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Understanding Round-the-Clock Tenders in India

The Current Context and Ways Forward

Executive Summary

India has been witnessing strong growth in renewable energy (RE) in terms of new power generation capacity addition in recent years. In August 2021, the nation surpassed the landmark of 100 gigawatts (GW) of installed renewable energy capacity. However, the penetration of RE in the overall electricity supply remains low. The main challenge of variable renewable energy (VRE), specifically solar and wind, is the intermittent and infirm nature of supply, reflected in its inability to meet variable electricity demand.

Electricity distribution companies (discoms) demand a firm and uninterrupted supply of renewable power to ensure grid stability. RE complemented with power from conventional sources that have low plant load factors (PLFs) or energy storage systems (ESS) can provide firm power to utilities and consumers.

To support grid stability vis-à-vis RE integration, India has been focussing on physical aggregation of capacities from multiple generation and/or storage technologies. Combining VRE with stable complementary power from conventional sources such as thermal, hydro power and/or from ESS is necessary to ensure round-the-clock (RTC) power supply.

Discoms demand a firm and uninterrupted supply of renewable power to ensure grid stability.

In October 2019, the Solar Energy Corporation of India (SECI) issued the first-ever RTC tender for 400MW (RTC-1). The following March, the SECI 5,000MW RE-plus-thermal (RTC-2) tender was announced (the capacity was reduced to 2,500MW in December 2020). In May 2020, the RTC-1 auction set the lowest bid (L1) tariff for the first year of the power purchase agreement (PPA) at Rs2.9/kWh (3% annual escalation for first 15 years).

To pave the way for deployment of RE power, complemented with power from conventional sources or storage, the Ministry of New and Renewable Energy (MNRE) issued guidelines for the tariff-based competitive bidding process for RTC power projects. For the RTC-2 auction conducted in October 2021, the L1 tariff was Rs3.01/kWh.

This report examines key tender conditions applicable to the RTC-1 and 2 tenders and briefly evaluates their impact on the relevant projects and stakeholders (discoms and developers), while also analysing the tenders' alignment with the intrinsic demand-based approach of the RTC mode of power supply.

Following this, we describe prospective methodologies available to RTC power developers for setting up the relevant projects. We also discuss international projects focussed on "firming-up" RE-integrated power.

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1. Introduction

Amid India's rising electricity demand and energy security concerns, RE presents as one of the significant solutions to power-up self-reliance. Technology advancement and economies of scale have brought down the cost of solar and wind power to below the cost of conventional thermal power. Risk-hedging of the Indian RE market, as quoted by SECI, "by way of advanced arrangement of land and evacuation through solar parks, green energy corridors, a secure and standardised PPA for 25 years with elaborate mechanism for risk apportionment and compensations, payment security, etc." has spurred the capacity addition of solar and wind power.

Even with the commendable growth of renewable energy installation, penetration of clean energy in the overall electricity supply remains low. The main challenge of variable renewable power, specifically solar and wind, is its intermittent and infirm nature, as shown in its inability to meet variable electricity demand. There needs to be a balancing power to offset the inconsistency in renewable power supply, as discoms demand a firm and uninterrupted supply of renewable power to ensure grid stability.

The challenges for discoms in integrating VRE can be alleviated through RTC procurement of VRE-integrated power, so that RTC power developers assume the role of feeding firm power into the grid. The RTC mode of supply leverages the developers' strengths of comprehending the generation profiles of various technologies over multiple geographies as well as enhancing VRE-integration methods.

RTC supply of power can meet the demand of the end procurer, the discom, either via fixed (continuous) demand procurement, slot-wise fixed demand procurement or real-time demand procurement.[1]

Combining VRE with stable complementary power from conventional sources such as thermal, hydro etc and/or from ESS is necessary for 24/7 power supply. About a decade ago, the first phase of the Jawaharlal Nehru National Solar Mission set the precedent for combining/bundling power of different sources, solar and thermal, when the former was relatively expensive. Now, however, new thermal projects cost in the range of Rs5-7/kWh, which is distinctly higher than the tariffs bid in the recently concluded renewable-plus-storage auction (~Rs4-4.3/kWh).[2]

In the current scenario, from environmental and economic perspectives alike, new capacity building of conventional thermal power is neither viable nor sustainable. In addition, the sector is already grappling with numerous stranded coal-based assets and idle thermal power capacity in India is on the rise. It is important, therefore, to complement the supply of RE with power from conventional sources that have low PLFs or ESS to provide firm power to utilities and consumers.

