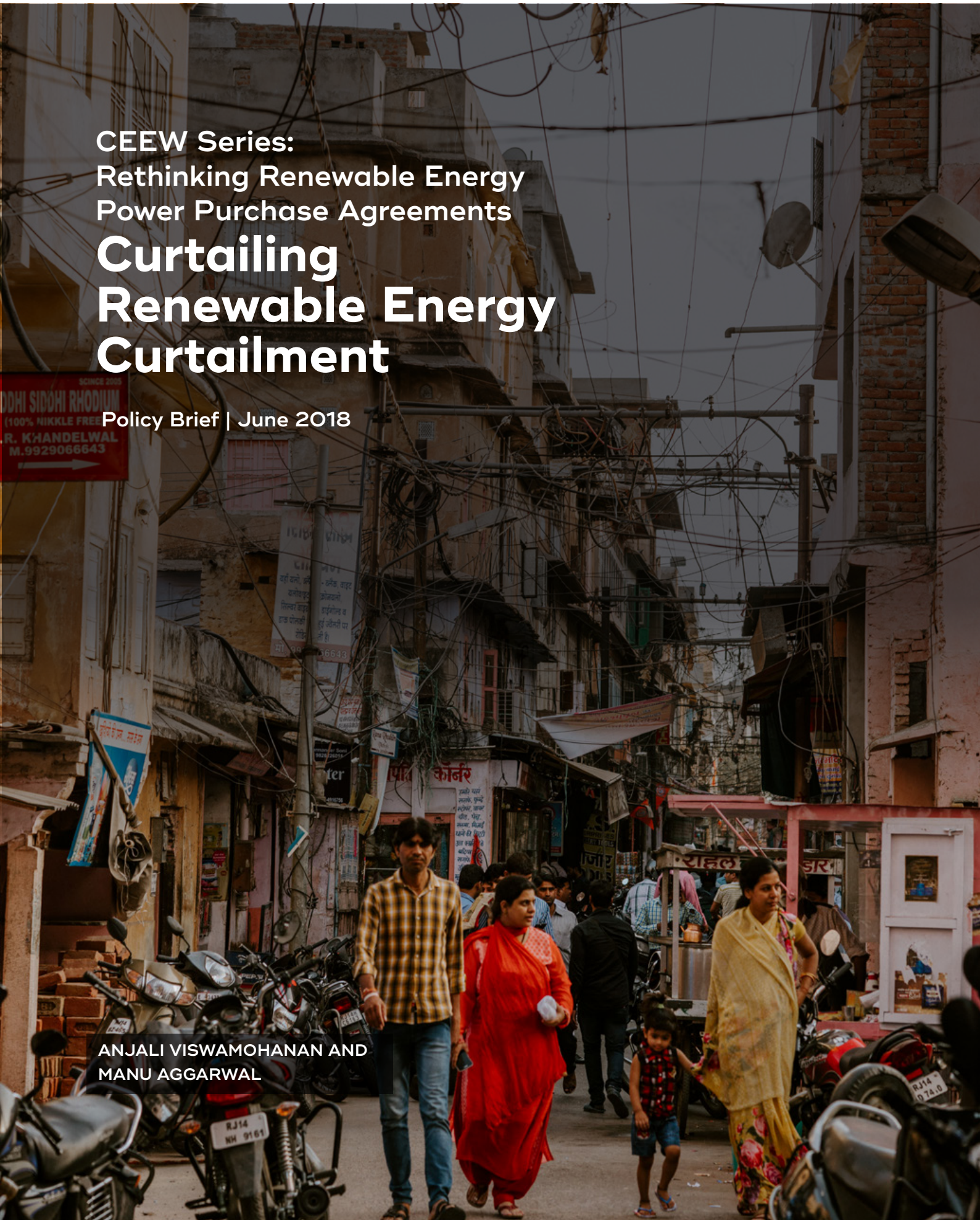
CEEW
THE COUNCIL

An initiative supported by

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION



CEEW Series:
Rethinking Renewable Energy
Power Purchase Agreements

Curtailing Renewable Energy Curtailment

Policy Brief | June 2018

ANJALI VISWAMOHANAN AND
MANU AGGARWAL

Image: Unsplash

CEEW
THE COUNCIL

An initiative supported by

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

CEEW Series:
Rethinking Renewable Energy Power Purchase Agreements

Curtailing Renewable Energy Curtailment

ANJALI VISWAMOHANAN AND MANU AGGARWAL

Policy Brief
June 2018
ceew.in

A policy brief on 'Rethinking Renewable Energy Power Purchase Agreements: Curtailing Renewable Energy Curtailment.'

Citation: Anjali Viswamohanan and Manu Aggarwal (2018) '*Rethinking Renewable Energy Power Purchase Agreements: Curtailing Renewable Energy Curtailment*' June.

Cover image: Unsplash

Peer reviewers: Dr P. C. Maithani, Scientist-G, Ministry of New and Renewable Energy; Deepak Gupta, Head – Power Sector Program, Shakti Sustainable Energy Foundation; Disha Agarwal, Program Associate (Renewable Energy), Shakti Sustainable Energy Foundation; Ashwin Gambhir, Senior Research Associate, Prayas Energy Group; Dr Geeta Gouri, Former member, Competition Commission of India; Deepto Roy, Partner, Shardul Amarchand Mangaldas & Co.; Kanika Chawla, Senior Programme Lead, CEEW; Kapardhi Bhardwaj, Programme Associate, CEEW.

Publication team: Alina Sen (CEEW), Mihir Shah (CEEW), Surit Das, Aspire Design, and Friends Digital

Acknowledgments: This policy brief has gained immensely from the insights of the members of the High-Level Working Group on Renewable Energy Policy and Finance (REWG), constituted jointly by CEEW and Shakti Sustainable Energy Foundation in 2016. The purpose of the working group is to bridge the gap between policy-related discussions and ground-level developments, aiming to alleviate the information asymmetry in the renewable energy market. The group consists of around 15 high-level sectoral experts and meets every six to eight weeks to discuss current issues in the RE market.

The **Council on Energy, Environment and Water** (http://ceew.in/) 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. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with the wider public. In 2018, CEEW has once again been featured across nine categories in the '2017 Global Go To Think Tank Index Report'. It has also been consistently ranked among the world's top climate change think tanks. Follow us on Twitter@CEEWIndia for the latest updates.

Shakti Sustainable Energy Foundation works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage energy efficiency, renewable energy and sustainable transport solutions, with an emphasis on sub sectors with the most energy saving potential. Working together with policymakers, civil society, academia, industry and other partners, we take concerted action to help chart out a sustainable energy future for India (www.shaktifoundation.in).

Council on Energy, Environment and Water
Sanskrit Bhawan, A-10, Qutab Institutional Area
Aruna Asaf Ali Marg, New Delhi 110067, India

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 has once again featured 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.

In over seven years of operations, The Council has engaged in more than 180 research projects, published well over 110 peer-reviewed books, policy reports and papers, advised governments around the world over 400 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on more than 50 occasions, helped state governments with water and irrigation reforms, and organised more than 210 seminars and conferences.

The Council's major projects on energy policy include India's largest energy access survey (ACCESS); the first independent assessment of India's solar mission; the Clean Energy Access Network (CLEAN) of hundreds of decentralised clean energy firms; India's green industrial policy; the $125 million India-U.S. Joint Clean Energy R&D Centers; developing the strategy for and supporting activities related to the International Solar Alliance; modelling long-term energy scenarios; energy subsidies reform; energy storage technologies; India's 2030 renewable energy roadmap; clean energy subsidies (for the Rio+20 Summit); clean energy innovations for rural economy; community energy; and renewable energy jobs, finance and skills.

The Council's major projects on climate, environment and resource security include advising and contributing to climate negotiations (COP-23) in Bonn, especially on the formulating guidelines of the Paris Agreement rule-book; pathways for achieving INDCs and mid-century strategies for decarbonisation; assessing global climate risks; heat-health action plans for Indian cities; assessing India's adaptation gap; low-carbon rural development; environmental clearances; modelling HFC emissions; business case for phasing down HFCs; assessing India's critical minerals; geoengineering governance; climate finance; nuclear power and low-carbon pathways; electric rail transport; monitoring air quality; business case for energy efficiency and emissions reductions; India's first report on global governance, submitted to the National Security Adviser; foreign policy implications for resource security; India's power sector reforms; resource nexus, and strategic industries and technologies; and Maharashtra-Guangdong partnership on sustainability.

The Council's major projects on water governance and security include the 584-page National Water Resources Framework Study for India's 12th Five Year Plan; irrigation reform for Bihar; Swachh Bharat; supporting India's National Water Mission; collective action for water security; mapping India's traditional water bodies; modelling water-energy nexus; circular economy of water; participatory irrigation management in South Asia; domestic water conflicts; modelling decision-making at the basin-level; rainwater harvesting; and multi-stakeholder initiatives for urban water management.

About the Authors

ANJALI VISWAMOHANAN | *anjali.viswamohanan@ceew.in* | *@aveeem*

Anjali is a lawyer by training and works with the renewable energy team at the Council on Energy, Environment and Water (CEEW). At The Council, her work involves analysing the impact of regulatory change on the renewable energy sector. She is also invested in studying contractual associations in the sector to improve overall efficiency.

