also an important stakeholder influencing the options for financing of RE projects and could play a role in realising innovative mechanisms for RE financing (Section 7.2).

2.4.2 Sectoral regulators

The Central Electricity Regulatory Commission (CERC) is the central-level power sector regulator; the state electricity regulatory commissions (SERCs) are the state-level power sector regulators. To encourage the development of the RE sector, these regulators

- Issue regulations that determine RE tariffs (under the FIT regime);
- Facilitate RE grid integration;
- Formulate RPOs for discoms and other obligated entities; and
- Specify preferential treatment and exemptions for RE, such as its must-run status, and the waiver of inter-state transmission charges.

However, regulations pertaining to scheduling and forecasting of RE generation are still in draft form in several states, including three RE-rich states, as at the end of June 2018 (Table 4). Further, regulators have in some cases failed to enforce existing regulation. State discoms have often not complied with RPO obligations and, in some cases, the terms of their PPAs (Sections 3.1 and 5.1). To ensure that formulated regulations have the desired effect, state-level regulators need to be prompt in implementing and enforcing regulation.

2.4.3 Power sector intermediaries

The transmission utility is the power sector intermediary that owns and operates the transmission network. Power Grid Corporation of India Limited, the central transmission utility, is responsible for setting up and operating the inter-state transmission infrastructure; state transmission utilities set up and operate the intra-state transmission network. State entities control most transmission assets, but some private sector entities too operate in the transmission sector.

Transmission system operators – state load dispatch centres (SLDCs) and regional load dispatch centres (RLDCs) – are entities that are responsible for ensuring the integrated operation of the power system in their respective state or region.[25] An SLDC is an independent power sector entity, but it is often housed within the state transmission utility; that could raise concerns

[24] India imports around 90% of its solar PV module requirements – sourced from The Economic Times, "DGTR for safeguard duty on solar panel imports", https://economictimes.indiatimes.com/news/economy/foreign-trade/commerce-ministry-recommends-imposition-of-safeguard-duty-on-solar-cells/articleshow/65013517.cms, Accessed on 18-7-2018

[25] CERC, Indian Electricity Grid Code 2010, 2010

over their independence. The RLDCs are operated by Power System Operation Corporation Limited (POSOCO), a central power systems utility. The SLDCs and RLDCs are responsible for matching the injection of electricity into the grid with the drawal of grid electricity and for the scheduling and dispatch of electricity. The SLDCs and RLDCs are empowered to issue orders for curtailing or backing down RE generation on technical considerations, such as maintenance of grid security, or if equipment or personnel are endangered.[26] The share of variable RE generation in India's energy mix is rising, and solar and wind generators have must-run status (for a detailed description, see Section 3.1). Therefore, ensuring the smooth integration of solar and wind generation could be a considerable challenge for these power sector intermediaries (for a detailed discussion, see Section 5.1).

Many state-owned discoms are in poor financial health due to inadequate tariff revisions, delays in transfers from states compensating them for electricity supply at concessional tariffs and large aggregate technical and commercial losses.

2.4.4 Offtakers

Offtakers purchase power from RE generators. Generally, RE power is sold to discoms under long-term PPAs, but it may also be used for captive consumption. It may also be sold in the open market to eligible large power consumers (with connected loads of more than 1 MW) under open access regulations. Under open access regulations, these large power consumers can purchase electricity from electricity suppliers other than the local discom.

Discoms are, usually, state-owned entities, though a few private sector entities operate in the distribution sector. A major consideration for investors while signing PPAs is a discoms creditworthiness (for a detailed discussion, see Sections 3 and 6). Many state-owned discoms are in poor financial health, because of

- Inadequate tariff revisions;
- Delays in transfers compensating discoms for the supply of electricity at concessional rates to consumer segments such as agricultural and small residential consumers; and
- Large aggregate technical and commercial losses.

The low credit-worthiness of discoms of certain states could be a source of competitive disadvantage for these states from the perspective of future RE capacity addition (Section 6).

2.4.5 RE financiers

RE financiers provide capital for setting up projects through either equity or debt investment. A variety of financiers[27] participate in the Indian RE space: debt investors, equity investors, and sources of both debt and equity.

[26] ibid

[27] Kanika Chawla, Money Talks? Risks and Responses in India's Solar Sector (CEEW, 2016)

2.4.5.1 Debt investors

While commercial banks have been the primary source of debt capital for RE projects, these are characterised by short-term liabilities with a limited capacity to offer longer tenor debt (15-18 years) suitable for RE projects.

Domestic and international banks, non-banking financial companies (NBFCs), and debt funds are sources of debt for RE projects. Private sector banks and NBFCs accounted for the largest share of debt (around 60 per cent) in 2017, at the debt origination stage, to utility-scale solar and wind projects, though operational projects are often refinanced by public sector banks.[28] However, commercial banks are characterised by short-term liabilities, and they have limited capacity to offer debt with a tenor of 15–18 years (ideal for RE projects with useful lives of 20–25 years).

Multilateral development banks (MDBs), bilateral development banks, and international development agencies (such as the World Bank, Asian Development Bank (ADB), and KfW) typically have investment portfolios focused on transmission projects, and they provide long-term debt capital (tenor of 15–18 years) for these projects. For example, KfW provided debt funding for India's Green Energy Corridor project.[29] Besides transmission projects, MDBs such as the World Bank and the ADB have also provided debt capital to the rooftop solar sector through dedicated lines of credit to public sector banks in India for on-lending to the rooftop solar sector.[30,31]

2.4.5.2 Equity investors

Private equity (PE) investors, such as Goldman Sachs and I Squared Capital, often take equity positions in RE developers and offer considerable management and operational expertise. Investment by PE firms inspires greater confidence among debt investors for extending credit to RE developers.

2.4.5.3 Institutional Investors

Institutional investors – pension funds such as Canada Pension Plan Investment Board and Caisse de dépôt et placement du Québec – are potential long-term sources of capital for RE projects. However, institutional investors have a lower risk-taking appetite than PE investors and, usually, take positions in operational projects only.

2.4.6 RE developers

Most developers – Indian and international – in the Indian RE space are private sector entities, but a few power sector generators are state-owned. They may be central sector entities or state-level entities. The commercial viability of utility-scale RE generation has been firmly established. Therefore, public sector generation entities should focus on underserved segments (such as rooftop solar) or other nascent segments (such as flexible thermal) and facilitate an increased quantum of RE integration (Section 7).

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[28]Bloomberg New Energy Finance, Cheaper Debt Lets IPPs Flex Muscles in Indian Auctions, 2017

[29]Press Information Bureau, Government of India, "Germany to Finance India's Green Energy Corridors", http://pib.nic.in/newsite/PrintRelease.aspx?relid=99421, Accessed on 16-6-2018

[30]ADB, "$100 Million ADB Loan to Punjab National Bank to Finance Solar Rooftop Projects", https://www.adb.org/news/100-million-adb-loan-punjab-national-bank-finance-solar-rooftop-projects, Accessed on 4-7-2018

[31]The World Bank, "State Bank of India (SBI) approves 100MW of Grid-Connected Rooftop Solar Projects under Word Bank Program", http://www.worldbank.org/en/news/press-release/2017/06/02/state-bank-of-india-approves-100mw-grid-connected-rooftop-solar-projects-under-word-bank-program, Accessed on 4-7-2018

Both financiers and developers are concerned with maximising risk-adjusted returns. To increase the competitiveness of RE tariffs, it is important that policy and market developments lower sectoral risks. If the risk is lower, more risk-averse investors, such as pension funds, may participate in the RE sector.

2.4.7 Consumers

The end consumers, the ultimate consumers of electricity, constitute the customers of discoms (Section 2.4.4 addresses open access offtakers). Tariffs are based on consumer type (residential, agricultural, C&I) and the connected load. Generally, the tariffs for agricultural and small residential consumers (in terms of units consumed) are cross-subsidised by C&I and large residential consumers. This has implications for the deployment of rooftop solar – consumer segments subject to higher grid tariffs may be more receptive to the adoption of rooftop solar (as reflected in the deployment pattern discussed in Section 2.2.2). Since the institution of net metering policies (Section 3.1.2), consumers with rooftop solar systems are producing electricity and feeding it into the grid; thus, they are now potentially producer-consumers, or 'prosumers'.


Image: unsplash

3. Drivers of Renewable Energy Deployment in India

Image: unsplash

Solar and wind installed capacity has risen sharply over the past few years (Figure 2 ,Page 5). This capacity addition has been driven by policy-and market-related factors. These factors taken together helped enhance the viability of RE projects.

3.1 Policy-related drivers of RE deployment

Policy-related interventions have facilitated the deployment of RE projects by lowering sectoral risks and, through fiscal and financial incentives, improving the economic viability of projects. This section presents an evolution of policy measures geared towards driving RE adoption. Table 3 presents a chronology of the major policy drivers of RE deployment as per the date of their introduction relative to major policy developments (in bold).[32] A brief analysis of these drivers is then presented.

Table 3: Evolution of major policy-related drivers of RE deployment

Month/Year	Utility-scale solar	Utility-scale wind	Rooftop solar
	Accelerated depreciation benefits		
	FIT regime		
	Renewable portfolio obligations		
Jan 2010	**Launch of National Solar Mission**		
May 2010	Must-run status for solar and wind generation		
Sep 2013	Commencement of Green Energy Corridor project		Capital subsidy scheme*
Feb 2014	Viability gap funding scheme		
Dec 2014	Approval of MNRE solar park scheme		Adoption of net metering policies*
Feb 2015	**Announcement of revision of RE targets to 175 GW in union budget**		
Sep 2016	Waiver of inter-state transmission charges for solar and wind energy generation		
Feb 2017	Inclusion of SECI in tripartite agreement to avoid payment delays		
Feb 2017	**First wind auction**		
Dec 2017	Floating solar programme		Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI) Concept Note
Apr 2018		Offshore wind programme	
May 2018	Solar-wind hybrid policy		

Source: CEEW analysis

*Note 1: Precise dates for the introduction of the capital subsidy scheme and the introduction of net metering polices by states are not available, though they correspond to the period after the commencement of the National Solar Mission and before the announcement of the 175 GW targets.

Note 2: Precise dates for the introduction of accelerated depreciation benefits, initiation of the FIT regime and RPO obligations are not available.

[32]The chronological arrangement of various policy drivers may be taken as indicative only and does not reflect precise dates.

3.1.1 Policy-related drivers of utility-scale RE deployment

Several policy-related drivers have supported utility-scale solar and wind deployment: FIT regime for wind energy; fiscal and financial incentives; aggressive renewable portfolio standards; must-run status; dedicated transmission infrastructure for RE; mitigation of land acquisition and evacuation infrastructure risks; enhanced commitment to clean energy transition; waiver of inter-state transmission charges; and mitigation of offtaker risk.

3.1.1.1 Feed (FIT) regime for wind energy

Wind energy had been exclusively under the purview of an FIT regime in India until the first auction-determined tariffs in February 2017. Determined by the respective state regulatory commissions, FITs helped drive investment by providing certainty to developers in terms of the availability of a remunerative tariff for wind generation. The transition to an auction-determined tariff regime translated into record-low wind tariffs. This contributed to a sharp decline in wind capacity addition (1.8 GW in FY 2017–18 versus 5.5 GW in FY 2016–17), amid fears of less remunerative tariffs and shrinking margins under the new regime.

