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Workshop on

Renewable Energy Integration and Procurement

March 18 -19, 2024

South Asia Regional Energy Partnership (SAREP) and Sri Lanka Energy Program

Session 2A: Competitive procurement and reverse auctions

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Who we are?

- Joint Venture of Ministry of Railways & RITES Ltd.
- Nodal Agency of Indian Railways for Renewable projects
- Company incorporated on 16.08.2013

Business Areas Includes

- Renewable Energy Planning & Execution
  - Solar Projects
  - Wind Projects
  - Round The Clock RE Projects
- Power Procurement & Planning
- Advisory on Regulatory Matters
- Energy Efficiency projects

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Agenda

- Renewable Energy Procurement Options – Auctions, Negotiated procurements, feed-in mechanisms
  - Auctions versus other Procurement Mechanisms
  - Designing Renewable Energy Auctions
  - Stages of Renewable Energy Auctions
  - Reverse Auctions
- System friendly procurement in India
  - Relevance and opportunity – bringing down costs, demand responsive
  - Global trends in RE system-friendly procurement
  - Evolution of system friendly procurement in India
  - Experience of SECI
  - Key features of RTC tenders of REMCL

Renewable Energy Procurement

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Renewable Energy Procurement Options

Feed-in mechanisms

- Feed-in tariffs and feed-in premiums used to pay for electricity
- Under feed-in tariffs, power producers receive a fixed payment for each unit of electricity generated, independent of the electricity market price
- Under a feed-in premium, a bonus is paid, in addition to the market proceeds, per unit of electricity generated

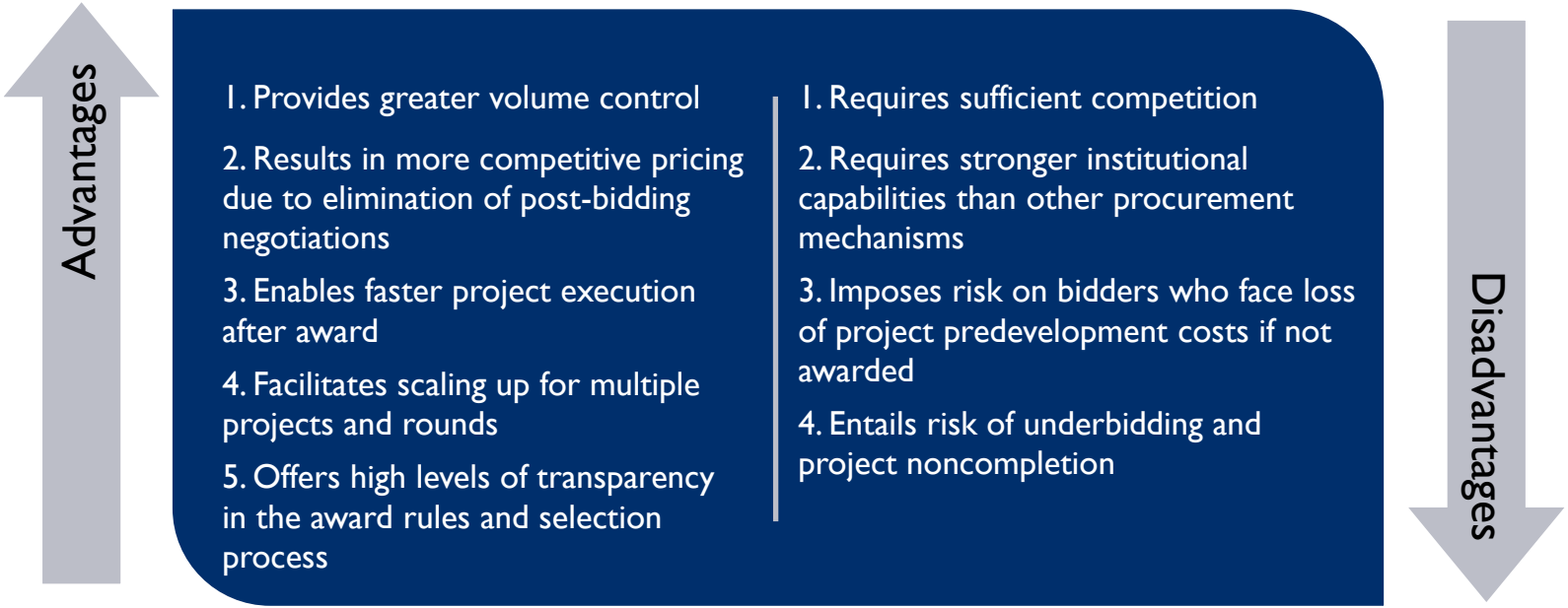
Negotiated procurements

- Competitive bidding with limited participation of serious bidders via qualification criteria
- Includes a post-bidding negotiation stage in which changes in project size and price are possible