Her broader interest lies in assessing the feasibility of energy transition scenarios as a response to the perpetually evolving technology mix. She is keen on structuring frameworks around governance issues such as transparency, specifically to advance the development of technology that deals with the growing climate change-related concerns of the developing world.

Prior to CEEW, Anjali worked with two of the top law firms in India, where she advised clients on investing in infrastructure projects. She holds a B.A., LL.B (Hons.) degree from the Gujarat National Law University (2013) and is enrolled as an advocate with the Bar Council of Maharashtra and Goa.

MANU AGGARWAL | *manu.aggarwal@ceew.in*

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

At The Council, Manu's work involves designing market-transformative insurance products, and restructuring regulatory and commercial contracts to de-risk renewables. Besides India, he is also assessing risks in emerging economies in Asia and Africa. Manu leads The Council's work on the non-UNFCCC negotiations on emissions due to international transport. He also closely monitors Indo-US energy and climate diplomacy.

In his previous avatars, he worked in business analytics, energy commodities trading, and international development. Manu is a graduate in Mechanical Engineering from Thapar University, Patiala. He is waiting for his CFA charter from the CFA Institute, USA.

Contents

Abbreviations

CEEW	Council on Energy, Environment and Water
CERC	Central Electricity Regulatory Commission
CUF	capacity utilisation factor
DISCOM	distribution companies
DSCR	debt service coverage ratio
ISA	International Solar Alliance
ISTS	Inter State Transmission System
NATAF	normative annual transmission availability factor
PPA	power purchase agreement
RE	renewable energy
REG	renewable energy generators
REMC	renewable energy management centres
RLDC	regional load dispatch centres
SLDC	state load dispatch centres

1. Introduction to the PPA Series

Many moving pieces affect the future of renewable energy (RE) development in an emerging market like India. The PPA – the contractual structure that the RE developer enters into with the offtaker of the power generated by the project, and capable of packaging and containing the risks associated with a number of the growing uncertainties in the market – is one significant moving piece. In India, PPA drafts have evolved slowly, in accordance with market needs; no major structural changes were effected since the draft developed for the very initial solar and wind projects around 2010. The Ministry of Power introduced guidelines for tariff-based competitive bidding for solar and wind projects in 2017 which was a marked shift towards using contractual provisions to address some of the growing market risks. The government has been proactive in remedying immediate market risks through external mechanisms – such as exemptions, pass-through of cost notifications, announcement of compensation methods – but issues that specifically pertain to PPAs, persist for developers and offtakers.

Curtailment issues

Offtakers have trouble predicting power demand or transmission efficiency, which leads to uncertainty over the offtake obligation, thereby causing issues for the developer. Curtailment issues stem from the fluctuating nature of renewable power and risks associated with having a fixed term for projects (25 years).

Offtakers find the must-run status of renewable power plants unfeasible, with rising proportion of RE in the energy mix, unless technical upgradation factors are taken care of. It results in predictable curtailment issues. State discoms and state load dispatch centres (SLDC) have raised this issue many times; SLDCs attribute backdowns to systemic conditions (such as lack of effective forecasting and dispatch mechanisms) and grid insecurities.[1]

Payment security mechanism

A system is needed to enforce offtaker obligations in case of default. An offtaker may delay payment, or fail to maintain the must-run status of the power plant, or fail to observe terms of payment security mechanism specified in the PPA, such as replenishing guarantee amount in case of utilisation. If a PPA is terminated prematurely, a developer has limited options (as identifying a substitute offtaker is difficult); also, payment is uncertain.

Market tariffs are falling, and developers need to secure cheaper sources of debt and equity to ensure that the tariffs they quote are competitive; the risk margin factored into the calculation of the quote is miniscule, and there is little leeway to accommodate project risks – foreseeable or unforeseeable – in the falling tariffs. Aggressive bidding resulted in the lowest solar tariff

1 Central Electricity Regulatory Commission order in the matter of Southern India Mills Association v. POSOCO & Ors. (Petition No. 91/MP/2014), dated 13 July 2016

of INR 2.44 per unit, discovered in May 2017 at the reverse auctions for solar plants in Bhadla, Rajasthan. The lowest discovered wind tariff was INR 2.43 per unit in Gujarat.

Fixed tariff issue

Tariffs are fixed for the life of the PPA (around 25 years). The repercussions of having fixed rates are being seen today. The Tamil Nadu discom has backed down from purchasing power from the 650 MW solar power park set up by Adani Green Energy citing unreasonably high tariff rates (INR 7 per unit for PPA signed in 2011 and the plant being inaugurated for operations in September 2016, when tariffs have dropped to below INR 3 per unit).[2]

Currently, PPAs prohibit parties from accommodating changes in market conditions without violating the contract. It is essential that contracts and commitments are honoured, but PPAs must have frameworks and provisions that enable stakeholders to deal with changes in unforseeable circumstances. Distribution companies (discoms) have sought to renegotiate a PPA to readjust the tariff rate agreed upon at the time of bidding of the project after many years of operations or even before signing it. Sometimes discoms are financially unable to pay the high tariffs agreed upon at the outset, throughout the project term. There may also be instances of inadequate demand for power for the discom to be able to fulfil its commitments.

Dispute resolution

Project developers need a contract that lets them manage risk, avoid and resolve foreseeable disputes, and accommodate changes in market conditions and project-specific factors without violating the contract. To avoid disputes on foreseeable grounds, PPAs need to have stringent and robust provisions. Investors and developers avoid the dispute resolution procedure in India because it is time-consuming and expensive and because they risk ruining their relationship with the concerned offtaker, which could affect other projects as well.

To bring in foreign investment, it would help also to have an offshore arbitration seat option to resolve disputes in a neutral jurisdiction and in accordance with internationally accepted rules (UNCITRAL, LCIA, or ICC). Currently, model PPAs prescribe onshore arbitration through the application of the Indian Arbitration and Conciliation Act, 1996, which raises a number of concerns for a foreign investor, such as giving Indian courts more opportunity for interference.

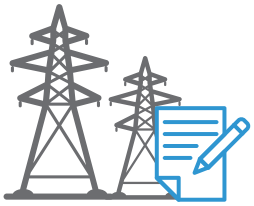
Need for standardisation

Worldwide, a PPA lists provisions for system size; purchase obligation; term; term renewals; tariff and tariff escalation; early termination by offtaker; purchase option of system; termination fee; production guarantee; shortfall payments; payment security; billing disputes; temporary system shutdown rights; liability and indemnity; force majeure; cure period; dispute resolution; governing law; and assignment. But several of these provisions are excluded from model PPAs issued by the state/central government and their agencies in India. Standardisation of the terms of a PPA is essential, especially from the global perspective and in light of the USD 120–147 billion investment required in RE projects to achieve the 100 GW solar target.[3] Foreign investment is essential for rapidly scaling up RE capacity in

2 Shreya Jai, 'Solar Park tenders, power purchase on hold as Rewa bids disrupt market', http://www.business-standard.com/article/economy-policy/solar-park-tenders-power-purchase-on-hold-as-rewa-bids-disrupt-market-117031600049_1.html (March 16, 2017)

3 Kanika Chawla, *Money Talks? Risks and Responses in India's Solar Sector*, Council on Energy, Environment and Water (2016)

India. Most foreign investors tend to invest in a portfolio of assets, which may be spread across states. The differences in terms of each asset increases the transaction cost of investments and may affect the confidence of some investors who are used to standardised PPAs in their home jurisdictions.



Standardising the terms of a PPA used in public tenders will serve to reduce transaction costs and promote investment and is, therefore, imperative.

Standardising the terms of a PPA used in public tenders will serve to reduce transaction costs and promote investment and is, therefore, imperative. As RE capacity increases, so does offtaker burden and investor/developer risk; to address these, the key terms of a PPA should be amended and an appropriate PPA implemented by central and state governments and agencies. In 2016, the 750 MW REWA solar park saw bids for the first-year tariff drop to a record low of INR 2.97.[4] Effective structuring of payment guarantees and overall optimisation of the mechanics of operation seen in the REWA PPA constitute part of the reason for such a drop.[5] It is important to have a standard set of documents – from bidding to implementation and operations – to make decision-making by authorities efficient, non-discretionary, quick, fair, transparent, and competitive. The Planning Commission's 2010 report on private participation in infrastructure emphasises it.[6] Standardisation has been applied successfully in the road infrastructure sector.

In a series of papers on rethinking renewable energy PPAs, each of the issues discussed above will be examined in light of:

i. the evolution of the contractual provisions in both solar and wind PPAs, intended to address these specific issues.
ii. Contractual provisions that have been developed and implemented in other jurisdictions to deal with similar issues in their market.
iii. Examination of the impact of the contractual provisions on the issue/ risk at hand, by examining the impact on each concerned stakeholder.
iv. Identifying whether these existing/ modified provisions are able to address variants of the same issue due to varying factors across projects and jurisdictions.
v. Arriving at a recommendation for contractual implementation of specific provisions that have been developed through analysis of the issues at hand.