[1] USAID. India: Round-The-Clock Power Procurement.
[2] Economic Times. SECI concludes world's largest renewable-cum-storage based firm-supply tender at Rs 4.04/kWh. February 2020.

Transitioning from plain vanilla and hybrid tenders, SECI began issuing renewable-plus-storage tenders from 2016. Later, with the objective of reducing demand-supply mismatch, SECI issued a tender for setting up 1.2GW of renewable-plus-storage projects with an assured peak power supply. Projects under this tender were eligible for peak and off-peak tariffs. The winners were Greenko and ReNew Power, at a flat (off-peak) tariff payment of Rs2.88/kWh and peak tariffs of Rs6.12/kWh (Greenko) and Rs6.85/kWh (ReNew Power).

New capacity building of conventional thermal power is neither viable nor sustainable.

Advancing along the demand-centric path for renewables, SECI issued the first-ever RE RTC tender of 400MW (RTC-1) in October 2019. Subsequently, in March 2020, the SECI 5,000MW RE+thermal (RTC-2) tender was announced (the capacity was reduced to 2,500MW in December 2020). In May 2020, the SECI RE 400MW (RTC-1) auction set the L1 tariff for the first year of the PPA at Rs2.9/kWh (3% annual escalation for first 15 years). Following this, to pave the way for deployment of RE complemented with power from any conventional source or storage, MNRE issued guidelines for the tariff-based competitive bidding process for RTC power projects. These cover such aspects as energy mix, tariff structure, PPA (including payment security) etc. For the RTC-2 auction conducted in October 2021, the L1 tariff was Rs3.01/kWh.

Table 1: Comparison of New-Generation RE Tenders

Tender Attribute	SECI ISTS-RE With Assured Peak Power Supply 1200MW (ISTS-VII)	SECI RE 400MW (RTC-1)	SECI RE 2500MW (RTC-2)
Tariff Design	Fixed	Scalable	Part fixed, part variable
Project Location	Co-located	No constraint	No constraint
Required Power Supply Profile	35% Annual Capacity Utilisation Factor (CUF)	80% Annual CUF, 70% Monthly CUF	85% Annual CUF
Peak Hour Duration	6 hours	Not defined	4 hours

Source: JMK Research, SECI.

2. Analysis of RTC 1 & 2 Tenders

RTC-1

Selection of RE power developer for "RTC" energy supply from 400MW RE power projects to New Delhi Municipal Council (NDMC), New Delhi, and Daman & Diu and Dadra & Nagar Haveli under tariff-based competitive bidding (RTC-I)

The original tender issued in October 2019 was amended five times between January and March 2020.

The project, which requires single contracted capacity to be in the range of 50MW-400MW, must be designed to interconnect with the network of interstate transmission system (ISTS) at a voltage of 220kV or above. Power procured by SECI under the tender has been earmarked for the buying entities and utilities, the NDMC, New Delhi (200MW) and Daman & Diu and Dadra & Nagar Haveli (200MW). Different components of RTC power – solar, wind, small hydro and thermal – can be connected with the ISTS network at multiple injection points.