Auctions

- Competitive process for procuring electricity
- Auctions organize the access to off-take contracts and determine the level of the price paid per unit
- No negotiation after the bidding concludes

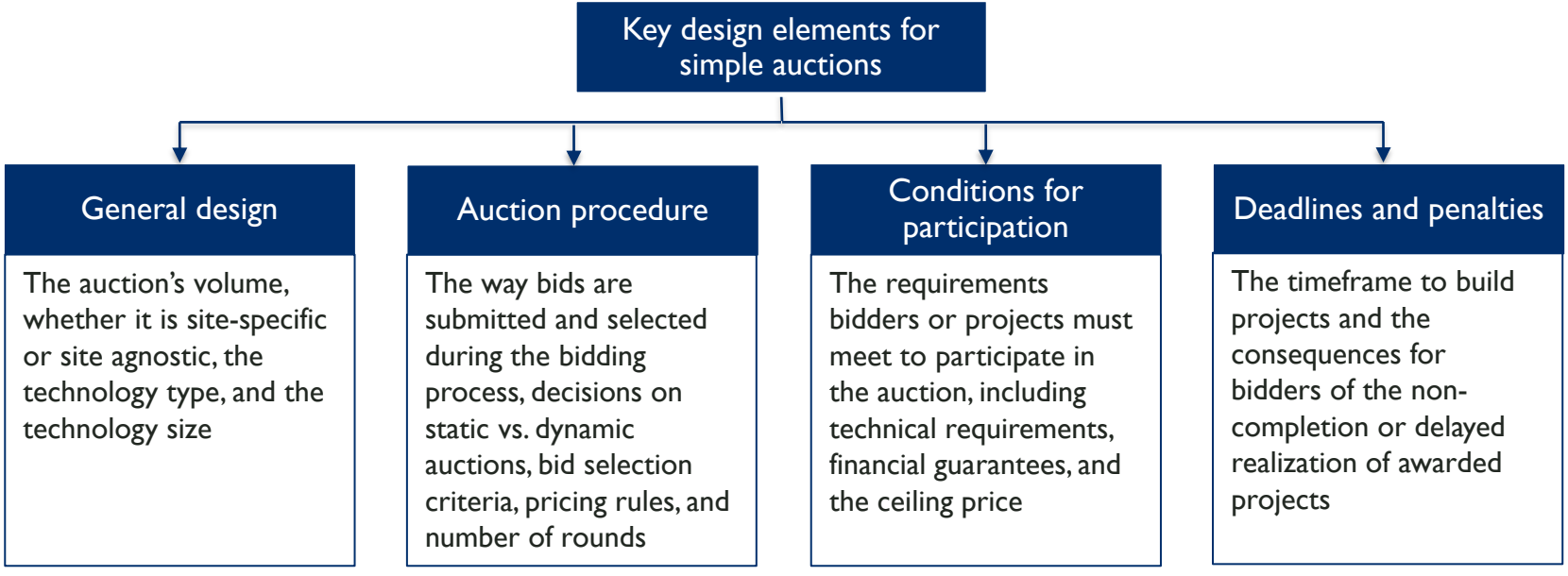
Auctions versus other Procurement Mechanisms



- Countries with limited market maturity and institutional capacities should design simple auctions
- Policymakers should define policy objectives to achieve with the auctions like:
  - Allocating of available funding efficiently
  - Achieving renewable energy generation targets through the timely implementation of projects
  - Grid and system integration of awarded projects
  - Positive socioeconomic effects at the local level

Designing Renewable Energy Auctions

- Key steps of the auction design process include:
  - Drafting required documents;
  - Preparing relevant institutions through training;
  - Securing enough funding for institutions to prepare the auction
  - Building the market by engaging bidders and financial institutions



Stages of Renewable Energy Auctions

Early auctions

- Simple energy-only auctions
- Test investor interest and risk allocation approaches
- Set a baseline for price discovery

Addressing grid integration

- Improving dispatchability and value of energy to the system
- Assigning selected integration responsibilities to RE generators
- More sophisticated approaches to project location

Electricity markets integration

- Requiring direct sales into wholesale markets with feed-in premium supplements
- Enabling RE to sell into ancillary services, peaking and balancing markets

Commercial and industrial PPAs

- Commercial and industrial consumers procuring power directly
- Meeting corporate climate commitments, hedging against wholesale market fluctuations
- Can be combined with others like ancillary services

To procure power on competitive costs reverse auctions can be the way forward

Reverse Auctions - I

What are Reverse Auctions?