We have identified the following thematic areas in a PPA which if re-worked (either individually or together with a related thematic area, could potentially address the issues identified in the paragraphs above:

i. Tariff Structuring
ii. Payment Security Mechanism
iii. Must-run status and evolution of curtailment provisions
iv. Changes in the law
v. Termination provision and payments

4 Debpriya Mondal, 'Solar tariff reaches a historic low of INR. 2.97 a unit at Rewa bidding', http://energy.economictimes.indiatimes.com/news/renewable/solar-tariff-reaches-a-historic-low-of-rs-2-97-a-unit-at-rewa-bidding/57084519 (February 11, 2017)

5 The MP state government had engaged the International Finance Corporation as transaction adviser to better structure the PPA and other transactional documents, at a fee of around INR 22.5 million (to be paid by the successful bidders)

6 Secretariat for Infrastructure, Planning Commission, 'Private Participation in Infrastructure' http://planningcommission.gov.in/sectors/ppp_report/3.Reports%20of%20Committiees%20&%20Task%20force/4.Private-Partcipation-in-Infrastructure.pdf (January 2010)

In this brief, the issue of curtailment – both for technical and commercial reasons, must-run status for renewable power and compensation for grid unavailability and instability will be examined, while the forthcoming issue briefs will examine the remaining thematic areas identified above.

Series Brief I: Curtailing Renewable Energy Curtailment

This brief examines the issue of curtailment for technical and commercial reasons and its impact on stakeholders; must-run status for renewable power; and the prospective role of granting compensation for grid unavailability and instability. The government and regulators could address the risk of curtailment through regulation and contractual structures. This brief identifies the evolution of PPAs so far and considers the impacts of these steps and points out the drawbacks of the solutions being implemented.

The brief recommends that risk be allocated to the party best able to control and manage it. It discusses how to structure compensation if the risk is not adequately contained, such that neither the developer nor the offtaker is unfairly impacted. This brief aims to solve one piece of the puzzle of curtailment risk – identify remedies to the power purchase agreement (PPA) by re-examining the contractual structure entered into between the renewable energy generator and the offtaker.

1. Introduction

The Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 (grid code) instituted the provision of *priority access* and the *must-run principle* to incentivise the development of the renewable energy industry in India. Accordingly, no solar or wind power plant, duly commissioned, should be directed to back down by load dispatch centre except in the specific case of such dispatch affecting grid security or causing danger to personnel or equipment.[7]

The grid code exempts RE power plants (except for biomass power plants) from the merit order dispatch principle – cheaper power must be provided to consumers first and that the more expensive power can be supplied only if the cheaper power is unavailable. In the initial years of renewable power production in India, tariffs were high, and deterred offtakers from scheduling renewable power for generation; and they were not mandated to, under law. Hence, the remedy in the form of must-run status and exemption from the merit order dispatch principles was announced for renewable power. This has been adopted by states in the state electricity grid codes. The reason for the exemption is largely because renewable power tariffs were high in the initial years of its production in India, which was a deterrent for offtakers to schedule renewable power for generation, and they were not mandated to, under law. Hence, the remedy in the form of must-run status and exemption from the merit order dispatch principles was announced for renewable power.

While the must-run status did help bring investment into the fledgling sector in its early years, it is becoming untenable owing to reasons including the inability of the transmission infrastructure to accommodate large quantities of unscheduled fluctuating renewable power renewable power, RE generators' failure to effectively forecast the quantum of generation of renewable power, etc. Further, it is pertinent to note that the must-run status was instituted, despite the concerns of discoms, transmission companies, load dispatch centres, conventional power generators,[8] amongst other stakeholders in the market, as listed out in the table below.

7 Clause 5.2 (u) of the Grid Code
8 Bridge to India, 'Urgent reform needed to achieve energy sector transformation in India', http://www.bridgetoindia.com/urgent-reform-needed-achieve-energy-sector-transformation-india/ (March 27, 2017)

Table I: Concerns of stakeholders, including the discom, transmission companies, load dispatch centres and conventional power generators with regard to the implementation of the must-run status

DISCOM	Transmission Companies ('TransCo')	Load Dispatch Centres	Conventional Power Generators
Largely, concerns pertaining to the high cost of renewable power and balancing supply of power from other sources of energy, such as thermal. In case of either curtailment or scheduled back down of thermal power, the fixed cost component will still have to be paid to the thermal energy generators.	The requirement for the grid to be able to accommodate the renewable power that will mandatorily be scheduled for offtake by the DISCOM, is a possible concern for the TransCo.	The load dispatch centres' concerns stem from technical issues pertaining to the integration of renewable power into the grid, such as grid balancing to ensure maintenance of grid frequency. Without reasonably accurate forecast, it is difficult for the system operator to consider RE as Must-Run and schedule it appropriately.[9]	Sudden loss in demand for the power generated is the prime concern. A minimum amount is guaranteed to the generator every month (subject to the availability factor of the plant), through the fixed cost component of the thermal power tariff. However, there are costs associated with the frequent ramping up and down of thermal power to accommodate renewable power.

In interpreting must-run status, electricity regulatory commissions have stated that while the must-run status is the objective, it will be subject to the conditions of safety and security of the grid.[10] Further, in 2015, the Tamil Nadu Electricity Regulatory Commission has gone on to state in its order that unfettered must-run status, which restrains the SLDC from backing down renewable power, has not been accorded to RE projects.[11] The understanding is that wind energy will be accommodated subject to grid security.

Curtailment has been a major concern for RE projects. Curtailment can be defined as a reduction in the output of a generator from what it could otherwise produce given available resources (e.g., wind or sunlight), typically on an involuntary basis[12]. Curtailment occurs when a transmission system operator issues an instruction to limit the energy output of a specific or a group of RE generators. While there is evidence for the incidence of curtailment across states in India, there are no definite numbers with regard to its extent across the country. Curtailment is heavily influenced by local factors such as the status of the grid infrastructure near a RE generation site and resource variability at those sites, there is considerable variation in the quantum of curtailment across months, states, and even districts in a state. Curtailment, in essence, is the antithesis to the must-run status. Breaking this down further, must-run status would mean that RE will not be curtailed/ directed to back down for reasons (which may include, variations in the generation/consumption patterns or any commercial parameters, merit order dispatches, etc.), except force majeure events and emergency.[13] Both force majeure and emergency events link to conditions or situations outside

Curtailment can be defined as a reduction in the output of a generator from what it could otherwise produce given available resources (e.g., wind or sunlight), typically on an involuntary basis.

9 Central Electricity Authority, Draft Report of Committee on Merit Order Dispatch and Integration of Renewables, February 2017

10 Order in the matters of M.P. No. 14 of 2012, D.R.P. No. 28 of 2012, M.P. No. 21 to 23 of 2014 and D.R.P. No. 45 of 2014 – Indian Wind Power Association & Ors. v. TANGEDCO Ltd. & Ors., before the Tamil Nadu Electricity Regulatory Commission dated 1 July 2015

11 Id.; also in direction issued by the Appellate Tribunal for Electricity in paragraphs 9 and 10 of its Order dated May 30, 2014 in Appeal No. 327 of 2013

12 Lori Bird, Jaquelin Cochran, and Xi Wang, Wind and Solar Energy Curtailment: Experience and Practices in the United States (2014), https://www.nrel.gov/docs/fy14osti/60983.pdf

13 As defined in the Gujarat Urja Vikas Nigam Limited PPA of 2017 for 500 MW grid connected solar PV projects under RfS number GUVNL/ Competitive/500 MW/Solar dated 15 June 2017

the control of either party to the PPA, which is likely to result in a disruption of the safe, adequate, and continuous electricity supply.

However, in the current scenario, curtailment of renewable power has been occurring for varied reasons, some of which are under the control of the parties to the PPA:

(i) Commercial curtailment – cost

Commercial considerations for curtailment of older RE capacities are linked to their higher tariffs and single part tariff structure as compared to the tariffs and double part tariff structure of conventional sources of power. With newer RE projects generating power at lower rates (for PPAs signed around 2 years back), the risk of commercial curtailment has dropped to a controllable extent for these projects. PPAs and current regulations prohibit any form of commercial curtailment. However, for RE project PPAs that were signed over two years back, with higher tariffs, the curtailment risk continues, despite PPAs and current regulations prohibiting any form of commercial curtailment.

(ii) Commercial curtailment – demand–supply mismatch

In some cases, curtailment may occur due to the incapability of the offtaker to effectively forecast the consumer demand for power. In case of low demand, an element of commercial curtailment comes into play, where expensive power or power for which penalty amounts (for curtailment) is low, is likely to be curtailed first. This is despite the merit order exemption available for renewable projects.

(iii) Grid unavailability

Transmission licensees are required to ensure compliance with the applicable standards of performance of the transmission system, as notified by the CERC/ SERC. These regulations specify a lower limit of availability that the transmission licensee needs to ensure for the system. The transmission charges payable to the licensee, is calculated using the normative annual transmission availability factor (NATAF), the transmission system availability factor for the month, together with the annual fixed cost per year. The transmission charges for parts of the system having different NATAF are aggregated thereafter. This brings further accountability on the transmission companies to ensure availability of the grid.

While most outages of the system are scheduled (for maintenance or other such reasons), there are occasions of unscheduled maintenance as well, where the scheduled power that is generated, will be curtailed. Transmission companies are mandated to ensure that these unscheduled outages do not occur frequently and are required to pay a compensation for failure to maintain the specified standards of performance. However, the process to obtain such compensation is cumbersome. *Under the regulations, the grid users have to approach the CERC/ SERC for the same, which is limited to the transmission charges to the extent they have affected the supply of electricity*.[14] The compensation does not include the loss of revenue to the developer for not being able to inject the electricity due to this unscheduled maintenance. Further, it is to be noted that no transmission charge is applicable for the use of the ISTS network for solar and wind projects for a period of 25 years from the date of commercial operation of the project, if the project begins its operations before December 2019 (with draft regulations[15] extending the date to

14 Regulation 7 of the Central Electricity Regulatory Commission (Standards of Performance of inter-State transmission licensees) Regulations, 2012.