Table 2: Final Salient Conditions of the RTC-1 Tender

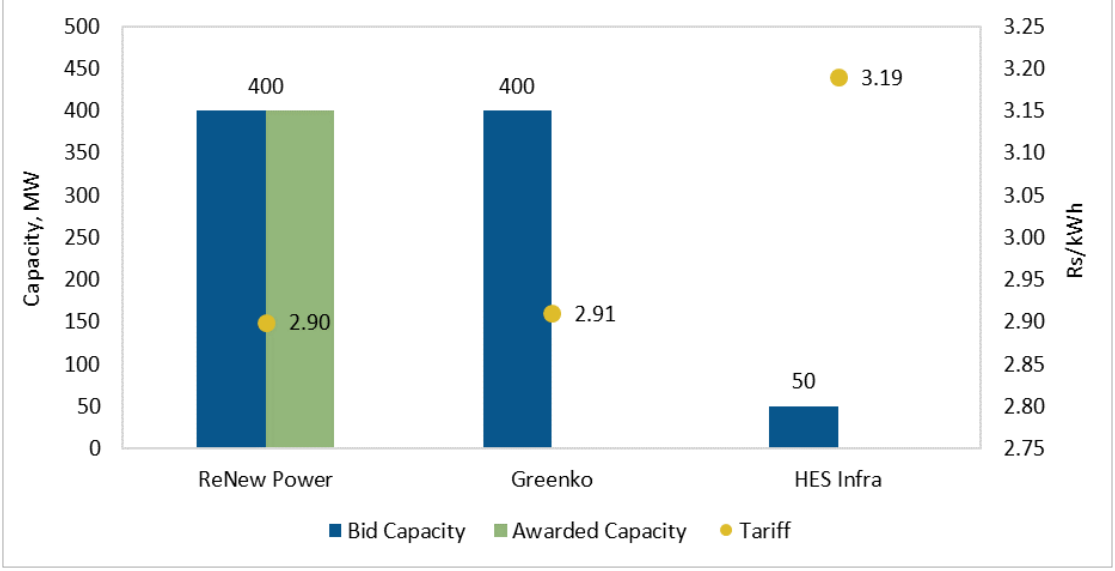
Tender Attribute	Condition
Capacity Utilisation Factor	• Annual CUF - Not less than 80%; • Monthly CUF - Not less than 70%
Tariff Escalation	• The single first year tariff quoted will have an escalation at 3% per annum up to the end of the 15th contract year of the term of the PPA, and shall subsequently be fixed at the tariff thereafter, for the remaining term of the PPA
Scheduled Commissioning Date (SCD)	• 24 months from the effective date of the PPA
Selection of Project Technology	• RE technologies as classified as renewable power generating source, by MNRE • For ESS, any form of storage such as battery energy storage, mechanical storage, pumped storage, etc.
Location of Generation Sources	• May be co-located, or may be located at different locations, to be considered a single project • ESS, if any, is mandated to be co-located with at least one of the sources of generation in the project.
Penalty for Shortfall in Energy Supply	• In case of shortfall in generation below energy corresponding to 80% CUF and up to (and including) 77.5% CUF: 300% of the PPA tariff for the shortfall in energy terms, in accordance with the terms of the PPA. • In case of shortfall in generation below energy corresponding to 77.5% CUF: In addition to the above compensation, tariff escalation for the immediately succeeding contract year shall be removed from the applicable tariff for the corresponding contract year.

Source: JMK Research, SECI.

As can be inferred from the above tender conditions, the RTC-1 tender does not feature the necessary characteristics to qualify as "RTC". The original tender provided for the respective discoms to demand power on an RTC basis; post the amendments, this provision is void. Furthermore, the tender, as it stands, mandates the discom to off-take power as scheduled by the developer. In fact, RTC energy supply, as per the tender, only signifies daily availability of energy as scheduled by the project developer.

In May 2020, ReNew Power was awarded the entire capacity of 400MW, having made the winning bid (vis-à-vis 1st year of PPA) at Rs2.9/kWh. The levelised tariff for the project amounts to Rs3.6/kWh.[3] Stiff energy generation conditions in terms of CUF, as specified above, demand significant oversizing of the project capacity.

Figure 1: SECI RTC-1 Auction Result



Source: JMK Research.
Note: The L1 tariff quoted is single first year tariff.

ReNew Power anticipates the 400MW RTC project will require 900MW of wind capacity and 400MW of solar capacity, supplemented by 100 MWh of battery storage, for a total project cost of approximately US$1.2bn (Rs8,950 crores).[4] Notably, the bid conditions allow for the resizing of energy storage up to three years from the commissioning date. Allowed two years to commission the project, the developer can resize the storage till 2025.

[3] Prayas (Energy Group). A critical look at the recent "Round-the-Clock" Supply of 400 MW RE Power tender by SECI. July 2020.
[4] ReNew Power. ReNew Power Signs India's First Round-The-Clock Renewable Energy PPA. August 2021.

RTC-2

Selection of RE power developers for supply of 2500MW of RTC power from grid-connected RE power projects, complemented with power from any other source or storage in India under tariff-based competitive bidding (RTC-2)

To promote grid-connected solar power, the Jawaharlal Nehru National Solar Mission Phase-1 provided for a scheme of "bundling" in which solar power, then relatively expensive, was bundled with cheaper thermal power from the unallocated quota of the Government of India (Ministry of Power), generated at NTPC coal-based stations.