3.1.1.2 Fiscal and financial incentives

Fiscal benefits – in the form of tax breaks, such as accelerated depreciation – helped lower the burden of taxation on solar and wind developers in the early years of projects and, thereby, bolstered their viability. Wind developers who had not claimed accelerated depreciation benefits in past years were offered as an alternative generation-based incentives, which provided additional financial incentives per unit of electricity generated over the applicable tariffs. These incentives drove RE deployment, particularly in the earlier years. When these incentives were withdrawn, at the end of FY 2011–12, wind capacity addition declined from 3.2 GW in 2011–12 to 1.7 GW in 2012-13.[33] Both these incentives were reinstated in subsequent years. The reinstatement of accelerated depreciation benefits for wind in the latter half of 2014 translated into 3.4 GW of capacity addition in FY 2015–16, as compared to 2.3 GW in 2014–15.[34]

In the case of solar energy, the MNRE offered viability gap funding (VGF) support to solar projects beginning with the Batch-1, Phase-2 tenders (held in the early part of 2014) under the National Solar Mission. The VGF support helped drive solar investment, particularly when solar generation was considerably less competitive than it is today.

Given the enhanced competitiveness of RE tariffs, the government lowered the cap for accelerated depreciation tax benefit for solar and wind projects from 80 per cent to 40 per cent[35], effective from FY 2017–18. Generation-based incentives for wind generation[36] have been withdrawn and VGF support has been phased out.

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[33] Hindu Business Line, "Restoration of accelerated depreciation set to create more wind capacity", https://www.thehindubusinessline.com/economy/policy/Restoration-of-accelerated-depreciation-set-to-create-more-wind-capacity/article20822222.ece, Accessed on 15-6-2018

[34] CEEW analysis based on CEA monthly installed capacity reports

[35] Ministry of Finance, Government of India, Key Features of Budget 2016-17, 2016

[36] The Hindu, "Removal of incentives to hit wind energy projects", http://www.thehindu.com/business/Industry/removal-of-incentives-to-hit-wind-energy-projects/article18191688.ece, Accessed on 16-6-2018

3.1.1.3 Aggressive renewable portfolio standards

RPOs help generate certainty of demand for RE at the state level though the non-compliance with RPOs by discoms has lowered their effectiveness.

The requirement for state distribution utilities (discoms) and large consumers of electricity to offtake RE generation through the mechanism of renewable purchase obligations (RPO), complemented the RE targets in generating certainty of demand for RE at the state level. This was particularly important in the initial years of India's clean energy transition when RE tariffs were significantly less competitive than present levels. However, the effectiveness of RPOs in ensuring certainty of demand has been reduced by the incidence of non-compliance with RPO obligations by discoms.[37]

The government plans massive increases to RE capacity by 2021–22.[38] To ensure offtake, existing regulation requires states to increase RPOs from 11.5 per cent of electricity purchased in 2016–17 to 17 per cent in 2018–19;[39] it also requires states to increase RPOs for solar energy as a subset of total RPOs from 2.75 per cent of electricity purchased in 2016–17 to 8 per cent by 2021–22.[40] To ensure that discoms comply with RPO obligations and meet targets, the MNRE has set up an RPO Compliance Cell to coordinate with central and state regulatory authorities on matters pertaining to RPO compliance. The cell will take up cases of non-compliance with the appropriate authorities.[41] In addition, the MoP has linked discoms' compliance with RPO obligations with their participation in the Ujwal discoms Assurance Yojna (UDAY), which aims to turn discoms around financially and operationally.[42]

3.1.1.4 Must-run status

In the early years of India's clean energy transition, RE tariffs were significantly higher than those of conventional sources of generation. Transmission system operators use the principle of merit order dispatch: when they receive injection requests, transmission system operators prioritise the lowest cost sources for dispatch (from the perspective of offtakers). Given the high RE tariffs in years gone by, these would not have been dispatched as per the rules. To deal with this issue, the Indian Electricity Grid Code, 2010 accorded RE power plants (except biomass power plants with installed capacity of 10 MW and above) must-run status[43] and exempted them from the merit order dispatch mechanism and scheduling regulations. Grid operators can curtail RE sources only in the case of technical constraints. Must-run status ensures the offtake of RE sources, and it has played an instrumental role in scaling up RE generation.

Must-run status ensures the offtake of RE sources, with transmission system operators permitted to curtail RE generation only in the case of technical grid constraints.

[37] Financial Express, "Piyush Goyal launches crackdown against power regulators, says do your job or go", https://www.financialexpress.com/industry/piyush-goyal-launches-crackdown-against-power-regulators-says-do-your-job-or-go/740394/, Accessed on 16-6-2018

[38] ibid

[39] Press Information Bureau, Government of India, "Year End Review 2017", http://pib.nic.in/newsite/PrintRelease.aspx?relid=174832, Accessed on 16-6-2018

[40] ibid

[41] MNRE, Order on Creation of Renewable Purchase Obligation (RPO) Compliance Cell dated 22-5-2018, 2018

[42] Ministry of Power, Office Memorandum on UDAY Scheme for Operational and Financial Turnaround of Power Distribution Companies (Discoms), 2015

[43] Central Electricity Regulatory Commission, Indian Electricity Grid Code 2010, 2010

However, now that utility-scale RE generation is becoming increasingly competitive, policy support in the form of must-run status could be withdrawn. As outlined in the draft National Energy Policy released in June 2017, dispatch could be made completely market-determined.[44] Generation-side improvements in scheduling and forecasting capabilities bolster the case for withdrawing must-run status.

Solar parks help mitigate land acquisition and evacuation infrastructure risks by providing developers with land and evacuation infrastructure for a fee.

3.1.1.5 Dedicated transmission infrastructure for RE

To facilitate the integration of new RE generation capacity and realise its RE ambitions, India needs to invest in strengthening its power transmission and distribution (T&D) infrastructure. To accomplish this, India initiated the Green Energy Corridor project in 2013.[45] The project is expected to cost around INR 380 billion (USD 5.6 billion).[46]

Envisioned as a dedicated transmission network for RE, the project bolstered both intra-state and inter-state transmission infrastructure to facilitate the evacuation of power generated in RE-resource-rich states to load centres countrywide. The project had aimed to set up 8,500 circuit kilometre (ckt-km) of transmission lines by March 2020, but only 3,000 ckt-km is expected to be set up by March 2019.[47] Although currently behind schedule, when completed the project should enhance the ability of the grid to absorb greater variable RE capacity.

3.1.1.6 Mitigation of land acquisition and evacuation infrastructure risks

In setting up solar and wind energy projects, two significant challenges are land acquisition and the inadequate availability of evacuation infrastructure.[48] Initial policy interventions aimed at addressing these challenges were focused mainly on solar generation through the MNRE's Solar Park scheme. Solar parks offer developers land parcels for setting up projects and the necessary supporting infrastructure, including evacuation infrastructure, for a fee. Wind energy generation did not receive the same support, perhaps because in early 2015,[49] when India's RE targets were revised, wind energy generation had had a long track record, and there was significant installed capacity. Moreover, wind has greater variability, and site selection is harder for wind projects relative to solar; wind turbine original equipment manufacturers are best equipped for selecting appropriate sites.

In 2018, the central government announced the National Wind-Solar Hybrid Policy to provide a framework for setting up hybrid wind-solar systems. The policy also aims to address the challenges of land acquisition and the inadequate availability of evacuation infrastructure in setting up solar and wind energy projects.[50] This policy could help RE project developers use the available land

[44] http://niti.gov.in/writereaddata/files/new_initiatives/NEP-ID_27.06.2017.pdf

[45] Press Information Bureau, Government of India, "Germany to Finance India's Green Energy Corridors", http://pib.nic.in/newsite/PrintRelease.aspx?relid=99421, Accessed on 16-6-2018

[46] Mercom, "Can Green Energy Transmission Corridor Development Keep Up with Rapid Renewable Energy Growth in India?", https://mercomindia.com/can-green-energy-transmission-corridor-development-keep-rapid-renewable-energy-growth-india/, Accessed on 16-6-2018

[47] Mercom, "Lack of Transmission Capacity a Growing Concern for Solar and Wind Companies", https://mercomindia.com/transmission-capacity-concern-solar-wind/, Accessed on 16-6-2018

[48] Kanika Chawla, Money Talks? Risks and Responses in India's Solar Sector (CEEW, 2016)

[49] Wind installed capacity stood at around 23 GW at the end of FY 2014-15

[50] Press Information Bureau, "MNRE Issues National Wind-solar Hybrid Policy", http://pib.nic.in/newsite/PrintRelease.aspx?relid=179270, Accessed on 30-5-2018

and evacuation infrastructure resources more efficiently. The floating solar programme and offshore wind programmes are two of the other policy measures that aim to address the risk of land acquisition.[51,52]

The signalling of commitment to the energy transition through the setting of RE targets lends predictability to the RE ecosystem with respect to a pipeline of future projects.

3.1.1.7 Enhanced commitment to clean energy transition

In 2015, the government announced an ambitious RE target of 175 GW by 2022, including 100 GW of solar and 60 GW of wind. India's commitments under the Paris Climate Agreement target a 40 per cent share of non-fossil-fuel-based installed capacity in India's energy mix by 2030. This clear signalling of the government's commitment to the clean energy transition provides the entire RE ecosystem greater predictability with respect to a pipeline of future projects.

3.1.1.8 Waiver of inter-state transmission charges

Solar and wind resources are not uniformly distributed across India but are concentrated in certain regions. Therefore, solar and wind generation will likely be more cost-effective in resource-rich states. Inter-state transmission of electricity allows RE to be transmitted from resource-rich states to fulfil the electricity demand in resource-poor states. It also enables discoms in resource-poor states to fulfil their RPO obligations, though the sale of power across state lines is subject to inter-state transmission charges. In 2016, the revised Tariff Policy provided for a waiver on these charges for solar and wind energy projects to encourage the deployment of RE projects in resource-rich states and facilitate the lowering of RE tariffs.[53] Subsequently, the MoP notified the waiver and made it applicable for projects commissioned up to 31 March 2022.[54] This waiver is applicable in the case of power procured through PPAs from solar and wind generators by obligated entities, including discoms, for the fulfilment of RPOs.[55]

The waiver has encouraged discoms and large C&I customers to procure more RE, but it upsets the level playing field in power generation, since these inter-state transmission charges are passed on to offtakers for conventional power procurement and are eventually borne by end consumers. Further, the need for an incentive to ensure that discoms purchase power from RE sources gives the impression that RE tariffs are not competitive. If budgetary support from states (or the central government) can make up for the amount forgone by transmission companies, buyers of conventional power will not have to pay for the exemptions granted to RE generation.