15 Draft Central Electricity Regulatory Commission (Sharing of Inter-State Transmission Charges and Losses) Regulations, Sixth Amendment, 2018
http://cercind.gov.in/2018/draft_reg/Noti27.pdf

March 2022).[16] Therefore, the recourse prescribed under the Standards of Performance Regulations does not hold good for renewable energy generators (REGs) currently.

(iv) Grid management issues

Statutorily, SLDCs are responsible for managing intrastate transmission systems, and regional load dispatch centres (RLDCs) for managing inter-state transmission systems. The SLDCs and the RLDCs are mandated to take all possible measures to ensure:

a. that the grid frequency always remains within the tight band of 49.90 – 50.05 Hz band (from the previous range of 49.7 to 50.2 Hz);[17]

b. optimum scheduling and dispatch of electricity within a state in accordance with the contracts entered into with the licensees or the generating company operating in the state; and

c. carrying out real-time operations for grid control and dispatch of electricity within the state through secure and economic operation of the state grid in accordance with the grid standard and state grid code.[18]

In performing these functions, the load dispatch centres are entitled to act in the larger public interest while dealing with scheduling and dispatch. The state grid codes specifically provide the SLDCs with the power to issue back down instructions to state generating systems.[19] The SLDCs have been instructed to clearly record reasons for back down in their records to make the working of the SLDC more transparent and avoid allegations of curtailment for commercial/ economic reasons.[20]

The SLDCs have been instructed to clearly record reasons for back down in their records to make the working of the SLDC more transparent and avoid allegations of curtailment for commercial/ economic reasons.

The SLDCs were conceptualised as independent bodies under the Electricity Act.[21] However, all SLDCs have been functioning under state transmission utilities in the interim period, until a body has been constituted under a state act for the purpose of operating the SLDC. The issue here is that there have been allegations that the SLDCs have not been functioning independently of the state electricity boards and the state transmission utility.[22] This may cast doubts in the minds of private players regarding the intentions of the SLDCs in issuing curtailment instructions to private RE generators.

16 CERC (Sharing of Inter-State Transmission Charges and Losses) (Fifth Amendment) Regulations, 2017 http://www.cercind.gov.in/2017/regulation/137_N.pdf
However, the Ministry of Power has passed an order in February, 2018 as per paragraph 6.4(6) of the National Tariff Policy, 2016, to waive interstate transmission charges for solar and wind projects commissioned till 31 March 2022.
17 Regulation 5.2(m) of the IEGC, 2010 (as amended)
18 Section 32 of the Electricity Act, 2003
19 For example, Clause 7.13 of the Rajasthan Electricity Regulatory Commission (Rajasthan Electricity Grid Code) Regulations, 2011
20 Renew Wind Energy (AP3) Pvt. Ltd. & Ors. v. Rajasthan State Load Dispatch Centre before the Rajasthan Electricity regulatory Commission, order dated 29 November 2017
21 Section 31 of the Electricity Act, 2003 – Constitution of the State Load Dispatch Centres
22 Load dispatch centre officials of six states to be penalised: CERC https://www.thehindubusinessline.com/economy/Load-dispatch-centre-officials-of-6-states-to-be-penalised-CERC/article20489229.ece (August 24, 2012)

TECHNICAL CURTAILMENT: A BIGGER ISSUE FOR WIND PROJECTS THAN IT IS FOR SOLAR

From an operational point of view, at the time of heavy generation of wind power during wind season, where the frequency shoots up beyond the frequency band of 50.05 Hz. In such scenarios, SLDCs are mandated to restrict the heavy wind power injection after taking all possible efforts viz. normalising the load shedding, backing down of the high cost power on merit order basis, etc. for accommodating the wind power. The risk to grid security posed by wind power is significant since maximum variation of quantum of power drawal / injection by any constituent at any instant from the central pool shall not exceed 150 MW, whereas the wind power is varying in the order of 1000 MW.

2. Effect of Curtailment on Various Stakeholders and Levelised Cost of Electricity (LCOE)

The impact of the issue of curtailment on the various connected stakeholders in the sector (including the DISCOM,[23] the REG, the investors and the financiers to the renewable energy project), has been analysed below.

Table II: Impact of the issue of curtailment on the various connected stakeholders in the sector including the DISCOM, the REG, the equity investors and the lenders to the renewable energy project

Discom	REG	Equity investors	Lender
Discoms prioritise power from generators that offer firm (not intermittent) and cheap supply of electricity, given their financial constraints and consumer demand. The other sources of power face curtailment, typically coupled with delayed payment issues. Financial health of the discoms and reliability of RE power are major factors. This issue has been significant in Tamil Nadu and Rajasthan – two of the most renewable energy dominant states. On the flipside, recurring issues of curtailment, creates a reputational risk for the DISCOM, thereby leading to higher prices.	For REGs, curtailment affects the cost-competitiveness of RE projects due to loss of revenue for power generated.[24] In wind projects in Rajasthan, highest power is generated in the pre-monsoon and monsoon period (April to September) but REGs are backed down either because of grid unavailability or that discoms are unwilling to offtake due to limited demand, leading to wastage of generated power. The issue is around factoring in these generation losses in the business plan at the time of bidding for the project, to structure debt and equity payments accordingly. On the flipside, some REGs have also been unwilling to comply and adopt regulations pertaining to forecasting, dispatch and scheduling for renewable power (which would lead to reduction of the overall levels of curtailment for technical reasons, in the long run).	Equity investors question the viability of projects if the project is prevented from selling power during peak power production periods. Further, the inability to account for a fixed amount of receivables per month/ year due to the inability to estimate quantum of curtailment, is an issue. Of late, the market is witnessing an aggregation of RE companies through buy-outs and acquisitions of smaller companies. One reason could be that investors are unable to sustain project losses due to curtailment in the race to win bid by quoting lower tariffs, for prolonged periods of time.	Repaying loans according to the loan schedule is affected since the financing model that the banker is relying on assumes payment for all power generated by the plant in accordance with the scheduled generation. The debt service coverage ratio (DSCR) and/or the interest rate for projects that are set up in areas where the issue of curtailment is high, may be much higher than for other projects.

Source: *CEEW analysis*

23 Since it is only a small fraction of power generated by RE projects that sold via the open access route, with the major bulk being usually sold through long-term PPAs signed with discoms, we have examined this issue from a discom perspective here.

24 Adani Green Power, Welspun Renewables Energy Private Ltd and others approached the Madras High Court in 2017, with TANGEDCO and the Tamil Nadu State Load Dispatch Centre (TNSLDC) as defendants, alleging curtailment with regard to their solar power projects in Tamil Nadu; A number of wind project developers in Rajasthan have approached the Rajasthan Electricity Regulatory Commission in 2017, alleging that the Rajasthan SLDC has issued multiple instructions for backing down of generation from their projects.

As per CEEW analysis, the impact of curtailment on the tariffs (in case of solar – for the Bhadla bid of INR 2.44), where curtailment is at 10 per cent, would lead to a 9.7 per cent increase in tariff, while 20 per cent and 30 per cent curtailment would lead to 24 per cent and 42 per cent increase in tariff, respectively.

Presently, there is no clear way to identify if the reason for curtailment was in fact, technical – i.e., linked to the maintenance of grid safety and security.

Further, in case of a project that is located in a curtailment-prone state or area, this may also lead to an increase in cost of finance, due to higher risk perception. This would also lead to an increase in higher power procurement cost for discoms, resulting in a higher tariff burden for consumers.

The issue around curtailment is twofold:

i. Presently, there is no clear way to identify if the reason for curtailment was in fact, technical – i.e., linked to the maintenance of grid safety and security. The underlying reason for this issue is that the data needed to verify the state of the transmission infrastructure at a substation level is not available easily.[25] This issue is widespread to the extent that state commissions have refused to interfere in matters of curtailment to ascertain whether comprehensive or concrete data was available to establish whether the grid was under a threat of collapse which warranted curtailment of wind power.[26] The lack of transparency further leads to suspicion regarding whether the power is actually being curtailed for commercial reasons, while merely citing technical issues. The risk of commercial curtailment was high previously, when RE tariffs were significantly higher than other sources of power and discoms were relatively financially worse off (prior to the Ujwal DISCOM Assurance Yojna scheme).

ii. With growing proportion of RE in the overall energy mix, the must-run status is untenable, owing to the fluctuating nature of the renewable power and the inability of the grid to take on high quantities of fluctuating power. The situation is troubling for REGs and investors since most renewable energy PPAs either explicitly or implicitly do not provide for compensation for curtailment or the failure to comply with the must-run status. Most PPAs explicitly permit shutting down of the evacuation line in case of an emergency, with no obligation to pay any compensation during such period. The only obligation on the offtaker is to ensure that reasonable endeavours are made to remedy the emergency situation at the earliest.[27]

25 Manu Aggarwal, Anjali Viswamohanan, *Addressing Renewable Energy Curtailment: A Composite Approach*, Council on Energy Environment, and Water (2018)

26 In the case of the *Indian Wind Power Association & Ors*. v. TANGEDCO & Ors. before the Tamil Nadu Electricity Regulatory Commission, date of order: 1 July 2015

27 Supra, footnote 13.

3. Assigning Responsibility for Technical Curtailment

(i) Transmission licensee – Grid Unavailability

The transmission infrastructure is expected to be available to the transmission licensee without interruption. However, as per calculation of the normative annual transmission system availability factor, used in determining the applicable transmission charges, the national grid is available 99 per cent of the time.[28] The predicted unavailability due to maintenance, etc., is scheduled. During this time of scheduled grid unavailability, power generation is not scheduled from certain power generators.