The RTC-2 tender, framed initially on the same principle, used the formal term "reverse bundling", which implies bundling high-cost coal-based thermal power with cheaper renewable energy.

In the space of a year from the original release in March 2020, the RTC-2 tender was amended seven times. The original Request for Selection (RfS) called upon RE developers for supply of 5,000MW of RTC power from grid-connected RE projects, complemented with power from coal-based thermal power projects in India. Amendments reduced the tender capacity to 2,500MW and removed the complementary power source (i.e. coal-based thermal power) constraint. The remaining valid tender conditions are below.

Bidders are allowed to tie up with any or no quantum (MW) of non-RE power capacity. Irrespective of the contractual arrangement between the RE power generator and thermal power generator, all the generator-related liabilities shall be of the former. The RE power generator can do a back-to-back tie up for supply from the thermal power generator and does not need to set up a new thermal power project under this tender.

Table 3: Key Conditions of the RTC-2 Tender

Tender Attribute	Condition
Minimum and Maximum Single Bid Offering	• 250MW & 2,500MW
Capacity Utilization Factor (CUF)	• Annual CUF – Not less than 85%; • Annual CUF (during peak hours) – Not less than 85%
Technology Mix	• Annually, minimum 51% of energy shall be offered from renewable energy sources. This 51% shall also include offer from the storage system, provided RE sources were used to store energy • The balance 49% can be offered from thermal power assets that are under construction or operational. Multiple tie-ups can be planned over different time spans.
Tariff Escalation	• Scalable for fuel and transportation only for non-RE power
Scheduled Commissioning Date (SCD) from the Effective Date of the PPA	• 24 months, for a project of not more than (and including) 1,000MW • 30 months, for a project of more than 1,000MW
Selection of Project Technology	• RE technologies as classified as renewable power generating source, by MNRE • For ESS, any form of storage systems such as, battery energy storage, mechanical storage, pumped storage etc.
Location of Generation Sources	• The sources of generation and ESS, if any, may or may not be co-located, to be considered a single project
Penalty for Shortfall in Energy Supply	• 400% of the applicable tariff payable during the year for the corresponding shortfall in energy terms

Source: JMK Research, SECI.

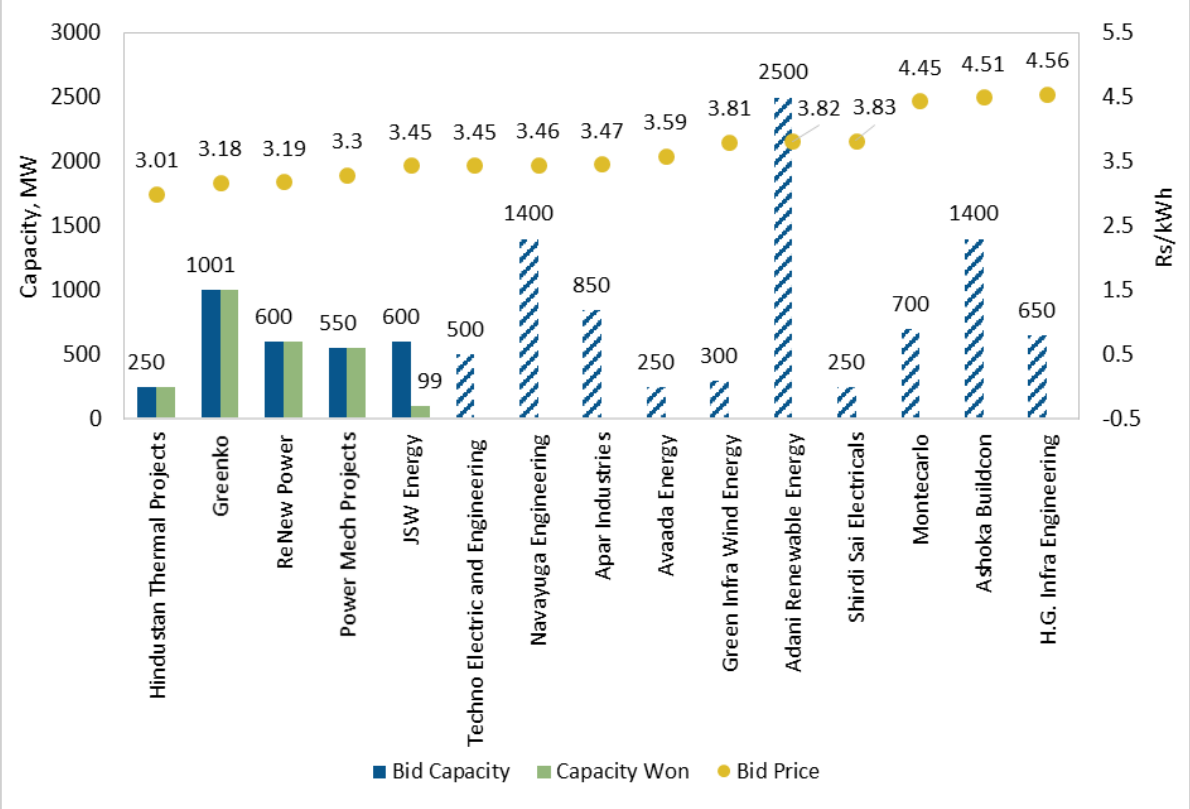
As in RTC-1, the sources of generation and ESS under RTC-2 can be connected with the ISTS network at multiple injection points. But ESS, if any, need not (unlike in RTC-1) be co-located with an RE source. Amendments nullified the constraint on location of generation sources but, it is to be noted, the greater the dispersion of injection points, the higher will be the costs for land, transmission etc. Additionally, this magnifies the risk of electricity grid imbalance.