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[51] Solar Energy Corporation of India, Expression of Interest (EOI) for development of about 10,000 MW Floating Solar PV (FSPV) Projects on Build, Own & Operate basis, 2017

[52] Cleantechnica, "India A Step Closer To First Offshore Wind Energy Auction", https://cleantechnica.com/2018/04/17/india-a-step-closer-to-first-offshore-wind-energy-auction/, Accessed on 18-7-2018

[53] Ministry of Power, Government of India, Order on Waiver of inter-state transmission charges and losses on transmission of the electricity generated from solar and wind sources of energy under para 6.4(6) of the revised Tariff Policy, 2016, dated 30-9-2016, 2016

[54] Ministry of Power, Government of India, Order on Waiver of inter-state transmission charges and losses on transmission of the electricity generated from solar and wind sources of energy under para 6.4(6) of the revised Tariff Policy, 2016, dated 13-2-2018, 2018

[55] ibid

3.1.1.9 Mitigating offtaker risk

Offtaker risk stemming from delays in payments by discoms is a major concern for developers and investors. If developers enter into PPAs with central government entities (SECI, NTPC), which in turn enter into PSAs with state entities, the central government entities take on the offtaker risk. In February 2017, SECI was included as a party to an existing framework to lower the risk of delays or defaults in payment by state discoms to developers.[56] Since 2002, power sales by NTPC to state discoms have been subject to the purview of a tripartite agreement between the central government, state discoms, and the Reserve Bank of India. In 2016, when the agreement was renewed, power sales by SECI to state discoms were also included in the ambit of the agreement.[57] If state discoms do not comply with PPAs, the developer is compensated using funds due to be transferred from the centre to the state government. The lowering of offtaker risk for developers through this mechanism has translated into more aggressive bidding activity and lower tariffs.

3.1.2 Policy-related drivers of rooftop solar deployment

Rooftop solar deployment has had two major policy-related drivers: the capital subsidy scheme and net metering policies. The proposed Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI) scheme could become a driver of rooftop solar deployment going forward.

3.1.2.1 Capital subsidy scheme

In India's rooftop solar sector, the dominant deployment model has been the CAPEX model (Section 2.2.2). However, the high upfront costs associated with the CAPEX model serve as a hindrance for the uptake of rooftop solar. The central government set up the Grid Connected Rooftop and Small Solar Power Plants Programme to incentivise the adoption of rooftop solar by offering a capital subsidy to the residential, social, government/PSU, and institutional sectors.[58] The applicable rates were 30 per cent of capital costs for general category states and up to 70 per cent for certain special category states.

3.1.2.2 Net metering policies

In order to further incentivise the adoption of rooftop solar, net metering policies were introduced in India. Net metering allows owners of grid-connected rooftop solar systems to sell excess electricity generated to the grid, which acts as an incentive for prospective owners to adopt rooftop solar. Based on cues from MNRE[59], most states in India have net metering policies in place.[60] However, implementational challenges have limited the efficacy of the net metering policies in driving rooftop solar adoption (Section 5.2).

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[56] Press Information Bureau, Government of India, "Historic low Tariff of Rs. 2.44 per unit discovered in Bhadla Phase-III Solar Park in auction by SECI", http://pib.nic.in/newsite/PrintRelease.aspx?relid=161755, Accessed on 16-6-2018

[57] Financial Express, "NTPC seeks tripartite pact renewal to ensure payments", http://www.financialexpress.com/economy/ntpc-seeks-tripartite-pact-renewal-to-ensure-payments/126196/, Accessed on 16-6-2018

[58] Press Information Bureau, Government of India, "Year End Review 2017 – MNRE", http://pib.nic.in/newsite/PrintRelease.aspx?relid=174832, Accessed on 16-6-2018

[59] Akshay Urja, Volume 5 Issue 4, February 2012, pages 44-45

[60] MNRE, "Grid Connected SPV Rooftop Systems Policy and Regulatory Framework in Various States", https://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Policy-and-Regulatory-Framework-in-Various-States.pdf, Accessed on 16-6-2018

3.1.2.3 Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI) scheme

The proposed Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI) scheme envisions a discom-driven model of rooftop solar deployment in India. As per the concept note released by the MNRE in December 2017, the scheme proposes to give discoms financial incentives linked to the incremental addition in rooftop solar capacity achieved in a financial year.[61] The financial incentives would enable capacity building at discoms for furthering rooftop solar deployment in their respective distribution areas. These incentives would also partially compensate discoms for revenue lost due to the adoption of rooftop solar.

Reduction in the cost of finance, accounting for over 60 per cent of solar and wind tariffs, amid declining risk perceptions for RE and a favourable financing environment has helped lower RE tariffs.

3.2 Market-related drivers of RE deployment

3.2.1 Improvements in cost-competitiveness of solar and wind generation

Improvements in terms of finance available to RE projects, and declines in equipment costs (wind turbine and solar PV modules),[62] have made RE tariffs more competitive and raised the demand for RE generation. Financing costs account for over 60 per cent of solar and wind energy tariffs and wind turbine/PV module costs account for around 20 per cent[63,64] (Figures 6 and 7, Page 23 and 24 respectively).[65,66]

3.2.1.1 Availability and terms of finance

Risk perceptions pertaining to utility-scale solar and wind energy generation in India have declined recently, because of policy and market-related factors and the favourable financing environment in international and domestic markets.

The benchmark US federal funds target rate remained close to zero in the years following the 2007 financial crisis and rose above 1 per cent only in 2017.[67] The financing regime in India was favourable as well. Interest rates fell considerably over the course of 2014–2018 because of mild rates of inflation. The benchmark repo rate rose for the first time in four years in the middle of 2018.[68] Further, the surge of liquidity experienced by Indian banks as a result of the central government's decision to withdraw high-denomination currency notes in November 2016 added to the impact of the aforementioned factors translating into lower interest rates.

[61] MNRE, Concept Note on SRISTI, 2017

[62] Bridge To India, "Another year from hell for module suppliers", http://www.bridgetoindia.com/another-year-hell-module-suppliers/, Accessed on 18-6-2018

[63] Kanika Chawla and Manu Aggarwal, Anatomy of a Solar Tariff (CEEW, 2016)

[64] CEEW's upcoming research paper 'Analysing the falling solar and wind tariffs: Evidence from India'

[65] Kanika Chawla and Manu Aggarwal, Anatomy of a Solar Tariff (CEEW, 2016)

[66] CEEW's upcoming research paper 'Analysing the falling solar and wind tariffs: Evidence from India'

[67] Y Charts, "US Target Federal Funds Rate", https://ycharts.com/indicators/us_target_federal_funds_rate, Accessed on 16-6-2018

[68] The Economic Times, "RBI hikes repo rate for the first time in Modi regime", https://economictimes.indiatimes.com/markets/stocks/news/rbi-pulls-the-trigger-hikes-rate-for-the-first-time-in-modi-regime/articleshow/64477379.cms, Accessed on 18-6-2018

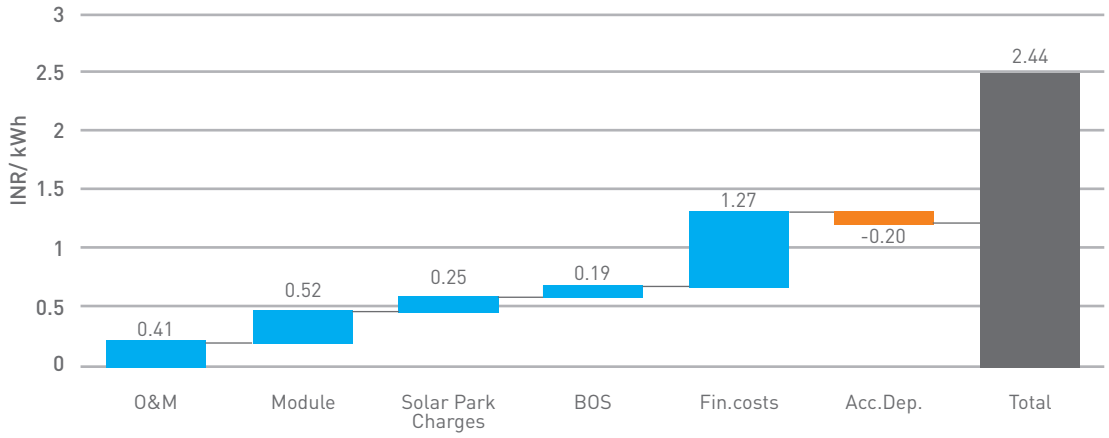
The cumulative impact of these factors considerably reduced the cost of capital for utility-scale projects.[69] However, interest rates are rising in India and worldwide, and could push up the cost of capital for RE projects.

In the case of rooftop solar, multilateral banks such as the World Bank and the ADB have provided dedicated lines of credit to state-owned Indian banks for on-lending to grid-connected rooftop solar projects. The World Bank provided a USD 625 million line of credit to the State Bank of India,[70] while the ADB provided a USD 500 million line of credit to the Punjab National Bank.[71] These lines of credit have expanded the availability of credit to the rooftop solar sector, though loans from these lines of credit have largely been restricted to projects by large developers with creditworthy offtakers.[72]

3.2.1.2 Decline in PV module and wind turbine costs

Over a five-year period, ending in 2017, unit PV module prices declined by around 80 per cent, and wind turbine prices declined by around 20 per cent.[73] These declines were driven by economies of scale facilitated in turn by the large-scale expansion of production. In addition, a global over-supply situation also contributed to the decline in solar PV module prices.

Figure 6: Breakdown of May 2017 Bhadla Phase-III INR 2.44/kWh solar tariff



Source: CEEW analysis

[69] Based on market intelligence, cost of debt for solar projects declined from around 14% to 9% between January 2016 and May 2017

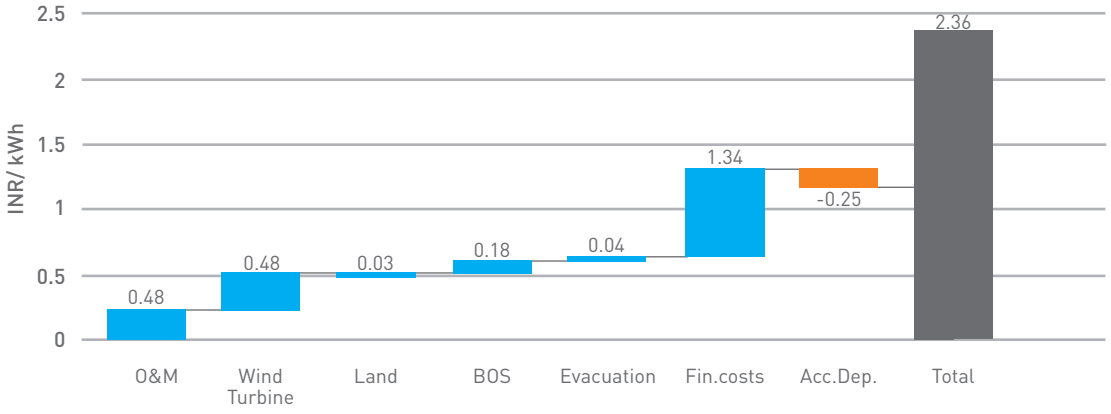
[70] The World Bank, "World Bank Approves $625 Million to Support Grid Connected Rooftop Solar Program in India", http://www.worldbank.org/en/news/press-release/2016/05/13/world-bank-approves-625-million-to-support-grid-connected-rooftop-solar-program-in-india, Accessed on 16-6-2018

[71] Punjab National Bank, "Rooftop Solar PV Projects", https://www.pnbindia.in/Rooftop-Solar-Power.html, Accessed on 16-6-2018

[72] Based on market intelligence

[73] Mint, "Wind power tariffs stay near record low of Rs 2.44/unit in SECI auction", https://www.livemint.com/Industry/w1YII5apaYDLhM4jW5LaAO/Firms-bid-Rs244-per-unit-in-Indias-wind-power-auction.html, Accessed on 16-6-2018

Figure 7: Breakdown of December 2017 Gujarat Urja Vikas Nigam Limited auction INR 2.43/kWh wind tariff



Source: CEEW analysis

Note: The estimated breakdown contains an error of INR 0.07/kWh

4. Opportunities and Co-benefits of Renewable Energy Deployment

Image: iStock

A combination of policy and market-related measures have driven the deployment of RE in India. The rising penetration of RE generation, in turn, offers several desirable socio-economic and strategic co-benefits: enhanced energy access; job creation; enhanced energy security; and a moderating effect on the growth of retail electricity tariffs. It also mitigates air pollution, while rooftop solar helps lower T&D losses and the need for capital investment in distribution infrastructure.