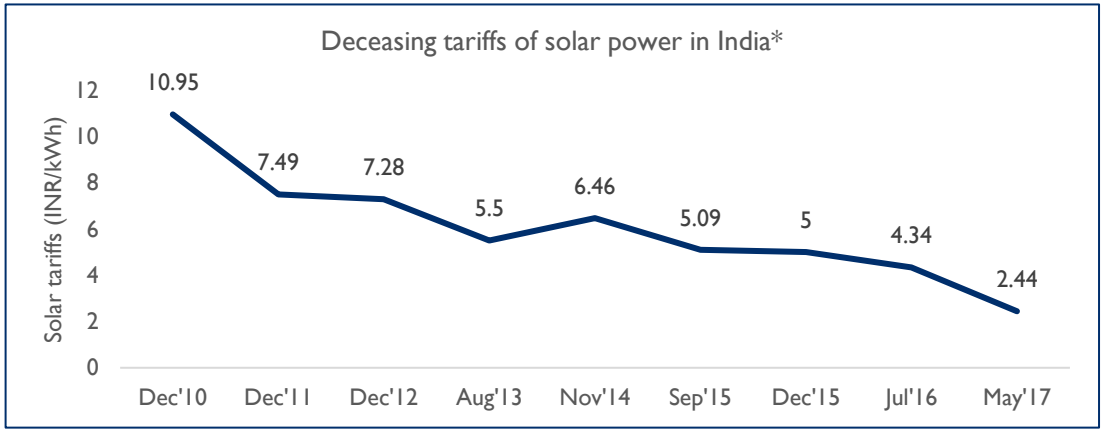
- In a reverse auction, energy generators make offers as to the price for which they can provide renewable energy generation.
- The public entity the selects the winning bidders that meet the criteria, starting with the lowest price offers until the required capacity levels are met.
- The winning bids are then secured through power purchase agreements with the utility.

Reverse Auctions in India

- The Jawaharlal Nehru National Solar Mission implemented reverse auctions for 25-year fixed price contracts beginning in 2010.
- The first phase of the auctions carried out between 2010 and 2011 were of a 25-year duration power purchase agreement.
- The total quantity to be auctioned during this phase was fixed at 1,000 megawatts (MW). This has proved remarkably successful, with capacity growing from 30 MW in March 2011 to 74,000 MW in January 2024*

*https://www.investindia.gov.in/sector/renewable-energy#:~:text=The%20installed%20solar%20energy%20capacity,of%20Solar%20Energy%20(NISE).

Reverse Auctions - II



Pros of reverse auctions	Cons of reverse auctions
Competitive opportunities for all qualified bidders	Possibility of quality compromise to achieve least cost
Transparent tariff discovery	A minimum number of bidders (2-3) required to conclude the bid
Leads to procurement of energy at least cost	

*Anatomy of a solar tariff, CEEW

System friendly procurement in India

Overview of Indian Power Market

- **Diverse Energy Sources:** India's power sector relies on a mix of energy sources including coal, natural gas, hydroelectric, nuclear, and renewable energy.
- **Electricity Demand Growth:** Rapid industrialization, urbanization, and electrification efforts have led to a significant increase in electricity demand, driving the need for expansion and modernization of the power infrastructure.
- **Government Initiatives:** Various government initiatives such as the, UDAY (Ujwal DISCOM Assurance Yojana), SAUBHAGYA (Pradhan Mantri Sahaj Bijli Har Ghar Yojana) and PM Surya Ghar Muft Bijli Yojana aim to reform and strengthen the power sector.

Transforming Acts & Rules of Indian Power Market

- **Electricity Act, 2003**
- **Energy Conservation Act, 2001**
- **Green Energy Open Access Rules, 2022**

The opportunity for system-friendly RE procurement

System-friendly RE procurement minimizes both generation and system integration costs

	Generation costs ≠ system integration costs
+	Investment and operational costs
+	Cost of capital (debt, equity)
=	**Electricity generation costs**
+	Grid expansion and upgrade costs
+	Balancing costs (including redispatch costs)
+	Provision of reserves
=	**System integration costs of RE generation**

- System-friendly RE procurement considers both cost types in award decision:
  - falling generation costs of RE, and
  - the system costs and benefits of RE

Result: DISCOMs are able to increase the uptake of RE generation and reduce their power purchase cost by taking advantage of falling RE prices.