The RTC power developers would need to seek Long Term Access (LTA) approval of higher order against the contracted capacity, in order to have flexibility in supply of RE and non-RE power. Also, the mandate of 85% CUF of the project on an annual energy basis strongly increases the likelihood of integration of ESS capacity in the technology mix or buffer tied-up thermal power capacity. This is even more relevant with the stringent peak power supply condition.

After about 18 months from the original RfS issuance, the RTC-2 auction in October 2021 attracted bids equivalent to 4.7 times the tender capacity (2,500MW). From the mix of RTC tender participants with varied profiles, the greatest showing was from conventional/renewable power companies with a strong foothold in the industry. The next largest representation came from core construction/infrastructure companies. The L1 tariff was Rs3.01/kWh, quoted by Hindustan Thermal Projects for a bid capacity of 250MW.

Although the auction was concluded, the allotment of capacities bid by the remaining winners is yet to be finalised as SECI has sought the corresponding winning prices to be matched with the L1 tariff. Ostensibly, given the wide range of tariffs quoted by the winners, Greenko, Renew Power, Power Mech Projects, JSW Energy may not be able to match the L1 tariff.

Figure 2: SECI RTC-2 Auction Result



Source: JMK Research.
Note: JSW Energy had won the remaining (99MW) capacity of the total tendered 2,500MW capacity as per the bucket-filling method. The allotment of capacities bid by the remaining (L2 to L5) winners is yet to be finalised.

The projects under both the RTC tenders would not assure 100% RTC power supply. As is evident from the effective provisions of both the SECI-tendered RfS, neither is technically an "RTC" tender.

3. Prospective Methodologies for RTC Project Deployment

Despite the absence of the "round-the-clock" mandate from the issued RTC tenders, a more meticulous approach to supplying power within the ambit of the tender terms is imperative. The following methodologies are expected to be adopted by the RTC power developers:

Optimising Energy Mix Using RE and/or Non-RE and/or ESS Capacities

Hybridisation of wind and solar power would be the certain route to generation of (whole or at least the majority of) the RE component in RTC power. However, SECI also allows combining wind and solar power from different locations and this combination, in essence, would not be deemed "hybrid" power. The wind-solar hybrid (WSH) system, in which the components are inherently co-located, not only enhances the CUF of the combined system but also that of the transmission infrastructure. But, to meet the significantly high CUF requirement of SECI-tendered RTC projects, it becomes necessary to complement combined wind and solar power with firm and predictable power.

- **Blending with thermal power**: Thermal power has profound capacity for achieving a high ramp rate (especially in the context of annual peak-hour CUF requirements). For conventional power producers such as Hindustan Thermal Projects and JSW, idle thermal capacities are expected to be used solely for variable tariffs, in the range of Rs2-2.5/kWh. The producers will optimise untied thermal capacity without any additional capex investment.