The attainment of India's 100 GW solar target could create 1 million jobs between 2017 and 2022, mostly concentrated in rooftop solar.

4.1 Enhanced energy access

India has made considerable progress in terms of electrification, but it has not achieved the goal of universal access yet. Launched in 2017, the Saubhagya scheme aims to provide electricity connections to around 40 million[74] unelectrified households by March 2019.[75] The provision of grid electricity could be an expensive proposition, particularly in remote locations. In such locations, distributed generation of RE, such as rooftop solar, may be a cost-effective solution in providing access to energy.

4.2 Job creation potential

Solar and wind energy generation offer immense potential for job creation. Solar and wind energy generation provided employment to an additional 21,192 people in FY 2016–17, including 10,221 in ground-mounted solar, 6,749 in rooftop solar, and 4,222 in wind power.[76] If India achieves its 2022 RE targets, it could result in the creation of 1 million jobs between 2017 and 2022, and it could provide new employment to 331,000 workers.[77] These jobs will be concentrated in rooftop solar, since this is the most labour-intensive segment (providing 24.72 job-years per MW, compared to 3.45 job-years per MW for ground-mounted solar and 1.27 job-years per MW for wind).[78] This highlights the importance of rooftop solar in India's RE ambitions.

4.3 Energy security

India is dependent on imports for around 80 per cent of its crude oil requirement and around 10 per cent of its thermal coal requirement.[79,80] The rising deployment of RE generation, in conjunction with the electrification of the transport sector, represent a route to reduce India's import dependence for its energy needs and, thereby, boost energy security. However, while risks associated with fuel sourcing are not applicable to RE generation, developers' reliance on imported solar panels and balance-of-system products exposes the sector to balance-of-payment implications.

[74] Ministry of Finance, Government of India, Budget Speech 2018-19, 2018

[75] Ministry of Power, Government of India, Office memorandum on Saubhagya scheme dated 11-10-2017, 2017

[76] CEEW and NRDC, Greening India's Workforce, 2017

[77] ibid

[78] ibid

[79] ET Energyworld, "India's crude oil imports hit record high in September - trade", https://energy.economictimes.indiatimes.com/news/oil-and-gas/indias-crude-oil-imports-hit-record-high-in-september-trade/61159334, Accessed on 18-6-2018

[80] Latest figure available for 2014 from NITI Aayog, "India Energy Dashboards", http://www.indiaenergy.gov.in/edm/#coalConsumption, Accessed on 18-6-2018

4.4 Deflationary effect on retail electricity tariffs growth

The decline in RE tariffs (Figure 1) has been accompanied by an average annual growth rate of 7 per cent[81] for grid tariffs over the past 10 years. Coal-based thermal generation, which currently accounts for nearly 60 per cent[82] of India's installed capacity, is exposed to a variety of risks including fuel availability, sourcing, and fluctuations in prices, besides dependence on imports for a part of the supply (Section 4.2). These risks could translate into higher financing costs for thermal projects and, therefore, higher project costs. These risks could also result in higher fuel costs. High project and fuel costs could raise thermal power tariffs and, therefore, grid tariffs. Renewable energy project costs and, consequently, tariffs, are not subject to risks pertaining to fuel availability (Section 4.2). Given the competitiveness of RE tariffs, an increasing proportion of RE generation in the electricity mix could reduce the delta between the average cost of supply and the average revenue realised.

Rooftop solar enables electricity generation close to the point of consumption and, thereby, lowers the T&D losses associated with centralised generation.

4.5 Mitigating air pollution

Air pollution has become a major cause for concern in India. Several Indian cities are among the world's most polluted cities.[83] Strengthening public opinion against the problem of unchecked air pollution has forced public officials to tackle this problem. Actions have included plans to shut down polluting thermal power plants.[84] Unlike thermal power generation, renewable energy generation does not pollute the air, and is a potential solution.

4.6 Lowering of T&D losses and capital investments

Rooftop solar enables electricity generation close to the point of consumption and, thereby, lowers the T&D losses associated with centralised generation. In select geographies, the targeted deployment of rooftop solar could help minimise the incidence of grid overloading and, in turn, the need for capital investment to upgrade distribution infrastructure.

[81] CEEW analysis based on discom ARR filings

[82] CEA, Monthly installed capacity report, March 2018

[83] BBC, "India cities dominate world air pollution list", https://www.bbc.com/news/world-asia-india-43972155, Accessed on 16-6-2018

[84] The Times of India, "Badarpur power plant likely to close by deadline", https://timesofindia.indiatimes.com/city/delhi/badarpur-power-plant-likely-to-close-by-deadline/articleshow/63472554.cms, Accessed on 18-6-2018

Image: unsplash

5. Risks

Image: Unsplash

Several risks pertaining to the RE sector could limit investment flow.

5.1 Risks for utility-scale solar and wind

Investments in utility-scale solar and wind energy generation carry several risks.[85]

- Land acquisition and construction risks are associated with the acquisition of land and obtaining the relevant clearances for setting up solar and wind projects.
- Offtaker risk includes delays in signing PPAs or offtaker non-compliance with PPA terms (such as delays in payments or renegotiation of PPAs).
- Transmission and evacuation infrastructure risk is the risk that the grid infrastructure to evacuate the power generated is not available; there is also the challenge of integrating the RE generated into the grid.
- Foreign exchange risk is the risk that the rupee will depreciate and reduce the return to foreign investors.

The risk of payments delays by offtakers has been successfully mitigated for central government offtakers though risks remain for state offtakers.

Cost-effective hedging instruments need to be developed to mitigate foreign exchange risks for international debt and equity investors.[86] For equity investors with well diversified portfolios, foreign exchange risks may not be significant.[87] Policy measures have managed to address land acquisition risk, offtaker risk, and transmission and evacuation infrastructure risk to some extent, and facilitated investment flow into the RE sector and the decline in tariffs (Section 3.1).

However, risks are evolving for renewables, and these continue to pose a threat to the pace of RE capacity addition. These risks are delays in payment; delays in signing, renegotiations, and cancellation of PPAs; change in law – impact of anti-dumping/safeguard duties on RE equipment costs; and transmission risk.

5.1.1 Delays in payment

For projects bid out by central government agencies such as SECI and NTPC, the risk that offtakers (discoms) will delay payments has been mitigated successfully, by including SECI and NTPC in the tripartite agreement (see Mitigating Offtaker Risk in Section 3.1).

But for projects bid out by state governments, payment may be delayed by three or four months.[88] Such a delay is the norm for private conventional generating plants, but the delay could be longer in the case of expensive RE projects installed in the past. This risk is not uniform for all the states. discoms in states such as Gujarat and Uttarakhand are the highest rated in the country and are less likely than others to delay payments.[89]

[85] For a more comprehensive discussion of risks, please refer to the following CEEW publication: Kanika Chawla, Money Talks? Risks and Responses in India's Solar Sector (CEEW, 2016)

[86] Kanika Chawla, Money Talks? Risks and Responses in India's Solar Sector (CEEW, 2016)

[87] ibid

[88] Indian Express, "Power firms ask RBI for special dispensation", http://indianexpress.com/article/business/banking-and-finance/power-firms-ask-rbi-for-special-dispensation-5102607/, Accessed on 16-6-2018

[89] PFC India, State Distribution Utilities Fifth Annual Integrated Rating, 2017

To absorb delays in payment by discoms, developers have to provision for a working capital buffer. That leads to higher tariffs. If the risk that payment will be delayed is low, a working capital buffer is not needed, and the tariff can be low. A robust payment security mechanism (PSM)[90] provided by the Madhya Pradesh government in the Rewa solar project achieved a tariff of INR 3.30 per kWh, the lowest at that time.[91] To achieve the lowest possible RE tariffs for their states and attract greater investment into their geographies, SERCs need to take strict actions against payment delays.

5.1.2 Delays in signing, renegotiations, and cancellation of PPAs

When discoms delay in signing, cancelling, or renegotiating PPAs, the risk posed to RE developers and investors is severe and damaging. The Indian central government may impose penalties on such discoms.[92] Falling RE tariffs over the course of 2016 and 2017 have incentivised discoms to choose from these tactics, to avoid procuring expensive electricity from RE plants installed a few years back. This risk, virtually absent in projects bid out by SECI and NTPC, exists mostly in projects bid out by state agencies.[93] The Indian central government is considering the imposition of penalties on discoms that indulge in any of these tactics.[94] These cases should be clearly distinguished from those in which contracts have been cancelled on genuine grounds. For example, the state of Madhya Pradesh cancelled a PPA because the developer could not complete the project on time.[95]

Tariffs for RE are unlikely to decline drastically from their current levels, unlike in the past (in the reverse auction regime, solar tariffs almost halved from INR 5 to INR 2.44 in two years, and wind tariffs dropped to INR 2.43/kWh). The risks pertaining to the delays in signing, renegotiation, or cancellation of PPAs are more severe for older PPAs, as their tariffs are significantly higher than either the latest RE tariffs or the average pooled purchase price of the discoms. However, even these risks could deter international and domestic investors from investing in defaulting states. If left unchecked, these risks could seriously derail the Indian RE journey and bring the investments in the Indian economy to a halt since infrastructure investments are highly contingent upon the ability of a country to maintain the sanctity of contracts.