System-friendly RE procurement is an opportunity to increase the uptake of RE in India

Matching demand curve

- Challenge: Changing demand patterns and trend toward higher evening peaks
- Opportunity: Dispatchable RE (hybrids, storage) during peak time through higher tariffs/supply blocks following load patterns

Mitigating grid integration/transmission costs

- Challenge: Grid constraints at the transmission level leading to congestion and curtailment or higher grid connection costs
- Opportunity: Requirement for minimum capacity utilization factors (CUF), consideration of grid connection costs in bids

Reducing intermittency

- Challenge: Balancing of real-time generation shortages and surpluses
- Opportunity: Procurement of more firm RE power, e.g. virtual or physical hybrids with higher CUFs (solar-wind + storage)

Global trends in RE system-friendly procurement

Time-based incentives and penalties	• Design options that incentivize RE generation to more closely match the DISCOM demand curve (e.g. price adjustment factors, supply blocks).
Aggregators (virtual hybrids)	• Several RE installations at different grid connection points are bundled and dispatched via virtual control systems. Virtual hybrids can thus feed in exactly as much electricity as has been purchased.
Procurement of (physical) hybrid solutions	• Competitive procurement of RE electricity from installations combining technologies such as wind, solar, storage or dispatchable technologies with the aim of combining complementary generation profiles to offset technology-specific intermittencies and to reduce grid connection costs.
Locational signals	• Locational signals aim to steer the location of projects to specific areas/grid connection points to avoid the concentration of projects in resource-rich but costly-to-connect areas.

Indian market is embracing System Friendly Procurement

	Short to medium term	Long term
Objective	RE participates in power market	Make renewables 100% responsive to demand
Requirements	Generation curve needs to be more predictable	
Technology	Use software for resource planning	Resource plans to target 100% renewables
Project structure	• Plants within a project need not be co-located. • Capacity of project/plants should not be defined. Only demand needs to be defined.	Move away from **project-based approach to aggregator-based approach**. A developer should be able to buy from existing plants.
Regulations	• Tighter forecasting and scheduling requirements for RE • How do you address F&S requirements	• Remove must run status of RE – allow it to be used as base and/ or peaking load
Procurement	• All upcoming PPAs should be system friendly procurement	• Re-structure all existing PPAs and make them system friendly.

Evolution of system friendly procurement

Standalone Renewable Energy Projects – vanilla solar and wind projects

Hybrid Renewable Energy Projects – wind-solar hybrids

Projects with Blending of Renewable Power and Brown Power – Wind and/or solar with thermal

Round The Clock Renewable Energy Projects – wind + solar + thermal / wind + solar + storage

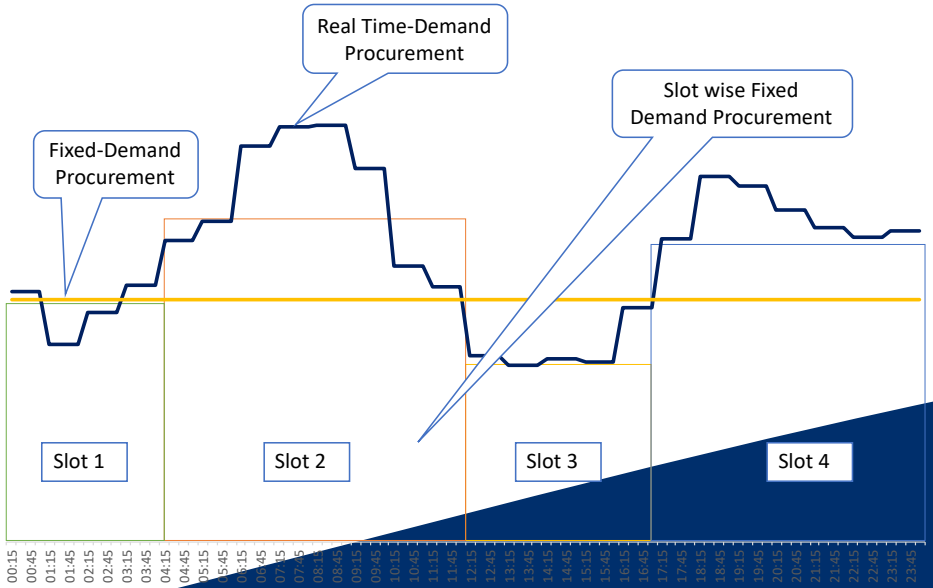
Demand Based Renewable Energy Projects – Load following, peak power demand projects