- **Blending with hydro power**: With respect to RTC-2, it is anticipated the winning companies with expertise in the RE market (ReNew Power and Greenko) will combine solar, wind and hydro power (such as run-of-the-river type) technologies. It is also anticipated that 70-80% of the annual energy generation demand will be met through solar and wind capacities and the rest via hydro. ReNew Power recently acquired 99MW of hydro assets from L&T and it is likely that this capacity will be used in the optimal mix planned for RTC tenders.

- **Integrating ESS**: Further in the assured energy generation context, use of ESS (charged by surplus RE power) can be beneficial for a limited duration when RE resources are unavailable. Long and short-duration storage capacities, such as pumped hydro energy storage (PHES) and battery energy storage system (BESS) respectively, could provide the critical non-intermittent RE power. However, if deployed, the capacity of BESS would be minimal due to the quite high cost.

Oversizing of RE Capacity

Higher CUF levels call for heavier oversizing of the RE component of overall project capacity. For a purely RE-driven project or RE-plus-storage project, the overcapacity is expected to be three or more times that of the contracted RTC capacity. The RE component as part of RE-plus-thermal project would require oversizing to a considerably lower degree.

Selling Excess Power to Third Party Procurer

RTC power developers are also expected to implement creative financial and technical engineering[5] such that they still earn healthy returns. In the event of

[5] Bloomberg Research Note.

excess energy generation, the developer can sell the surplus to third parties. When there is an energy generation deficit, the developer must pay penalties for lack of supply In both scenarios – RE-plus-thermal and pure RE, the excess generation from the RTC projects may be sold in power exchanges, where the average cost of solar and non-solar power are ~Rs3.5/kWh and ~Rs4/kWh in the Green Term Ahead Market (GTAM),[6] and/or routed through medium or long-term open access contracts.

The financial modelling below examines three methodologies to determine the best potential technology mix for supply of RTC power.

Table 4: Key Assumptions for Financial Modelling

Parameter	RTC-1	RTC-2
RE Plant Locations	Solar plant – Rajasthan; Wind plant – Gujarat	Solar plant – Rajasthan; Wind plant – Gujarat
Wind Cost (Rs crores/MW)	Rs 6 Crore/ MW	Rs 6 Crore/ MW (US$0.8 million/ MW)
Solar DC Cost (Rs. crores/MW)	Rs 2.73 Crore/ MW (US$0.36 million/ MW) Mono-module+fixed-tilt	Rs 4 Crore/ MW (US$0.53 million/ MW) Bifacial module+single-axis tracker
CUF Solar (DC)	0.21	0.225
CUF Wind	0.37	0.37
Project Tenure	25 years	25 years
Debt Equity Ratio	75:25	75:25
Interest Rate	8.5%	9%
Return on Equity	13%	13%
BESS Cost	US$260/kWh	US$260/kWh

**Prices are exclusive of Goods and Services Tax (GST), Basic Customs Duty (BCD).*

[6] Costs highlighted indicate average solar and non-solar prices in first year of GTAM on Indian Energy Exchange (IEX).

Table 5: Summary of Potential RTC Project Deployment Methodologies

Parameter	RTC-1	RTC-2	
Nature of Technology Mix	Leveraging RE+ESS technologies	**1st Option** - Leveraging purely RE resources (80% RE rest other sources)	**2nd Option** - Leveraging RE+thermal resources (51% RE and 49% thermal)
Minimum Annual CUF Requirement	80%	85%	85%
Solar to Wind Ratio	30:70	40:60	30:70
Oversizing of RE Capacity	225%	250%	Since RE would be bundled with thermal, oversizing would be ~50%
Surplus Generation Owing to RE System Oversizing	25-30%	30-35%	Very low
BESS Component	100 MWh	Not included	Not included

Source: SECI, Industry interviews, JMK Research.

Of the possible technology amalgamations, the RE-plus-thermal model may be best suited under the current scenario to satisfy the assured power supply conditions of the issued RTC tenders. However, in the long run, RE+BESS would be the most viable solution.

4. Global Experience

Countries such as the U.S., Germany, and Chile have piloted RTC power procurement, providing more dispatchable renewable power for balancing the electricity supply and demand.[7] The RTC systems in Germany and Chile demonstrate the management for demand-based supply by the producers while the pilot systems in the U.S. and Germany realise a firmer RE power supply.