5.1.3 Change in law – impact of antidumping/safeguard duties on RE equipment costs

Similar to other geographies such as Europe[96] and the USA[97], the Indian government had been contemplating trade restrictions in the form of anti-dumping duties (ADD) and safeguard duties on solar panels and cells, to safeguard domestic solar manufacturers from alleged unfair trade

[90] PSM is a three- tiered payment security mechanism- Irrevocable letter of credit equal to one month's tariff, overdraft of INR 480,000,000, and Government of Madhya Pradesh's Guarantee Obligation

[91] CEEW analysis

[92] Clean Technica, "India Mulls Penalty For Refusal To Sign Solar PPAs", https://cleantechnica.com/2017/09/08/india-mulls-penalty-refusal-sign-solar-ppas/, Accessed on 16-6-2018

[93] The Economic Times, "After Uttar Pradesh, Jharkhand manages to renegotiate solar tariffs", https://economictimes.indiatimes.com/industry/energy/power/after-uttar-pradesh-jharkhand-manages-to-renegotiate-solar-tariffs/articleshow/59976279.cms, Accessed on 16-6-2018

[94] Clean Technica, "India Mulls Penalty For Refusal To Sign Solar PPAs", https://cleantechnica.com/2017/09/08/india-mulls-penalty-refusal-sign-solar-ppas/, Accessed on 16-6-2018

[95] Financial Express, "Madhya Pradesh cracks whip, cancels solar PPAs signed with Canadian firm's India unit Sky Power Solar", http://www.financialexpress.com/economy/madhya-pradesh-cracks-whip-cancels-solar-ppas-signed-with-canadian-firms-india-unit-sky-power-solar/844434/, Accessed on 16-6-2018

[96] The Guardian, "Solar industry says EU tariffs on Chinese imports will raise panel prices", https://www.theguardian.com/environment/2017/sep/08/solar-industry-says-eu-tariffs-chinese-imports-will-raise-panel-prices, Accessed on 16-6-2018

[97] New York Times, "Trump Slaps Steep Tariffs on Foreign Washing Machines and Solar Products", https://www.nytimes.com/2018/01/22/business/trump-tariffs-washing-machines-solar-panels.html, Accessed on 16-6-2018

practices for some time.[98] The safeguard duty case was subject to the regulatory jurisdiction of the Ministry of Finance, and the ADD case was subject to the regulatory jurisdiction of the Ministry of Commerce and Industry. Recently, the government merged the two trade watchdogs into the Directorate General of Trade Remedies (DGTR).[99]

The DGTR recommended that a safeguard duty be imposed on solar cells imported from China and Malaysia for two years (25 per cent in the first year, 20 per cent for the first six months of the second year, and 15 per cent for the remaining part of the second year).[100] Based on petitions from developers, the Orissa High Court stayed the imposition of safeguard duties. The Ministry of Finance notified the imposition of the duties beginning 30 July 2018,[101] but later suspended the order, and instead provided for a provisional assessment of safeguard duty on cell imports to be paid by the importer if the courts subsequently allowed the imposition of safeguard duties.[102] The case in the Orissa High Court is still under litigation.[103]

Though the matter is under litigation, the government has assured that these duties will be allowed to pass through[104] (developers would be allowed to raise tariffs to incorporate the change in duties for PPAs affected by such a change in law). But such developments create a lot of uncertainty among the broader stakeholders and could stall the momentum created in the sector in the last four years. The 'change in law' provision in PPAs should be articulated in a more transparent manner to obviate the need for clarifications from the government.

5.1.4 Transmission risk

Renewable energy projects take 12–18 months from the signing of the PPA to commissioning,[105] but the setting up of the supporting power transmission infrastructure takes 3–5 years.[106]As most solar and wind projects are located far from demand sources, this mismatch in commissioning time could play a spoiler in the Indian RE revolution. The central and state authorities are implementing many transformative schemes, such as the Green Energy Corridor and forecasting and scheduling regulation for states, to integrate the planned capacity of 175 GW of RE by 2022. However, issues such as right of way and land acquisition could delay the commissioning of transmission infrastructure in India,[107] which could, in turn, raise the risk of unavailable transmission infrastructure or curtailment/backing down for RE capacities to be installed.

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[98] Bridge To India, Anti-dumping duty on PV cells and modules, 2017

[99] Mint, "India merges anti-dumping, import safeguard bodies", https://www.livemint.com/Politics/Pvg3Ht9aDPsbO8OdPEeODM/India-merges-antidumping-import-safeguard-bodies.html, Accessed on 16-6-2018

[100] The Economic Times, "DGTR for safeguard duty on solar panel imports", https://economictimes.indiatimes.com/news/economy/foreign-trade/commerce-ministry-recommends-imposition-of-safeguard-duty-on-solar-cells/articleshow/65013517.cms, Accessed on 18-7-2018

[101] The Economic Times, "Orissa High Court stays safeguard duty on imported solar panels", https://www.thehindu.com/business/Industry/centre-imposes-25-safeguard-duty-on-import-of-solar-cells/article24565771.ece, Accessed on 18-8-2018

[102] Mercom, "No Safeguard Duty on Solar Imports for Now, Says Ministry of Finance", https://mercomindia.com/no-safeguard-duty-solar-for-now-finance-ministry/, Accessed on 21-8-2018

[103] Mercom, "Orissa High Court Sets Next Hearing for Solar Safeguard Duty Case on August 27, 2018", https://mercomindia.com/orissa-court-next-hearing-safeguard-august-27/, Accessed on 21-8-2018

[104] The Hindustan Times, "Govt to amend solar bid rule to allow pass through of import duty hike", https://www.hindustantimes.com/business-news/govt-to-amend-solar-bid-rule-to-allow-pass-through-of-import-duty-hike/story-pFr5joF2wvVvGPdXnyAzfM.html, Accessed on 16-6-2018

[105] TNERC, M.P. No. 10 of 2017, 2017

[106] FICCI, Power Transmission The Real Bottleneck, 2013

[107] ibid

To strengthen/upgrade the sub-stations and transformers, the central government launched in 2014 the Integrated Power Development Scheme.[108] This has been a welcome move, but continued instances of backing down have been reported in some parts of India.[109,110] Curtailment risk poses a significant threat to the receivables of developers. If it manifests more frequently than the assumptions factored in the project's financial model, curtailment risk could severely impact a project developer's cash flow and debt repayment ability.

Indian authorities have also provided for compensation in the case of backing down of generation under the revised tariff bidding guidelines for both solar and wind projects.[111] To protect the Indian RE journey from curtailment risk, better coordination is required between transmission planning agencies and generation capacity-tendering entities.

RE projects take 12–18 months from the signing of the PPA to commissioning, while the setting up of power transmission infrastructure takes 3–5 years – in the absence of adequate planning, this mismatch in commissioning times could retard RE capacity addition.

5.2 Risks for rooftop solar

Rooftop solar is characterised by a specific set of risks, different from those applicable to utility-scale solar and wind: consumer-related challenges; reluctance of discoms to facilitate rooftop adoption; and the lack of bankability of projects.

5.2.1 Consumer-related challenges

Consumer-related challenges are low consumer awareness; lack of access to credit; and lack of access to roofs.

5.2.1.1 Low consumer awareness

Consumer awareness of the benefits of rooftop solar is low. The competitiveness of rooftop solar tariffs under the OPEX model has improved, particularly for C&I consumers (Section 2.2.2). However, consumers still consider rooftop solar an expensive source of power. Also, consumers have low awareness of government rooftop solar schemes and of the process of obtaining a net metering connection.[112] These constitute barriers for the uptake of rooftop solar in India.

Discoms, which have a ready consumer-facing interface, could be tasked with improving consumer awareness of rooftop solar. The

Discoms are reluctant to support rooftop solar adoption in the C&I segment, which pays the highest tariffs and cross-subsidises electricity consumption for small residential and agricultural consumers.

[108] Press Information Bureau, Government of India, "Integrated Power Development Scheme", http://pib.nic.in/newsite/PrintRelease.aspx?relid=111621, Accessed on 16-6-2018

[109] RERC, Order on petition no. RERC-786-799/16, & 812-815, 847/16, 1164-1176/17 and 1196/17, 2017

[110] Mint, "Renewable energy firms worry about back-down by power discoms", http://www.livemint.com/Industry/ASu58DZtfl5xnomADH13wL/Clean-energy-firms-worry-about-backdown-by-discoms.html, Accessed on 16-6-2018

[111] Ministry of Power, Government of India, Guidelines for Tariff Based Competitive Bidding Process for Procurement of Power from Grid Connected Wind Power Plants, 2017

[112] Based on stakeholder consultations

proposed SRISTI scheme envisions such a role for discoms, among other activities proposed for creating an enabling ecosystem for rooftop solar deployment within their distribution areas.[113]

5.2.1.2 Access to credit

A large section of residential and micro, small and medium enterprise (MSME) C&I consumers lacks creditworthiness. That limits their access to credit, which is needed to fund the upfront costs of systems in the CAPEX model, and lowers the bankability of projects with such consumers as offtakers in the OPEX model and, in turn, poses a challenge for the deployment of rooftop solar. From the perspective of banks, low-income residential consumers with limited credit histories are not creditworthy customers or offtakers, and assessing the profitability of MSMEs is difficult because they do not maintain accounts regularly.[114] Typically, little information is available on the credit histories of MSMEs. All this has historically limited these businesses' access to bank credit.

5.2.1.3 Lack of access to roofs

To set up a rooftop solar system, a consumer needs access to a suitable roof space or they need to have the right to use one. If they lack such access or rights, they cannot adopt rooftop solar.

In partnership with BSES Yamuna, one of the major discoms in Delhi, CEEW has developed innovative business models for increasing the adoption of rooftop solar among residential consumers in the discoms service area. At tariffs comparable to grid electricity, the on-bill financing model could raise penetration among consumers with poor credit, and the community solar model could persuade consumers without roof space to adopt rooftop solar.[115] Risk mitigation (Section 7.2) could help increase the adoption of rooftop solar for the C&I segment.

5.2.2 Reluctance of discoms

Discoms are reluctant to support rooftop solar adoption – particularly in the C&I segment, which pays their highest tariff – because they forgo revenue. Since C&I consumers cross-subsidise electricity consumption for small residential and agricultural consumers, the loss in business from these consumers magnifies the financial burden on discoms. The reluctance of discoms to support rooftop solar adoption manifests in long delays in approvals for net metering connections and in regulations limiting the size of rooftop installations. But the cost-competitiveness of solar PV technology and declining module prices make the transition to rooftop solar inevitable. To facilitate adoption, it is important to design incentives that redefine discoms' business models and align their interests with rooftop solar adoption. The SRISTI scheme, for example, proposes to tie financial incentives to the scale of rooftop adoption in discoms' service areas.[116]

The small size and disaggregated nature of projects, non-standardised PPAs, and the lack of creditworthiness of low-income residential and MSME offtkers lowers the bankability of rooftop solar projects.

[113] MNRE, Concept Note on SRISTI, 2017

[114] Mint, "Banks rework funding strategies for MSMEs", https://www.livemint.com/Industry/OPacHSLXT6eqypt8ajeQqJ/Banks-rework-funding-strategies-for-MSMEs.html, Accessed on 31-7-2018

[115] Neeraj Kuldeep, Selna Saji, and Kanika Chawla, Scaling Rooftop Solar: Powering India's Renewable Energy Transition with Households and DISCOMs (CEEW, 2018)

[116] MNRE, Concept Note on SRISTI, 2017

5.2.3 Bankability of projects

Under the OPEX model, most of the rooftop solar deployment so far has been limited to projects with creditworthy government or large corporate entities as offtakers. Several factors limit the bankability of rooftop solar projects other than projects with such offtakers and limit the flow of capital.

The small size and disaggregated nature of rooftop projects increases transaction costs for banks. In addition, the lack of standardisation of PPAs increases the burden of due diligence on banks. At the branch level, there is limited understanding of the rooftop solar sector and little institutional capacity for processing rooftop solar loans. Low-income residential consumers and MSME C&I offtakers are not creditworthy. Smaller developers have low creditworthiness and limited track records. Lastly, rooftop solar technology has a limited performance record.

Innovative financial solutions could improve the bankability of rooftop solar projects and increase the flow of finance to such projects (Section 7.2, Page 44).