A provision to deal with such scheduled unavailability is a part of the 2017 MoP Guidelines for solar PV PPAs as well, where no compensation will be provided for the first 50 hours of grid unavailability (amounting to 0.5 per cent unavailability, annually). Other jurisdictions such as South Africa, cap grid unavailability time in the PPA at close to 175 hours per year (amounting to 2 per cent unavailability), after which compensation for system events kicks in. Curtailment in case of system operator default is compensated beyond the grid unavailability time of 175 hours per year, at the commercial energy rate. A similar model has been employed in the REWA PPA. Identifying grid issues in the state and the area where the project is being set up is essential to agreeing on the reasonable number of hours of downtime for the grid.

Identifying grid issues in the state and the area where the project is being set up is essential to agreeing on the reasonable number of hours of downtime for the grid.

(ii) RE generator – Failure to comply with system operating requirements

PPA provisions mandate that the RE generator complies with all applicable laws, good industry practices and technical specifications pertaining to supply arrangements and system operations, including requirements and directions prescribed by the SLDC/RLDC and the appropriate commissions. The CERC has released forecasting and deviation regulations specifically for solar and wind energy projects, which are to be adopted by each state electricity regulatory commission. Most states are at various stages of the process prior to the actual enforcement of these regulations.

Once the forecasting and deviation regulations are in place in all states, there will be a requirement for solar and wind generators to ensure compliance with the deviation scale (as specified for each state), or suffer the brunt of penalties (as specified for each percentage slab for each state). There is high likelihood of curtailment in the event that

28 Association of Power Producers, 'CERC Shocker: Power stocks plunge; NTPC, Power Grid will be hot most, says brokerages', http://www.appindia.org.in/index.php?option=com_news&view=detail&id=94&Itemid=102

the deviation exceeds the minimum specified scale (which varies from 8[29] to 15 per cent from state to state). In the case of curtailment, penalties will not be levied on the generators.

Reluctance of REGs to adopt scheduling and dispatch regulations

Effective from February 2014, the frequency range for operation has been modified to 49.90 Hz – 50.05 Hz form the previous range of 49.7 Hz to 50.2 Hz.[30] Further, the state load dispatch centres are required to ensure that the deviation in injection does not exceed 150 MW or 12 per cent of the schedule for each time block.[31] Ensuring such high standards of maintenance of grid frequency and stability would not be feasible without mandating compliance of the REGs with the forecasting and scheduling mechanisms.

As per the provisions of the grid code, scheduling was supposed to be mandatory for wind energy generators with effect from January 2011. However, REGs, specifically wind power generators have expressed discontent with the implementation of scheduling regulations and delayed implementation of the scheduling regulations for RE projects.[32] The reluctance may be on account of the scheduling regulations being a hindrance to the implementation of the must-run status to its full extent.

Due to the high invariability of renewable power, for renewable-rich states having combined installed capacity of wind and solar projects in the range of 1000–3000 MW, the revised deviation has been fixed at 200 MW and states with a combined installed capacity of wind and solar projects more than 3000 MW, have been given a deviation limit of 250 MW.[33]

Notification of scheduling and deviation regulations for all states, to ensure compliance by all RE is necessary to ensure grid stability.

(iii) Load dispatch centres – grid management issues

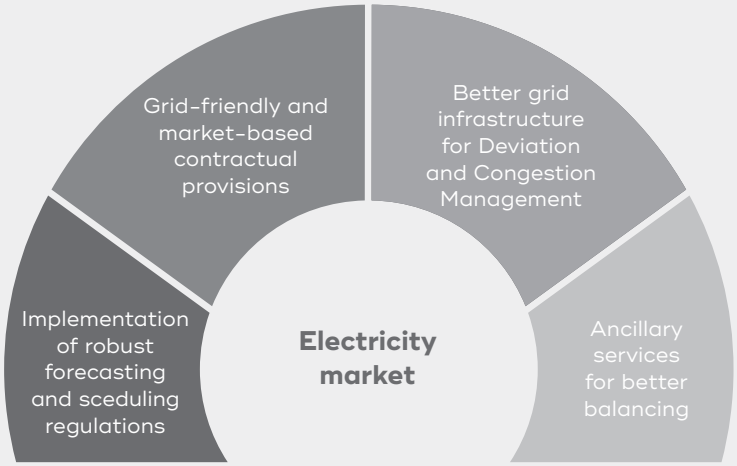
Under the Electricity Act, the SLDCs are empowered to take any action to ensure integrated grid operation and to achieve the maximum economy and efficiency in the operation of the power system. All other stakeholders in the system, including every licensee, generating company, generating station, substation and any other person connected with the operation of the power system are required to comply with the directions issued by the SLDC.[34]

Therefore, it is within the SLDC's right to curtail power from scheduled RE sources, even if the power is within the deviation band, if there is an issue of grid instability. This is termed as an emergency event, which permits technical curtailment.

29 Punjab Electricity Regulatory Commission (Forecasting, Scheduling, Deviation, Settlement and related matters for Wind and Solar Generation sources) Draft Regulations
30 As per the Regulation 5.2(m) of the grid code, as amended by the Amendment Regulations, 2014
31 Regulation 7(1) and (2) of the Deviation Settlement Regulations
32 Order in Petition No. 179/MP/2015, before the CERC on 28 February 2017 in the matter of Jaipur Vidyut Vitaran Nigam Limited & Ors. V. POSCO & Ors.
33 As per the CERC (Deviation Settlement Mechanism and related matters) Third Amendment Regulations, 2016.
34 Section 33 (1) and (2) of the Electricity Act, 2003

4. Means of Limiting Curtailment Risk and Better Managing the Integration of an Increasing Share of RE in India's Energy Mix

Factors that need to be considered for a well-functioning electricity market



Source: CEEW analysis

(i) Development of better grid infrastructure

India is in the process of developing the Green Energy Corridor, with a goal of strengthening India's intrastate and inter-state transmission systems to accommodate increasing amounts of intermittent generation from RE sources like wind and solar. It would also help connecting RE rich states to states with relatively lesser RE generation potential.

So far, the tendering of RE projects has not been occurring in consonance with the development of grid infrastructure which is needed to accommodate such increased RE capacities.[35] This is clearly evidenced by instances where the state electricity commissions have instructed the discoms within their states to not enter into PPAs with wind power generators due to grid stability issues, apart from also impacting the financial health

35 Saumy Prateek, Grid Infrastructure in India needs to scale rapidly to keep up with solar and wind tenders, Mercom; https://mercomindia.com/grid-infrastructure-india-solar-wind-tenders/ (January 11, 2018)

issues of the discoms.[36] Going forward, there must be a clear mechanism to ensure that grid congestion or security issues are resolved before tendering out solar and wind projects.

(ii) Implementation of robust forecasting and scheduling regulations

The recent increase in variable wind and solar power generation, future projections of higher share of RE in the total generation portfolio and associated challenges of grid management make wind and solar power forecasting a mandatory task for the Indian electricity grid.

Amongst the renewable-rich states, the states of Madhya Pradesh, Andhra Pradesh, Rajasthan, Gujarat, Telangana, Maharashtra and Tamil Nadu have proposed draft forecasting and deviation regulations to deal with the challenges associated with grid integration of solar and wind power. Karnataka, Andhra Pradesh, and Rajasthan have been the only states so far to notify these regulations. The regulations prescribe forecasting measures to be adopted by the REGs for intrastate projects, together with penalty amount for per band of deviation – for e.g., INR 0.5 per kWh for quantum of shortfall or excess energy beyond 15 per cent and up to 25 per cent; Re. 1 per kWh for remaining quantity of shortfall/ excess energy for deviation beyond 25 per cent and up to 35 per cent. Notification of scheduling and deviation regulations for all states, to ensure compliance by all RE, is necessary to ensure grid stability.

Further, it is necessary to strengthen the control infrastructure, which includes renewable energy management centres (REMC) at load dispatch centres at state, regional, and national level – which would supplement the forecasting and scheduling requirement of the new REGs and perform these services for the older REGs. Implementation of these provisions would ensure that there is more certainty in terms of the quantum and fluctuation of the power.

(iii) Increased balancing control area

Balancing of the grid requires emphasis on the tools used and methods followed (current and suggested) to mitigate the effects of wind and solar variability on day-ahead and time-ahead basis.

If RE generation is be dispersed over a large geographical area, the overall balancing requirement of the system is reduced. It is suggested that energy storage/ banking options need to be explored and a significant push towards the R&D of these technologies is required.