The different routes taken by these countries to align with demand-based supply are as follows:

- Supply blocks (Chile)
    - The Chilean government created a tender mechanism for solar and wind projects. The new scheme allowed power producers to participate in technology-agnostic auctions to supply power during specific "time blocks". This worked to the benefit of RE developers as they could now compete against conventional thermal players for time blocks during which there is sufficient RE resource availability.

[7] USAID. India: Round-The-Clock Power Procurement.

- On-peak tariff (Nevada, USA)
    - Renewable-integrated storage power producers get incentives to supply during peak hours of 4-9 PM in summer (June-August). The peak tariff is about 6 times than that paid to the generators during off-peak hours.
- Virtual Power Plant (VPP) (Germany)
    - VPP enables the creation of a network of RE generating assets, flexible consumers and energy storage systems. One of the largest VPPs in Germany, operated by the Norwegian company Statkraft, connects the electrical output of about 1,400 IPPs, aggregating capacity in excess of 10GW. A central control system connects the various participating units, collects real-time data from these units, monitors market prices and develops production forecasts. Acting as a single dispatchable entity, VPP helps optimise the energy price as well as utilisation of networked units.

The different approaches to demand-based power supply in other countries show the way for India, where it is imperative to implement time-based incentive models, encouraging RE supply to match demand. Aggregating multiple capacities of generation and storage technologies via VPPs can be explored as a further means of enhancing grid balancing.

5. Conclusion

In India, the evolution of RE tenders from plain vanilla solar/wind to hybrid to assured peak power to RTC tenders highlights the increasing focus on firming of VRE-integrated power. Discoms are now driving the next set of tenders and auctions to manage their RTC requirements with renewable energy sources meeting 80-85% annual CUF conditions during peak and off-peak hours alike.

However, the two SECI tenders (RTC-1 and RTC-2) cannot technically be identified as "round-the-clock", as the condition for minimum annual energy availability is set less than 100%. Furthermore, given the provision of multiple generation locations, the allied projects may not even qualify as hybrid power. Reducing intermittency of VRE by blending power (from varied primary sources) with or without integrated ESS augments not only project reliability but also grid infrastructure utilisation.

The government could support RTC projects through viability gap funding to cushion against tariff spikes.

The high cost of lithium batteries still makes BESS largely unviable. Only small capacities of BESS can be expected if

included in the technology mix. Furthermore, in the initial phase, amid rising commodity prices, the government could lend additional support to RTC projects by way of viability gap funding (VGF) to cushion against potential tariff spikes. In view of the intensifying need for integration of large-scale generation and storage technologies, it is crucial now to implement utility-scale hybrid-plus-storage pilot projects backed by institutions such as SECI and MNRE.

Financial modelling of the various possible mixes of technology shows that an RE-plus-thermal model may be best suited under the current scenario to satisfy the assured power supply conditions in the RTC tenders. However, in the long run, RE+BESS would be the best viable solution.

Taking a cue from how other countries approach demand-based power supply, it is imperative that India implements time-based models to give incentives for RE supply to match demand. To further enhance grid balancing, aggregation of multiple capacities of various generation and storage technologies through VPP can be explored.

While thermal power remains in the picture, it would be difficult for RE generators to get access to foreign low-cost financing options for clean technology deployment. In such a scenario, technical engineering can play a significant role to increase the CUF. Deploying high-wattage bifacial modules with single-axis tracker along with robotic cleaning can lead to an additional increase of 18-20% in energy generation.

Also, in the context of RE tariffs, it would be remiss not to consider the potential threat of a delay in signing of power sale agreements (PSAs) by discoms. Pre-COVID, discoms' high anticipation of declining tariff rates led to reluctance in RE procurement from SECI.[8] And now, the rise in cost of solar power by virtue of the surge in solar equipment prices is likely to exacerbate SECI's challenge of PSA signing with the discoms.

To conclude, RTC (in the truest sense) power generation is a significant challenge as well as an opportunity for the renewable industry. Cost-effective power procurement models that target grid imbalancing need to be streamlined in the market to improve the capacity utilisation and reliability of power infrastructure.

[8] IEEFA. India's Power Sale Agreement (PSA) Hold-Up: Fixing a Renewable Energy Bottleneck. April 2021.

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