Image: unsplash

6. State-specific Prospects for Utility-scale Renewable Energy

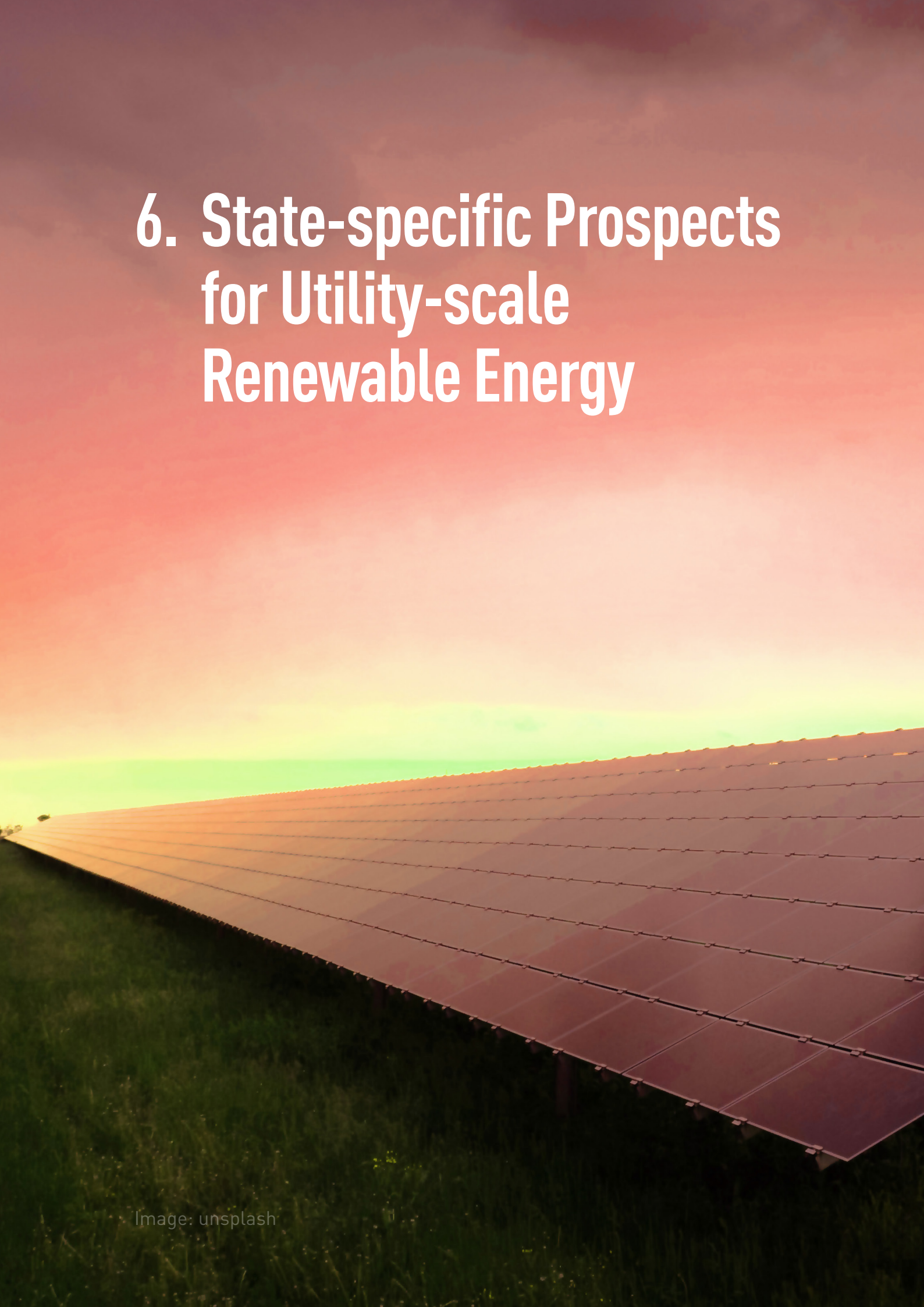

Image: unsplash

Karnataka and Telangana clearly lead the pack in installed solar capacity; Tamil Nadu and Gujarat lead in installed wind capacity (Table 1). In the Indian renewables market, risks shift constantly (Section 5); could the current RE leaders in the standing remain leaders? This would depend on a multitude of factors – the regulatory regime for the increased penetration of renewables; the future demand potential of electricity; the extent of power supply shortage in the state; and the ability of major buyers such as discoms and, in turn, consumers to pay for the electricity consumed in a timely manner.

Contract enforcement and the prompt implementation of regulations geared towards RE integration are crucial elements of a favourable regulatory regime for increasing RE penetration.

This report zeroes in on five proxies (grouped into four categories) to measure these parameters (Table 4).

1. Regulatory regime for increased penetration of RE
    - Whether regulations pertaining to forecasting and scheduling of solar and wind generation have been notified
    - Instances of PPAs renegotiation/cancellation, which represents the status of contract enforcement in the state
2. Power deficit, which captures the extent of the supply shortage in the state
3. Utility grade, which represent metrics of financial and operational performance of discoms (as per the MoP's Sixth Annual Integrated Ratings for State discoms, 2017) and thereby the ability of these discoms to procure electricity
4. State GDP per capita, which represents the consumers' ability to pay

6.1 Regulation and policy for increased penetration of RE

Most states mandate RE developers to forecast and provide day-ahead and intra-day revisions for day-ahead schedules for their generating units, but only some states have notified these regulations; several states have drafted but not notified them.[117] This will be a critical requirement for the increased penetration of RE sources in the states and in turn, the Indian grid (Column 2 in Table 4, Page 39). Of the RE-rich states, Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan, and Telangana had notified these regulations by the end of June 2018. This single factor could change how these states stack up in terms of RE capacity addition.

Contract enforcement is another crucial component of a favourable regulatory regime for increasing RE penetration and for infrastructure investments in general, which are characterised by long-term contracts. Infrastructure projects entail huge capital costs and could easily become stressed if contracts are not enforced in time. Given the regulated nature of the Indian electricity market, this becomes a critical factor in attracting investments.

Renewable energy tariffs have come down significantly in the last two years and incentivised many Indian electrical utilities to renege on/renegotiate the PPAs signed at higher prices.[118] While it

[117] CEEW analysis based on information from state electricity regulatory commissions' websites

[118] Business Standard," Tamil Nadu govt in talks with Adani, others to reduce solar power price" http://www.business-standard.com/article/economy-policy/tamil-nadu-govt-in-talks-with-adani-others-to-reduce-solar-power-price-117061901111_1.html, Accessed on 16-6-2018

makes economic sense to procure electricity at lower prices, such an action could singlehandedly halt the Indian RE run as investors lose confidence in the ability of states and regulators to enforce contracts. In the last two years, this has been observed in at least three states – Andhra Pradesh, Tamil Nadu, and Karnataka (Column 3 in Table 4).

These constitute the bare minimum policy-related and regulatory measures to support the increased penetration of RE. More steps can be taken. The development of electricity markets and a shift towards shorter and medium term contracts, instead of long-term PPAs, would likely increase the demand for RE, characterised by lower tariffs compared to conventional generation. Similarly, retail tariff reform, through market-reflective tariff setting, could also increase the demand for RE, given the competitiveness of RE tariffs. To incentivise discoms to purchase more electricity and, thereby, renewable power, regulations must enforce minimum standards of reliability of electricity for consumers.

6.2 Shortage of power in the state

Some Indian states suffer from shortage of power supply. These states are more likely to commission additional electricity capacity. Alternatively, they could also procure power from plants situated in other states. But, to reduce T&D losses and avoid transmission charges, procuring electricity from nearby plants makes the most economic sense. Karnataka and Rajasthan have the largest power deficits in RE-rich states (last column, Table 4). While this situation could evolve in the future, investors could look to invest in RE capacities in states characterised by power shortages.

Table 4: Current leaders in RE might not remain leaders in future

States/ Parameters	Regulatory framework	Instances of PPAs renegotiation/ cancellation	Utility grade of discoms	State GDP per capita (in millions INR) for 2016–17	Power surplus/ deficit (in million units) for 2016–17
Andhra Pradesh	Yes	Yes	A, B+	122376	-44
Gujarat	No	No	A+, A+, A+, A+	151825 *	-1
Karnataka	Yes	Yes	A, B+, B, B	161058*	-362
Madhya Pradesh	Yes	No	B+, C+, C+	72599	0
Maharashtra	No	No	B+	162238*	-65
Rajasthan	Yes	No	B, B, B	93026*	-421
Tamil Nadu	No	Yes	B	157116	-24
Telangana	Yes	No	B+	158360	-12

Sources: Regulatory Framework: CEEW analysis based on websites of SERCs as of June 2018
Utility Grade of DISCOMs: MoP, State Distribution Utilities Sixth Annual Integrated Rating, 2018
Power Deficit: CEA, Load Generation Balance Report 2017–18, 2017
**Projected data for 2016-17*

6.3 Consumers' ability to pay and future demand potential of electricity

In addition to the ability of bulk buyers to procure electricity, the ability of end-consumers to purchase electricity from these buyers is also an important consideration in making investment decisions. Otherwise, discoms might not get into a contract with any of the generating stations. The state GDP per capita is a good proxy to measure the income of consumers in a state and, in turn, consumers' ability to pay. Maharashtra and Karnataka lead the pack on this parameter (Column 5 in Table 4).

Investors would be wise to base their investment decisions on power deficit (section 6.2) and the future demand potential of electricity in a specific state. GDP per capita could be a good proxy to measure the extent of economic activity and the strength of industrial base in a state. These two, in turn, would decide the future demand potential of electricity. Karnataka and Maharashtra lead the pack on this front (Column 5 in Table 4).

6.4 Ability of bulk electricity buyers to procure electricity

The most important factor in raising capital for infrastructure projects is the creditworthiness of the counterparty. State discoms are the largest buyers of electricity, and they have different utility grade ratings, which represent the state of their financial and operating metrics. States such as Rajasthan, which have high solar irradiation but poorly rated discoms, could achieve tariffs lower-than-current ones by improving their utility grade ratings. Madhya Pradesh, Rajasthan, and Tamil Nadu need to work on improving the financial health of their discoms to achieve lower RE tariffs and make their states more RE investment-friendly (Column 4 in Table 4).

States can achieve lower RE tariffs by improving the financial health and thereby the creditworthiness of their discoms

If a discom from another state offtakes power, that discom's creditworthiness needs to be considered. The project can be located in a resource-rich state even if that state is characterised by poorly rated discoms, thus ensuring that investments can be scaled up in states with favourable resource availability.

The above-mentioned factors are not comprehensive, but capture the most important determinants for investors to invest in a specific state. Investors, depending on their risk profiles, should assess these trade-offs and make decisions accordingly.