(iv) Through provisions in the PPA

Over the years, regulators have come out with provisions in different forms in the PPA to specifically deal with the issue of curtailment risk for both solar and wind energy projects. We have analysed the essence of those provisions (pertaining to curtailment) that have been included in solar and wind project PPAs, which significantly differ from each other. The analysis of the provision and its effectiveness on both commercial curtailment risk and technical curtailment risk, has been provided in Annexure A below. The key takeaways from the analysis has been provided in the tables below.

36 Kaavya Chandrasekaran, 'Karnataka discoms barred from buying more wind power', https://economictimes.indiatimes.com/industry/energy/power/karnataka-discoms-barred-from-buying-more-wind-power/articleshow/59100232.cms (June 12, 2017)

Table III: Analysis of the levels of curtailment risks on implementation of the solar PPA provisions listed below

S. No.	Clause	Commercial Curtailment Risk	Technical Curtailment Risk
1.	**Early RE PPAs** - REG's obligation of **minimum guaranteed generation** and liability to pay a compensation in case of shortfall in generation, which may (in some cases), be adjusted in case of non-availability of grid.	The provision does not address the risk of commercial curtailment.	The provision does not address the risk of technical curtailment.
2.	**All PPAs post 2010 - Must-run status** – as has been specifically defined in some PPAs,[37] to mean that the project will not be directed to back down due to variations in the generation/ consumption patterns or any commercial parameters, merit order dispatches or existence/ apprehension of any other charges or levies related to dispatch, except Force Majeure events[38] and emergency.	In case of over-supply of RE due to the must-run status, curtailment is likely to occur on a commercial basis for REGs with higher tariffs	Curtailment for technical reasons has been expressly allowed through this provision
3.	**REWA PPA (2017) - Minimum supply obligation (MSO)** – of a specified quantity of units generated by the project, has been termed as minimum supply. In case of technical issues of the grid or back down instructions, which subsists for more than 175 generation hours in a contract year,[39] the offtaker is liable to pay a compensation equal to the applicable tariff for the quantum of power that could not be supplied due to these issues.	Receipt of back-down instructions is covered as a separate category where compensation is provided to the extent of the MSO	Curtailment beyond 175 hours is compensated, to the extent of the MSO
4.	**Ministry of Power Solar Bidding Guidelines (2017): Minimum generation compensation in case of back down** = 50 per cent x [*average generation per hour* x *number of hours of backdown* x *PPA Tariff*]. This specifically excludes cases where the compensation is on account of considerations of grid security or safety of equipment or other conditions and accordingly no protection is available in such circumstances.	Since compensation payable even for commercial curtailment is limited to 50%, this risk is high.	There is a specific exemption for technical curtailment, for which no compensation is due.

Source: CEEW analysis

37 Gujarat Urja Vikas Nigam Limited PPA of 2017 for 500 MW grid connected solar PV projects under RfS number GUVNL/ Competitive/500 MW/Solar dated June 15, 2017

38 Force majeure clause is used in any contract to excuse a party from its obligation, due to the occurrence of an unforeseen event, which was beyond the control of either party.

39 It is interesting to note that this would amount to around 2 per cent of the total grid availability hours.

Table IV: Analysis of the levels of curtailment risks on implementation of the wind PPA provisions are listed below

S. No.	Clause	Commercial Curtailment Risk	Technical Curtailment Risk
1.	**Most PPAs prior to 2013** - PPAs which prescribe that curtailment can only be on account of a system emergency and there is no obligation on the offtaker to compensate for such loss in production of wind power.	There is little scope for curtailment for reasons apart from a system emergency	Technical curtailment has been permitted
2.	**SECI PPA (2017)** - REG is required to declare the capacity utilisation factor (CUF) of the project and is mandated to maintain generation between 90 per cent and 120 per cent of the CUF, incurring a penalty in case of failure to meet the generation obligation. The lower limit will be relaxed to the extent of grid non-availability, which is beyond the control of the REG.	While the provision does not expressly guard against the risk, since it is post 2017, the risk is low due to market conditions of low tariffs	No incentive to reduce to limit technical curtailment
3.	**TANGEDCO Wind PPA (2017):** Compensation mechanism is provided for grid unavailability and grid management issues that persist beyond 50 hours a year, where the lower of a normative CUF of 27.15 per cent[40] or committed CUF, will be taken for the purpose of calculation of generation compensation. The generation loss during the year will be offset by procurement of excess generation by the generator (equal to the amount curtailed) in the succeeding three contract years.	Risk is low due to an overall limit.	The remedy listed may not provide adequate comfort to the REGs, especially in high curtailment regions.
4.	**Ministry of Power Wind Bidding Guidelines (2017):** Generation compensation for backdown hours during a monthly billing cycle = 50 per cent x (average generation during the month) x PPA Tariff. Where, average generation is linked to the CUF. The Guidelines further mention that specific conditions for exclusion of generation compensation will be specified in the PPA.	Since compensation payable even for commercial curtailment is limited to 50%, this risk is high.	The exemption from payment of generation compensation for certain conditions, places the risk at moderate.

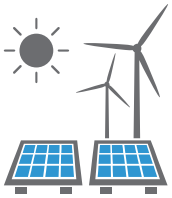
Source: CEEW analysis

Overview of evolution of provisions in the PPA related to solar and wind PPAs

As can be gauged from the analysis of the provisions (Annexure A), the contractual provisions and structures to limit curtailment have evolved in recent years (post 2016 for solar projects and 2017 for wind projects). The 2017 guidelines for bidding of both solar and wind projects includes suggestions for contractual provisions that could effectively deal with market risks. One such provision is around compensation for grid downtime or transmission unavailability, where it prescribes that in case of grid downtime or transmission unavailability beyond 50 hours per year, compensation will be payable. However, the provision specifically

40 The normative CUF when prescribed for other wind projects, has to be based on specific factors of the project. For example, if the project utilises tall wind mills of 100+M, the wind power density will be high, leading to higher CUF of more than 30 per cent, as per the CERC (Terms and Conditions for Tariff Determination from Renewable Energy Sources) Regulation, 2017.

excludes instances of technical curtailment. Effectively, these hours of downtime would not be counted as curtailment since it will be linked with pre-planned downtime of the grid. Further, the quantum of 50 hours, may not adequately reflect the grid instability issues experienced in all regions.



The 2017 guidelines for bidding of both solar and wind projects includes suggestions for contractual provisions that could effectively deal with market risks.

Further, the REWA PPA appears to take this one step further to cover all issues of the grid, which may even lead to curtailment, therefore citing a higher number of 175 hours (see minimum supply obligation clause in Table I).

The REWA PPA model of providing tariff compensation in case the REG is unable to meet its minimum guaranteed supply obligation, due to reasons that are beyond the control of the REG, with an exemption of 175 hours per year (for both curtailment and grid unavailability), would be extremely beneficial to the REG. However, if the guaranteed supply obligation is for less than 70 per cent of the generation capacity of the project, without including the exemption factor (as is the case in the REWA PPA – see serial number 3 in Table I, Annexure A, below), the extent of comfort provided by the provision may not be extensive.[41]

The 50 per cent compensation provision provided in both the wind and solar 2017 MoP bidding guidelines, will marginally reduce risks for newer projects that are awarded in accordance with these guidelines (see serial number 4 in Table I and II, Annexure A below.

The table below compares the change in tariff due to curtailment factors of 10 per cent, 20 per cent and 30 per cent, with and without a 50 per cent compensation for backdown (as proposed in the 2017 solar bidding guidelines). The base price considered is that of the Bhadla bid of INR 2.44 per unit.

Table V: Analysis of change in tariff due to curtailment factors of 10 per cent, 20 per cent and 30 per cent, with and without a 50 per cent compensation for backdown (excluding grid insecurity issues)

Curtailment levels	Change in cost of power in case of curtailment	Cost of power in case of 50 per cent compensation for curtailment
No curtailment	2.44	-
10 per cent curtailment	2.96	2.8
20 per cent curtailment	3.37	2.96
30 per cent curtailment	3.88	3.2

Source: *CEEW analysis*

The resulting change in cost per unit of power even with a 50 per cent compensation per unit of curtailment is significantly high – 34 paisa higher in case of a 10 per cent curtailment and 50 paisa higher in case of a 20 per cent curtailment. This is also a significant revenue loss for the REG, which may not have been accounted for in their financial model, leading to the business becoming unsustainable.

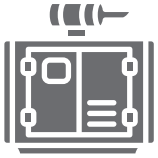
41 These numbers are as per REWA draft PPA that was available in the public domain as of November 2016 and may not represent the final figures that were agreed upon between the parties.

Balancing Grid Stability and Interests of the REGs

Growing renewable capacities has presented a set of unique technological challenges, not previously faced by the grid. Small scale introduction of renewable power into the grid could be smoothly integrated. However, at the scale that India is looking to scale up the production of RE, there is need to look at newer approaches for extending and operating the grid.

It has been clearly established both through regulation itself and the interpretation of these regulation by the electricity regulatory commissions in India that the must-run provision is subject to grid safety and security concerns. While must-run will protect the REGs against commercial curtailment, it is not a sufficient measure against technical curtailment, which is an exception to the must-run status.

As the structure of the PPA and the ability of the PPA provisions to deal with market issues has evolved, technical curtailment has been contained to some extent through contractual measures, specifically through the structure contemplated in the REWA PPA. It is necessary that the REGs be compensated to the complete extent that the generated power is not being utilised, due to the incapacity of the grid to take on the renewable power that has already been contracted for.