How RTC helps address RE challenges

- Manage the variations in RE sourcing by taking portfolio approach
- Determines optimal capacity requirement of RE sources by bringing in specialized players in designing solution
- Optimizes the overall cost of the supply portfolio by competitive bidding
- Shifts the responsibility of managing various sources from a Consumer (IR) to supplier

RTC procurement can be designed as per the need of the buyers

1. Fixed (Continuous) Demand procurement
2. Slot wise Fixed Demand procurement
3. Real time Demand procurement



RTC tender design options

Model	Benefits	Challenges
Fixed (Continuous) Demand procurement	• Simple procurement model for the supplier and buyer • Expected to receive high responses from suppliers	• Meeting peak demand – surplus power disposal • Not meeting peak demand - buyer needs to find other avenues for procuring power – difficulty in management

Slot wise Fixed Demand procurement	• Higher potential to meet peak demands	• Same as above, but in lesser degree
		• Comparatively complex
		  • Optimizing slots VS expected tariffs
		  • Structuring procurement
		• Potentially higher cost of power

Real time Demand procurement	• No surplus power, no shortfalls	• Granular load curve forecasting needed - modelling • Additional flexible generation capacity reserves needed • Difficult to monitor the contracts • Comparatively much higher expected cost of power

900 MW RE RTC tender of REMCL

Key features	• Technology agnostic tender within RE sources • Flexibility to developers for involvement of storage as part of bid • Minimum annual availability of the project – 75% for first four years and 85% thereafter • Minimum time-block wise availability – 50% • Penalty for shortfall of energy – 200% of tariff

Results of the tender	• Total 3 bidders awarded
	  • NTPC Renewables– 500 MW
	  • Project Nine RE power – 300 MW
	  • Sprng Akshaya Urja – 100 MW
	• Weighted Average Tariff of INR 4.11/kWh or LKR 15.18/kWh
	• Total installed RE capacity: ~3.0 GW

2nd RE RTC tender by REMCL for 750 MW

- Given the success of first RTC tender, REMCL planned to launch the 2nd RE RTC tender of 750 MW

Results of the tender	• Total 5 bidders awarded
	  • NTPC Renewables– 200 MW
	  • Re New power – 200 MW
	  • ACME Cleantech– 100 MW
	  • TEQ Green-100 MW
	  • Torrent Power-100 MW
	• Weighted Average Tariff of INR 4.35/kWh or LKR 16.06/kWh
	• Total installed RE capacity: ~2.3 GW