7. Accelerating the Clean Energy Transition – The Road Ahead

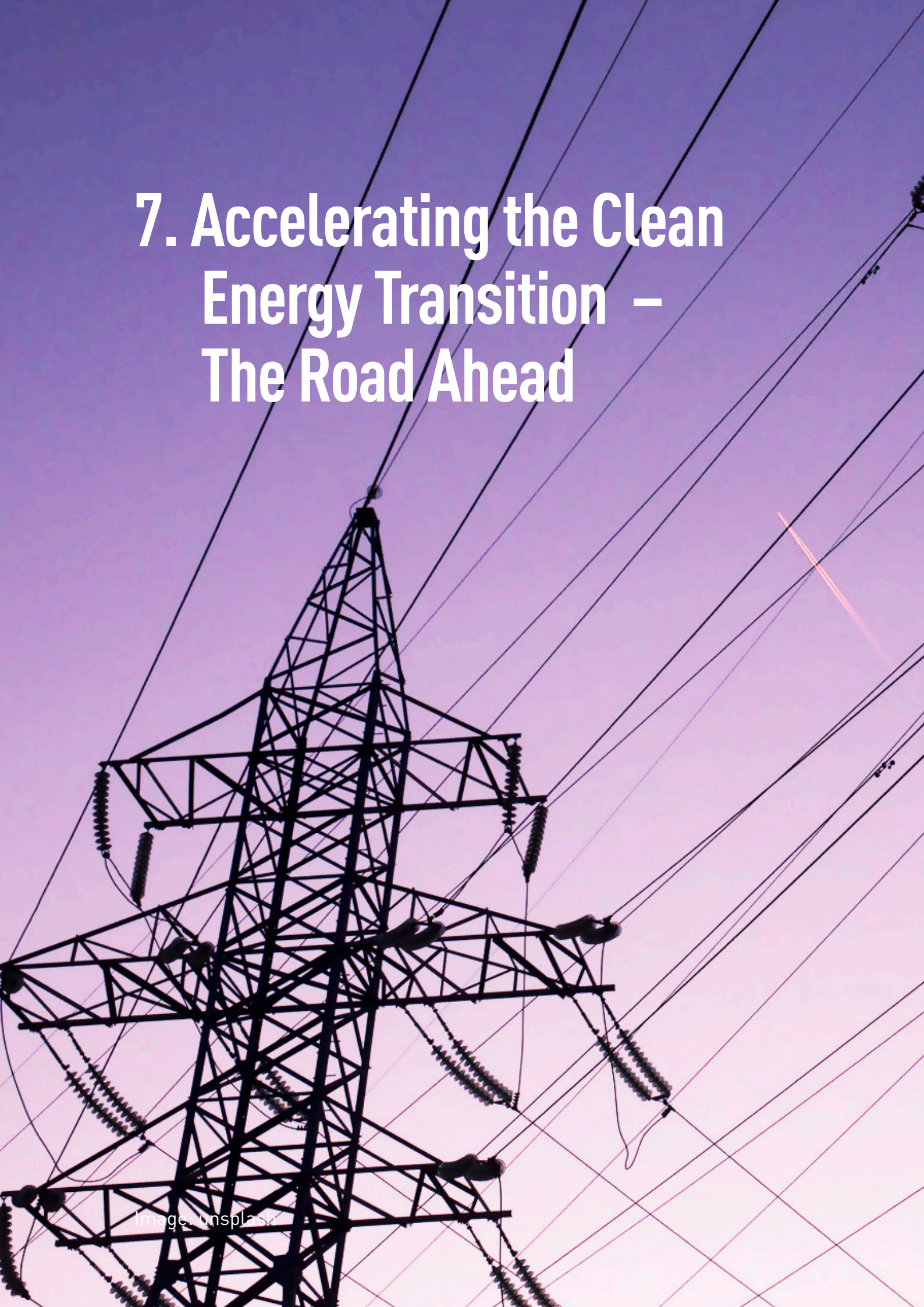

Image: Unsplash

To enhance investment flows and accelerate the pace of India's clean energy transition, risks constraining these investments must be mitigated. This section focuses on major risks that constitute priority areas for intervention.

7.1 Utility-scale RE generation – the integration challenge

Utility-scale RE generation in India is now commercially viable, and so public funds should not be used for direct lending to RE projects. However, given the pace and scale of India's upcoming RE deployment, considerable RE generation capacity will have to be integrated into the grid. That will be a major challenge, and it should be the focus of public investment.

With utility-scale RE generation now commercially viable, public funds should be targeted towards the grid integration of RE instead of direct lending to projects.

7.1.1 Strengthening T&D infrastructure

7.1.1.1. One nation, one grid

The unevenness in distribution of RE generation in India – largely concentrated in eight states with high RE potential – calls for a robust T&D network to evacuate power to non-RE-rich states. In addition, the infrastructure at the substation level within states requires strengthening to facilitate RE integration.

7.1.1.2. One region, one grid

Moreover, India's grid could be connected with those of its neighbours to form a regional grid. This could enable power deficit countries in the region to benefit from surplus generation in others, thereby boosting the region's energy security as a whole. [119]

Besides boosting collective energy security, the formation of a regional grid in South Asia could enhance the capacity for absorption of RE in the region, as exemplified by interconnected grid systems in northern Europe.[120] While the RE deployment in India's immediate neighbourhood is now only a few gigawatt (GW), most countries in the region do have long-term RE deployment goals and would benefit from an interconnected grid (Table 5, Page 43). Alternatively, these countries could offtake RE generated from India through grid interconnection to increase the proportion of RE in their respective energy mix.

Regional grid interconnection is a complicated process. It requires the harmonisation of grid codes, operating procedures, and standards across countries. However, given the benefits of such a course of action, countries in the region could build upon previous efforts at achieving grid interconnection. Specifically, they could operationalise the SAARC Framework Agreement for Energy Cooperation.

[119] Press Information Bureau, Government of India, "Shri Piyush Goyal calls for Building SAARC Power Grid", http://pib.nic.in/newsite/PrintRelease.aspx?relid=110632, Accessed 16-6-2018

[120] Agora Energiewende, Increased Integration of the Nordic and German Electricity Systems, 2015

Table 5: RE deployment in India's neighbourhood

Country	Installed RE capacity	Long-term RE target/ policy
Afghanistan	50 MW[121]	350–450 MW by 2032[122]
Bangladesh	437 MW[123]	3.1 GW by 2021[124]
Nepal	45 MW[125]	To achieve universal access to clean, reliable and affordable RE solutions by 2030[126]
Sri Lanka	442 MW[127]	972 MW by 2020[128]
Bhutan		25 MW by 2025[129]
Myanmar		15 per cent-20 per cent share of RE in installed capacity by 2020[130]

Note: Installed RE capacity figures for Afghanistan and Sri Lanka correspond to the year 2014 whereas those for Bangladesh and Nepal correspond to the years 2015 and 2016 respectively. Accurate installed capacity figures for Bhutan and Myanmar were not available.

7.1.2 Contractual provisions in PPAs

The risk of curtailment can be lowered through contractual provisions in PPAs such as minimum offtake guarantees and monetary compensation in case of non-compliance with contractual provisions. [131] These provisions must be complemented by their effective enforcement in order to translate into a credible mechanism for protecting developers and investors from revenue losses stemming from curtailment.

7.1.3 Improved scheduling and forecasting for RE integration

Besides grid interconnection, investments in IT-enabled forecasting and scheduling equipment could further facilitate RE integration. Greater accuracy in scheduling and forecasting could lower the incidence of curtailment of RE generation, which has become a significant problem in India with increasing RE penetration.[132] The setting up of Renewable Energy Management Centres (REMCs), co-located with SLDCs, under the Green Energy Corridor project aims to meet this need. The REMCs are to be equipped with advanced forecasting tools and are expected to conduct real-time monitoring of RE generation, which should translate into better forecasting and dispatch of RE generation.

[121] Ministry of Energy and Water, Islamic Republic of Afghanistan, Afghanistan National Renewable Energy Policy, 2014

[122] ibid

[123] IEA, "Scaling Up Renewable Energy Program for Bangladesh", https://www.iea.org/policiesandmeasures/pams/bangladesh/name-157149-en.php?s=dHlwZT1yZSZzdGF0dXM9T2s,&return=PG5hdiBpZD0iYnJlYWRjcnVtYiI-PGEgaHJlZj0iLyI-, Accessed on 16-6-2018

[124] ibid

[125] http://www.aepc.gov.np/docs/resource/rescenter/20160606165013_RE%20Subsidy%20Policy%202016%20(2073%20BS)_Unofficial%20Translation_English.pdf

[126] ibid

[127] Clean Technica, "Sri Lanka Considering 20% Renewable Energy In Power Generation", https://cleantechnica.com/2015/09/29/sri-lanka-considering-20-renewable-energy-power-generation/, Accessed on 16-6-2018

[128] ibid

[129] TERI, "Bhutan: 25 MW of renewable energy by 2025", http://www.terienvis.nic.in/index1.aspx?lid=1763&linkid=1261&langid=1&mid=4, Accessed on 16-6-2018

[130] National Energy Management Committee, The Government of the Republic of the Union of Myanmar, Myanmar Energy Master Plan, 2015

[131] Anjali Viswamohanan and Manu Aggarwal, Curtailing Renewable Energy Curtailment (CEEW, 2018)

[132] EnergyNext, "Renewable Integration: Need for curtailment risk assessment", http://www.energynext.in/renewable-integration-need-for-curtailment-risk-assessment/, Accessed on 16-6-2018

7.1.4 De-risking private investment through financial instruments

Financial instruments mitigating curtailment risk constitute short to medium term solutions for facilitating RE grid integration.

While the strengthening of T&D infrastructure constitutes a long-term solution for effective RE integration, financial instruments aimed at risk mitigation constitute short to medium term solutions. Insurance products or guarantees offer a means of mitigating the risks of RE curtailment, which would support greater private investment in RE generation. Two such instruments are outlined in Section 7.2.

7.1.5 Flexible conventional generation to support RE deployment

Investments in clean conventional sources of generation are complementary to greater RE deployment. Pumped storage hydroelectric projects could play a role in facilitating RE integration into the grid. In the case of thermal power generation, emphasis should be placed on technologies that make the grid more flexible to complement the increasing penetration of RE. Reinvigorating gas-based generation, and investing in technologies such as automatic generation control in the case of coal, could help achieve this objective.

7.2 New paradigms of financing

7.2.1 Focus on risk mitigation instead of direct lending

The achievement of India's NDCs under the Paris Agreement would require investments of around USD 448 billion in RE alone between 2018 and 2030.[133] The enormity of the investment needed to achieve these targets necessitates the large-scale participation of private sector capital to augment public sources. While the use of public sources of capital for direct project financing certainly helps enhance the flow of finance towards the clean energy sector, the deployment of capital through innovative means such as instruments geared towards risk mitigation could facilitate much higher private sector capital per unit investment than direct project finance.

Green investment banks are examples of financial institutions that have been successful in using limited capital – usually, though not exclusively, public capital – to mobilise large quantities of private sector capital. A case in point is the Connecticut Green Bank, set up with public money, which mobilises total investments of USD 9 for every USD 1[134] invested.

7.2.2 De-risking underserved market segments

Green investment banks are market-making institutions/vehicles that facilitate the development of underserved clean energy market segments.[135] This is achieved by a reallocation of risks pertaining to the market segment. Green banks underwrite risks that constrain investment flow, thereby crowding private sector investment in to these market segments. Green banks have greater capacity than conventional financial institutions to underwrite risks and are usually, though not exclusively, funded by public capital.