Provisions where both the RE generator and offtaker are able to agree on a certain amount of downtime for the grid per year, is necessary.

Transmission risk is foreseeable (as can be gauged from similar experiences in other countries undergoing a RE revolution). It is to this extent that the provisions where both the RE generator and offtaker are able to agree on a certain amount of downtime for the grid per year, is necessary. For the agreed time, neither party shall take any action for either the loss of power or the inability to cater to the extent that the complete performance of the contract is intended for.

The issue of variability can be dealt with by switching in fast-acting conventional reserves on an as-needed basis, by either installing large scale storage on the grid or through other means of balancing regional and local excesses or deficits. At present, the variability issue is handled by ramping conventional reserves up or down on the basis of forecasts. The grid system is yet to be developed completely to accommodate large scale fluctuating renewable power and sophisticated forecasting mechanisms are yet to be put in place to deal with technical issues (that lead to curtailment). In the meantime, it is necessary to incorporate balanced contractual provisions based on close-to-accurate estimations of the extent of the curtailment issue for each project based on the location of the project and the variability of the power.

5. Recommendations

Several factors should be considered in devising a robust contractual solution to the curtailment issue.

Decide on a quantum of guaranteed power generation

The REG and the offtaker should at the outset decide on a quantum of power that is the minimum quantity the REG is guaranteeing to supply and the maximum quantum that the offtaker is guaranteeing to offtake. This quantum may be decided for the REG based on quality of panels, resource risk, availability, and effectiveness of forecasting mechanisms, and for **the offtaker,** based on effective forecasting of demand, dealing with variability of demand, and scheduling conventional power to effectively bundle renewable power with stable conventional power. The offtaker may be required to further investigate transmission unavailability risks and grid congestion risks through the past records of performance of the transmission company and the concerned load dispatch centres. **The structure of the PPA should ensure that all measures are taken so that the REG is able to recover revenues associated with this minimum agreed quantum of power (on an annual settlement basis), as long as the REG is able to produce and supply the same.**

Remedying the root cause of the problem – guaranteeing supply and demand

(i) REG accountable for scheduling and deviation

One root cause of the issue of curtailment is the failure to forecast and schedule power effectively and to ensure the supply of power within the prescribed frequency band. The enforcement of forecasting and deviation regulations on REGs has been lax until recently. It is important to recognise that the efficiency of the overall system to ensure minimum wastage of generated power, requires each party to play its role effectively. Failure to ensure predicted supply of power within the prescribed frequency band should lead to penalty/ curtailment. Therefore, over and above the deviation settlement mechanism regulations, more stringent performance obligations with regard to the agreed quantum of minimum supply may be included in the PPA.

(ii) Offtaker accountable for demand risks

The offtaker is required to be in complete control over scheduling demand. Taking into account the must-run status accorded to RE projects, the only permissible reason for curtailment is technical reasons that can be categorised as emergencies. The offtaker must be made obligated to compensate at the rate of the PPA tariff for his failure to forecast demand effectively, at least until the minimum offtake obligation is met, as decided in the previous recommendation.

Holding all concerned parties accountable

(i) Dealing with the transmission unavailability risk

While as per the Standards of Performance Regulations that has been instituted to set strict parameters concerning grid performance – whereby transmission lines are required to be available 90 per cent of the time (at the minimum),[42] there have been cases filed by wind power generating companies have alleged that grid availability has been varying between 30 per cent to 80 per cent on a daily basis.[43]

The non-availability of the grid has a direct impact on the REG, since the proportion of revenues are directly dependent on the quantum of evacuation. The provisions for compensation in case of failure by the transmission licensees to comply with the prescribed standards of performance, indicate that the quantum of compensation will be limited to the transmission charges. Transmission charges per unit of generation will vary from project to project, based on factors such as the capacity, utilisation factor, applicable transmission charges, etc. *However, it would not amount to much beyond INR 1 per unit, which is not a comparable compensation for the loss of generated power.* Further, it is to be noted that no transmission charge is applicable for the use of the ISTS network will be payable for solar and wind projects for a period of 25 years from the date of commercial operation of the project, if the project begins its operations before December 2019.[44] Therefore, the recourse prescribed under the Standards of Performance Regulations does not hold good for REGs currently.

In the alternative, similar to the grid unavailability provision prescribed in the 2017 solar and wind bidding guidelines, grid transmission companies may decide on a reasonable minimum floor (in terms of number of hours) for grid unavailability in a year (which is 50 hours at present in the bidding guidelines). All parties will account for the decided number of hours of unavailability of the grid per year (which includes both scheduled and unscheduled unavailability). Unavailability of the grid infrastructure beyond this period, must be compensated in terms of generation loss at tariff price per unit.

(ii) Dealing with grid management issues

Incapability of the SLDC to control the stability of the grid, despite efforts of all other parties to the transaction to ensure compliance with prescribed standards and procedures, must not be a risk on the revenue flows. This is to account for occasions where curtailment occurs despite all efforts taken by the offtaker to ensure adequate demand forecast, supplier ensures adequate generation forecast and is in compliance with the frequency band, and the transmission company ensuring line availability.[45]

Tighter definitions and smaller basket for technical issues Controlling the occasions and causes for technical curtailment is a much-needed solution for the sector that is likely to suffer from increasing levels of curtailment in the coming years, due to higher volumes of variable renewable power in the grid. Strictly defining occasions of technical

42 Regulation 5 (a)(iii) of the CERC (Standards of Performance of inter-State transmission licensees) Regulations, 2012
43 Order in the matters of M.P. No. 14 of 2012, D.R.P. No. 28 of 2012, M.P. No. 21 to 23 of 2014 and D.R.P. No. 45 of 2014 – Indian Wind Power Association & Ors. v. TANGEDCO Ltd. & Ors., before the Tamil Nadu Electricity Regulatory Commission dated 1 July 2015
44 CERC (Sharing of Inter-State Transmission Charges and Losses) (Fifth Amendment) Regulations, 2017 http://www.cercind.gov.in/2017/regulation/137_N.pdf
45 This has been contended by wind energy generators in the matter of M.P. No. 14 of 2012, D.R.P. No. 28 of 2012, M.P. No. 21 to 23 of 2014 and D.R.P. No. 45 of 2014 – Indian Wind Power Association & Ors. v. TANGEDCO Ltd. & Ors., before the Tamil Nadu Electricity Regulatory Commission dated 1 July 2015

curtailment in the PPA, which will be supplemented by rigorous data to justify occasions of technical curtailment is the need of the hour.

Enforcing stricter performance standards on the LDCs: Complete avoidance of technical curtailment of renewable power may not be possible in the coming few years. This is largely due to the inadequacy of the existing infrastructure to adequately deal with the rising quantum of renewables that will be injected into the grid (pursuant to the 2022 target). In these circumstances, allowing for a base level of exemption (in terms of number of hours per year) to the load dispatch centres to ensure complete effective grid management, may be considered. This number may be decided based on factors such as number and capacity of RE projects connected to each substation and grid condition in that particular area.[46] The offtaker covers for the performance of the load dispatch centre and the transmission company through the PPA. However, the risk is passed on to the load dispatch centre and the transmission company through separate agreements between each of the load dispatch centre and the transmission company with the offtaker.

Introducing accountability: Failure to ensure grid management to the extent agreed upon in the PPA, would lead to a compensation obligation, calculated at per unit loss beyond the agreed threshold, at the tariff price.

(iii) Issues linked to grid unavailability that may also fall in the ambit of grid management issues

The Standards of Performance Regulations prescribe permissible restoration times for occurrence of events such as insular failure, tower collapse, snapping of phase conductor, failure of earth wire, failure of interconnecting transformers, and failure of reactors. Further, there are scheduled outages of the grid for maintenance reasons.

Unscheduled outages, where power generation and offtake has been scheduled but the power generated has to be curtailed due to reasons of grid unavailability. This may lie within the ambit of technical reasons cited by the load dispatch centre for curtailment. To this extent, both the load dispatch centre and the DISCOM would do well to account for unscheduled transmission outages in the minimum floor in terms of the number of hours where curtailment may occur for grid management issues.