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[133] IFC, Climate Investment Opportunities in South Asia, 2017

[134] Connecticut Green Bank, "Green Bank 101: A Robust Economic Development Engine", https://www.ctgreenbank.com/economic-development-engine/, Accessed on 16-6-2018

[135] CEEW-NRDC, Greening India's Financial Market: Opportunities for a Green Bank in India, 2016

Green investment banks have successfully helped scale up clean energy market segments at the national and sub-national level in developed and developing countries. A similar model could be adapted to channel greater investments to underserved clean energy related market segments such as rooftop solar, solar powered irrigation systems, storage, and flexible thermal in the Indian context. Such an institutional risk mitigation mechanism could be set up either as a standalone institution or subsumed under the operations of existing institutions[136] as 'green windows'. Green windows can utilise funds allotted specifically to deploy innovative instruments for risk mitigation such as guarantees and aggregation vehicles.

Green banks underwrite risks that constrain investment flow into underserved RE market segments, thereby crowding in private sector investment.

Such approaches geared towards de-risking could represent solutions to the factors lowering the bankability of rooftop solar projects (Section 5.2.3). Given the small size and disaggregated nature of projects, aggregation constructs that produce project portfolios of a viable size from the perspective of financiers could be a part of the solution. Financial instruments such as guarantees and PSMs could help mitigate offtaker risks in the case of projects with less creditworthy offtakers.

7.2.3 De-risking utility-scale RE segments

Such financing paradigms could de-risk more mature RE segments as well, supporting greater private investments into these segments. Two such examples of financial instruments aimed at risk mitigation that can support growth in utility-scale market segments are presented below.

7.2.3.1 Common Risk Mitigation Mechanism (CRMM)[137]

The Common Risk Mitigation Mechanism (CRMM) is a one-stop-guarantee for underwriting political risk, offtaker risk, and foreign currency risk of solar projects in emerging economies. The CRMM will have two key parts; one is the guarantor.

In the first stage, a capitalisation of USD 1 billion in the guarantor could be leveraged to deploy (and guarantee) as much as 15 GW of grid interactive solar capacity across 20 developing countries. The guarantor could be capitalised with international public money and small contributions from the participating countries.

Financial instruments geared towards risk mitigation such as the CRMM and the GIG represent more efficient use of capital in mobilizing RE investments than direct lending.

The other key part is a digital platform that will create a global marketplace. The CRMM platform could manage aggregated pipelines of projects and guarantees, creating a one-stop shop for investors to buy bundles of investment grade projects in multiple geographies, and a global consolidated market for insurers and re-insurers to access these consolidated risks and offtake the risks that interest them.

The guarantee mechanism would consist of a risk transfer instrument, which would provide dedicated swaps and guarantees on a list of main risks. The guarantee entity would minimise its

[136] Such as Indian Renewable Energy Development Agency, SECI, Small Industries Development Bank of India, India Infrastructure Finance Company, and National Bank for Agriculture and Rural Development.

[137] CEEW, CII, TCX, TWI, Common Risk Mitigation Mechanism – Feasibility Study, November 2017

capital requirements by transferring a large part of the subscribed risk to existing insurance and hedging instruments offered by MDBs and development finance institutions (DFIs) and to private or semi-private insurance and re-insurance entities.[138] Existing de-risking mechanisms could benefit from better access to a larger pipeline of solar projects and would be provided with bundled risk packages that can be managed with ease.

The CRMM began to be developed in May 2017 when several national governments entrusted an international multi-stakeholder taskforce with the mission to define and structure a common mechanism aimed at de-risking investments in solar under the aegis of the International Solar Alliance. The participating governments are of Argentina, Australia, Brazil, Burkina Faso, Cameroon, Chad, France, India, Ivory Coast, Mali, Namibia, Niger, Nigeria, Senegal, Seychelles, Uganda, and Yemen.

7.2.3.2 Grid integration guarantee

In India, RE tariffs are among the lowest in the world. However, as competition grows, the extent to which developers factor in curtailment risk into their bids is unclear. When this risk manifests, banks, investors, and developers are often left with stressed assets. Mitigating this risk would lower the cost of capital for RE projects, result in more effective resource utilisation of installed RE capacity, lower RE tariffs, and in effect, lower GHG emissions.[139] Power systems across the world use sophisticated dispatch and communication systems. CEEW intends to design a Grid Integration Guarantee (GIG) by using the data generated in power systems operations to model and calculate premiums using a combination of actuarial methods and big data techniques.

The GIG indemnifies solar and wind generators against loss of revenue due to the curtailment of renewable power from the grid.[140] Risk premiums on the GIG would inform policymakers about the feasible pace of renewable capacity additions and help quantify the cost of grid integration.[141] The GIG would cover the tail-end curtailment risk with market-reflective pricing and would be developed, with an implementation toolkit.

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[138] MDBs include the World Bank Group, European Investment Bank, European Bank for Reconstruction and Development, Inter-American Development Bank, and ADB. DFIs include Agence Française de Développement, KfW, Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden N.V, CDC, and Overseas Private Investment Corporation. Private or semi-private insurance and re-insurance entities include The Currency Exchange Fund, GuarantCo, African Trade Insurance, and AXA.

[139] CEEW, Addressing Renewable Energy Curtailment: A Composite Approach, 2018

[140] ibid

[141] ibid

8. Conclusion

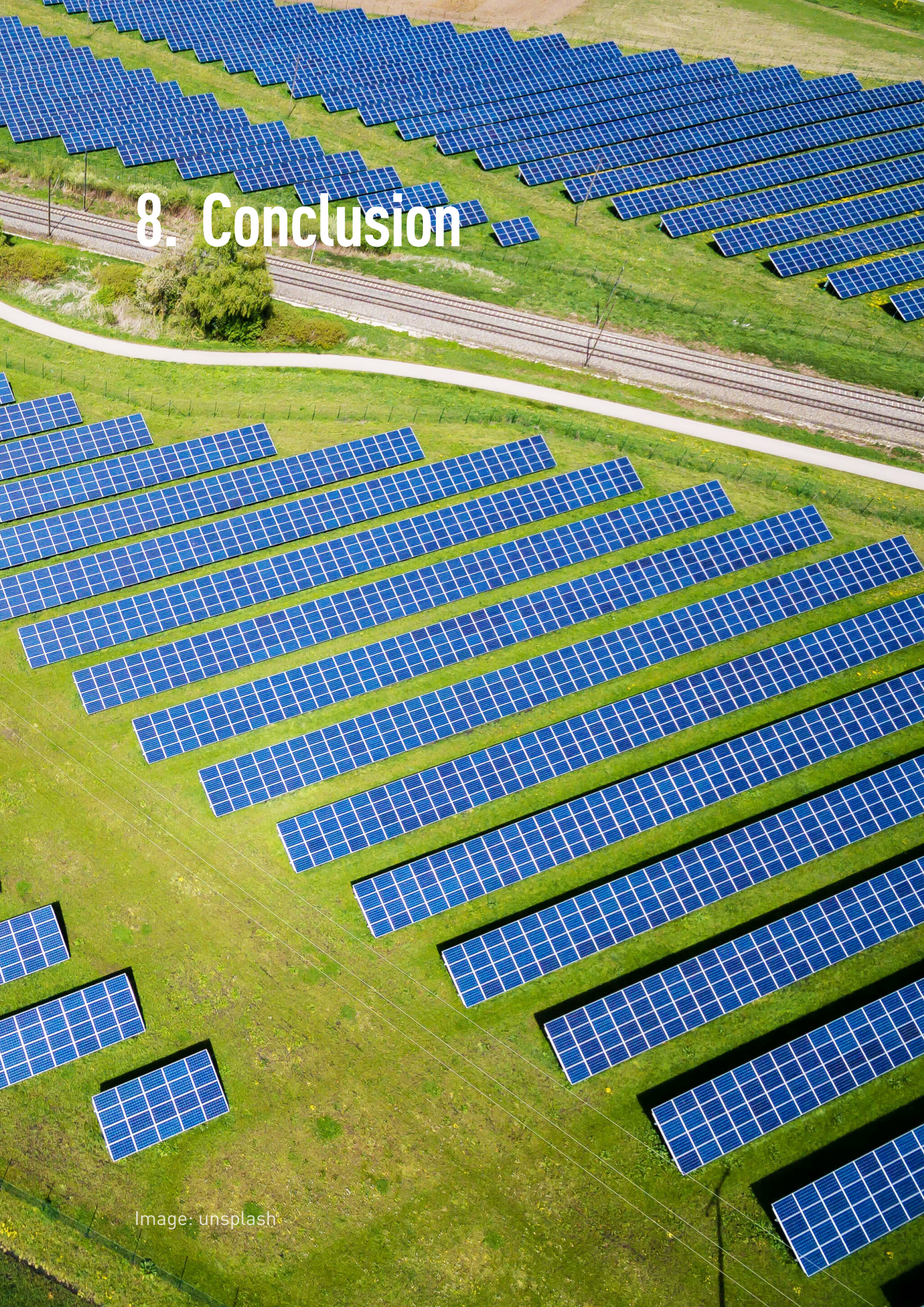

Image: unsplash

Investors find the Indian RE sector increasingly attractive, as evidenced by trends in RE investment in India. Sectoral risks are lower, as reflected in the decline in auction-determined utility-scale RE tariffs. Policy-level interventions have reduced the uncertainty of demand, facilitated the setting up of supporting infrastructure, helped mitigate offtaker risk, and offered preferential treatment to RE in the form of exemptions from inter-state transmission charges and must-run status. Policy-related measures have been augmented by favourable market developments: declines in unit costs of PV modules and wind turbines; and favourable changes in the terms of financing. Lower risk perception of RE investments, supported by a favourable international financing environment for much of India's RE journey since the launch of the National Solar Mission, have translated into more favourable terms of financing.

Some measure of success has been achieved in the deployment of utility-scale RE, but capacity addition has lagged behind in the underserved rooftop solar segment. Policy measures aimed at incentivising rooftop solar deployment have had implementational challenges at the discom level, and the flow of finance to the rooftop solar segment has been limited by the lack of bankability of projects. To scale up capacity addition in the sector, new approaches and financing paradigms are needed, such as risk mitigation through financial instruments to crowd in private sector investment. Public sector capital should be deployed in such ways in order to stimulate growth in such underserved market segments.

Policy-level interventions have reduced uncertainty in the RE ecosystem overall, but there is considerable variation among states in the supportiveness of regulatory frameworks, financial health of discoms, and the future demand potential for electricity. These variations differentiate states in terms of attractiveness for RE investment. The evolving direction of policy measures at the central and state levels could have negative implications for RE investment. The uncertainty surrounding the potential imposition of duties on imported PV modules has hampered investment. The increased competitiveness of RE generation could lead to the withdrawal of support mechanisms such as the must-run status.

While RE capacity addition has increased over the past few years, existing and evolving risks need to be addressed to scale up deployment to the level of the country's ambitions. Stricter implementation of some existing policy measures is needed to raise their effectiveness. Additional interventions are needed to address major risks for RE capacity addition, particularly the challenge of RE integration. In order to integrate greater RE capacity into the grid, T&D infrastructure, and scheduling and forecasting capabilities, need strengthening; and curtailment risk needs to be mitigated by robust contractual provisions and financial instruments.


Image: unsplash

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