46 Manu Aggarwal, Anjali Viswamohanan, Addressing Renewable Energy Curtailment: A Composite Approach, Council on Energy Environment, and Water (2018)

Annexure A

Table I: Evolution of Clauses that influence curtailment risks (both commercial and technical) in solar PPAs and their impacts on the REG, commercial curtailment risk and technical curtailment risk:

	Clause	REG	Commercial Curtailment	Technical Curtailment
1.	**REG's obligation of minimum guaranteed generation** and liability to pay a compensation in case of shortfall in generation, which may (in some cases), be adjusted in case of non-availability of grid.	The performance obligation is on the REG with limited recourse contractually for instances of curtailment. The REG has no certainty regarding the quantum of offtake. Further, this is in some ways, a contradiction to the must-run status, which specifies that all power generated by the project must be offtaken.	Commercial curtailment risk is prevalent. The presumption is that the DISCOM has the ability to offtake the entire supply of power that the REG is obligated to generate under the terms of the PPA. No compensation has been specified in case of DISCOM's failure to offtake for reasons of lack of power demand, etc.	Technical curtailment risk is high. There is no mention of compensation in case of technical curtailment.
2.	**Must-run status** – as has been specifically defined in some specific PPAs,[47] to mean that the project will not be directed to back down due to variations in the generation/ consumption patterns or any commercial parameters, merit order dispatches or existence/ apprehension of any other charges or levies related to dispatch, except force majeure events and emergencies.	The concern regarding curtailment due to occurrence of emergency events, is likely to be exacerbated, since no compensation is offered for curtailment due to reasons of force majeure and emergency. Here, the REG needs to be more stringent regarding scheduling and forecasting measures. Curtailment risks citing technical reasons are higher.	Offtaker may be unable to take on the full quantum of power generated by the REG, primarily due to the fluctuating quality of the generated power and technical issues pertaining to integration of large quantities of renewable power. Further, the lack of a penalty provision, increases the risk of commercial curtailment.	Curtailment for technical reasons has been expressly allowed through this provision, increasing the risk of technical curtailment.
3.	**REWA PPA: Guaranteed energy offtake**[8] of a specified number of solar energy units capable of being generated each year by the project.	The REG is able to manage risks better in this scenario as he is able to factor in a fixed offtake amount and a variable component for the extra units.	Commercial curtailment risk is low. The quantum of offtake agreed upon is likely to be estimated reasonably, anticipating demand and the offtaker's other commitments.	A specific compensation for technical curtailment has not been specified. The risk of technical curtailment prevails.

47 As per the REWA PPA issued along with the bid documents in November, 2016

	Clause	REG	Commercial Curtailment	Technical Curtailment
4.	**REWA PPA: Minimum Supply obligation –** of a specified quantity of units generated by the project, has been termed as minimum supply. In case of technical issues of the grid or back down instructions, which subsists for more than 175 generation hours in a contract year,[48] the offtaker is liable to pay a compensation equal to the applicable tariff for the quantum generated in the preceding year.	The effectiveness of this provision relies on the number of units that is agreed upon between the parties to be the minimum quantity of supply. Curtailment risk is prevalent for units above this minimum quantity.	Commercial curtailment risk for the guaranteed quantum is low – receipt of backing down instructions has been covered as a separate category in addition to technical curtailment. However, the risk prevails for units over and above the minimum supply obligation.	Technical curtailment risk for the guaranteed quantum is negligible since it will be limited to 175 generation hours. Curtailment beyond this level will be compensated. However, the risk prevails for units over and above the minimum supply obligation.
5.	**MoP 2017 Solar Bidding Guidelines: Minimum generation compensation in case of back down**= 50 per cent x [*average generation per hour* x *number of hours of backdown* x *PPA Tariff*]. This specifically excludes cases where the compensation is on account of considerations of grid security or safety of equipment or other conditions.	If curtailment is on account of technical reasons such as inadequate demand alone, the 50 per cent compensation would be beneficial to the REG. However, based on the tariff, if the REG is at risk of commercial curtailment, 50 per cent compensation would force the REG, investors and debtors to factor in a 50 per cent return per unit generated, leading to higher lending cost, and therefore, a higher project cost.	Commercial curtailment risk in this case is high for projects that have been bid out at higher tariffs, since this would enable the DISCOM to offtake power from cheaper sources, while having to pay a lower amount as compensation/ penalty.	On account of the exception, for which zero compensation has been offered, the technical curtailment risk continues to prevail.

Source: CEEW analysis

48 It is interesting to note that this would amount to around 2 per cent of the total grid availability hours.

Table II: Evolution of Clauses that influence curtailment risks in wind PPAs and impact on the REG, commercial curtailment risk and technical curtailment risk:

	Clause	REG	Commercial Curtailment	Technical Curtailment
1.	**Andhra Pradesh Wind PPA (prior to 2013)**: REG has an obligation to operate the project in a manner so as to avoid fluctuations in the grid network. Curtailment can only be on account of a system emergency, the duration of which is at the DISCOM's reasonable judgement – to alleviate the emergency. No obligation to compensate for such reduction in production of the wind power.	The onus of performance has been placed on the REG in this case – to ensure operation of the project in such a manner that causes minimal disruption in the grid. Curtailment can be on account of system emergency situations, which can be controlled to a certain extent, if the REG is able to control the fluctuation of the power that is being injected into the grid.	The provision seeks to protect the REG firmly from any form of commercial curtailment, while leaving technical curtailment at the discretion of the offtaker.	Technical curtailment is expressly allowed and no form of compensation will be provided for the same.
2.	**Karnataka Wind PPA (prior to 2013)**: Offtake of energy from the project is subject to system constraints and backing down will be in accordance with the grid code. Upon the occurrence of an emergency, including voltage/ frequency variations, shut down of the line is permitted, with no obligation to pay any compensation during such period.	The REG is inadequately protected against the risk of curtailment. This provision creates a high level of uncertainty regarding the overall quantum of offtake from the project. It becomes extremely difficult for the REG to guard against the curtailment risk in this scenario, since the definition of emergency, which entitles the operator to issue backdown instructions, is very broad.	Commercial curtailment risk in this case is high for projects that have been bid out at higher tariff.	Technical curtailment risk is high. The definition of emergency during which curtailment is permitted includes any situation of frequency variations, which may be due to no fault of the REG.
3.	**2017 SECI Wind PPA**[49] The REG is required to declare the CUF of the project and is mandated to maintain generation between 90 per cent and 120 per cent of the CUF, incurring a penalty in case of failure to meet the generation obligation. The lower limit will be relaxed to the extent of grid non-availability, which is beyond the control of the REG.	The onus of performance is on the REG to generate. In case of failure to generate the minimum amount (equal to 90 per cent of the CUF), a penalty is payable by the generator. Curtailment is counted as an exemption to the failure to generate the agreed quantum of power, for which the minimum mandated generation will be lowered to the extent of the curtailment, so that the generator will not be penalised.	Commercial curtailment risk is low, assuming that projects bid out post 2017, will be at low tariffs.	Technical curtailment risk is high since there is no incentive provided to ensure that curtailment be reduced to the extent possible, by way of penalising measures.

49 SECI PPA under the scheme for setting up of 1000 MW of ISTS-connected wind power projects (tranche II), under RfS No. SECI/C&P/WPD/1000 MW/T2/RfS/052017, dated May 21, 2017

	Clause	REG	Commercial Curtailment	Technical Curtailment
4.	**2017 TANGEDCO Wind PPA**[50] Compensation mechanism is provided for grid unavailability and grid management issues that persist beyond 50 hours a year, where the lower of a normative CUF of 27.15 per cent[51] or committed CUF, will be taken for the purpose of calculation of generation compensation. The generation loss during the year will be offset by procurement of excess generation by the generator (equal to the amount curtailed) in the succeeding three contract years.	While this may be a better scenario for the REG in relative terms, it may not be the ideal one. Going forward, as the quantum of fluctuating renewable power being integrated into the grid increases, the corresponding risk of curtailment will also increase. In this scenario, offsetting the generation loss in one year due to grid related issues, in the succeeding three years, may not guarantee the anticipated returns for the REG. The PPA draft is silent on the consequences in case of failure of TANGEDCO to offtake the quantum of curtailed power within the time frame of the following three years – in which case the only options available with the REG is to terminate the PPA or seek dispute resolution measures pertaining to TANGEDCO's inability to offtake the agreed quantum of power.	Commercial curtailment risk is low since an overall limit for technical curtailment itself has been prescribed in the PPA.	The offtaker has an incentive to limit the quantum of curtailment to below 50 hours. In case of curtailment, the requirement to add onto the offtake quantum in the following years, will add onto the overall risk for the offtaker itself. This may be a sufficient deterrent for the offtaker to limit curtailment overall. However, this depends on the overall condition of the grid and the ability of the offtaker to manage the grid.
5.	**2017 MoP Wind Bidding Guidelines:** Generation compensation for backdown hours during a monthly billing cycle = 50 per cent x (average generation during the month) x PPA Tariff. Where, average generation is linked to the CUF. The Guidelines further mention that specific conditions for exclusion of generation compensation will be specified in the PPA.	If curtailment is on account of technical reasons such as inadequate demand alone (which is unlikely), the 50 per cent compensation would be beneficial to the REG. However, based on the tariff, if the REG is at risk of commercial curtailment, 50 per cent compensation would force the REG, investors and debtors to factor in a 50 per cent return per unit generated, leading to higher lending cost, and therefore, a higher project cost.	Commercial curtailment risk in this case is high for projects that have been bid out at higher tariffs, since this would enable the DISCOM to offtake power from cheaper sources, while having to pay a lower amount as compensation/ penalty.	On account of the exception, for which zero compensation has been offered, the technical curtailment risk continues to prevail.

Source: CEEW analysis

50 Energy Purchase Agreement for Wind Power Generator covered under tender specification in CE/NCES/OT No.2/2017-18

51 The normative CUF when prescribed for other wind projects, has to be based on specific factors of the project. For example, if the project utilises tall wind mills of 50 M, the wind power density will be high, leading to higher CUF of more than 30 per cent, as per the CERC (Terms and Conditions for Tariff Determination from Renewable Energy Sources) Regulation, 2017.

Image: Unsplash

Council on Energy, Environment and Water (CEEW)
Sanskrit Bhawan, A-10, Qutab Institutional Area
Aruna Asaf Ali Marg, New Delhi - 110067, India
+91 11 40733358
ceew.in | @CEEWIndia | info@ceew.in