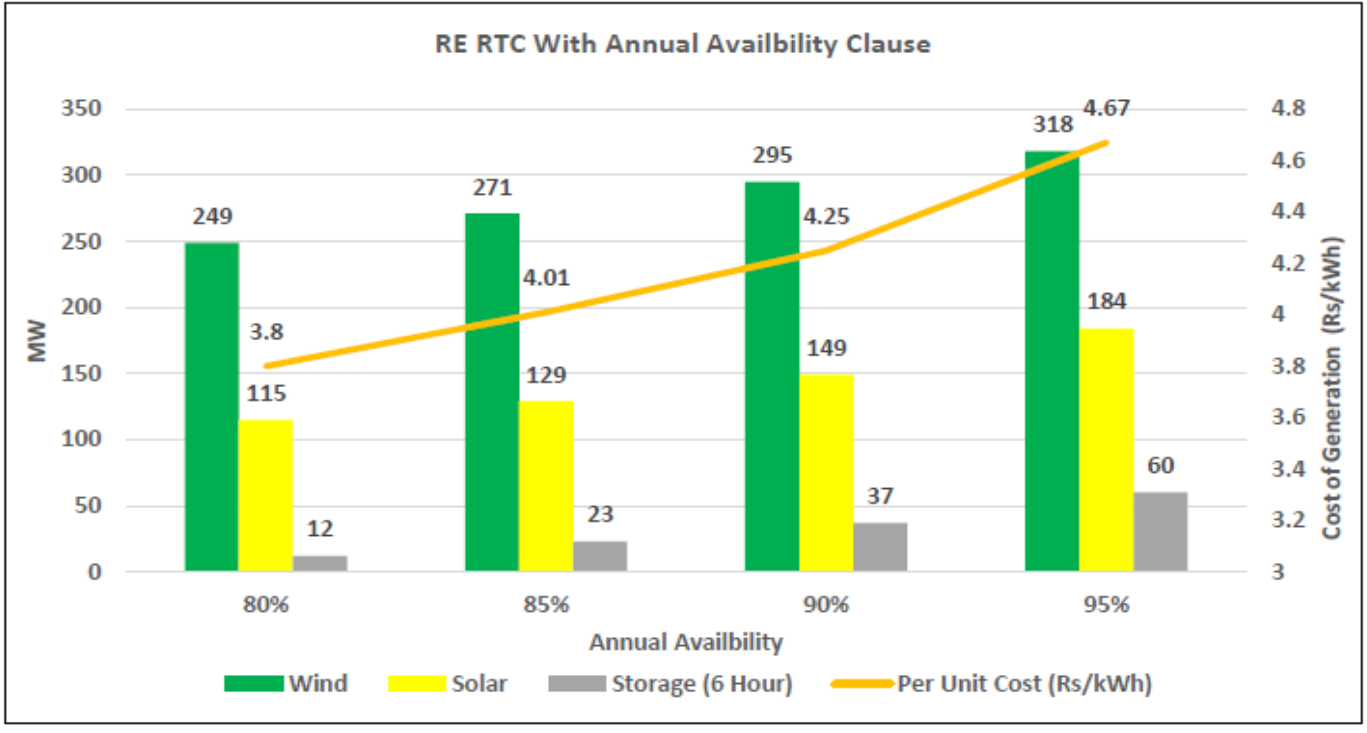
Estimated assumptions for RTC projects

Name of technology	Cost of Investment (INR/MW)	Cost of Investment (SL Rupee/MW)	Land requirement for 1MW project capacity
Solar	4.5 Cr	~16 Cr	4-5 Acres
Wind	6 Cr	~22 Cr	5 Acres
Hydro	8-10 Cr	~30 – 37 Cr	1.2 – 2.5 Acres
PSP (6 hours)	4-6 Cr	~15 – 22 Cr	As per design
Battery (5-hour storage)	8 Cr	~30 Cr	As per design

*Techno-Economic Analysis of Renewable Energy Round the Clock (RE-RTC) Supply for Achieving India's 500 GW Non-Fossil Fuel Based Capacity Target by 2030, CEA, 2024

Variability in RE RTC scenarios with different annual availability

- A case for a 100 MW RE RTC is shown for combination of Gujarat Solar and Maharashtra Wind
- The per unit cost varies between SL Rupee 14.03 – 17.25 (INR 3.8 – 4.67)
- With higher annual available requirement, the capacity and storage requirement increase significantly. This corresponds to higher investment requirement and higher per unit cost of generation



*Techno-Economic Analysis of Renewable Energy Round the Clock (RE-RTC) Supply for Achieving India's 500 GW Non-Fossil Fuel Based Capacity Target by 2030, CEA, 2024

Q & A

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Electricity Act 2003: Transforming India's Power Sector

- **Key Features:**

1. **Liberalization of the Sector:** Introduces competition, encouraging private participation and investment in generation, transmission, and distribution.
2. **Regulatory Framework:** Establishes regulatory commissions at the central and state levels for fair regulation, ensuring consumer protection and efficient functioning of the sector.
3. **Tariff Rationalization:** Aims for rationalization of tariffs, promoting cost efficiency and transparency in pricing mechanisms.
4. **Promotion of Renewable Energy:** Encourages renewable energy sources, setting targets for renewable energy generation and facilitating their integration into the grid.
5. **Consumer Rights:** Empowers consumers with rights such as access to quality power, accurate billing, and timely grievance redressal.
6. **Efficiency Improvement:** Focuses on improving operational efficiency, reducing losses, and promoting energy conservation and efficiency measures.
7. **Facilitation of Cross-border Trade:** Facilitates cross-border trade of electricity, fostering regional cooperation and integration.

Energy Conservation Act 2001: Driving Sustainable Energy Practices

- **Key Features:**

1. **Mandatory Energy Audits:** Requires designated consumers to conduct regular energy audits to identify energy-saving opportunities and improve efficiency.
2. **Energy Efficiency Standards:** Sets minimum energy performance standards for appliances, equipment, and processes to promote energy-efficient technologies and practices.
3. **Designated Consumers:** Identifies energy-intensive industries, commercial buildings, and establishments as designated consumers obligated to comply with energy conservation measures.
4. **Energy Conservation Fund:** Establishes a fund to finance energy conservation projects, research, and capacity-building initiatives.
5. **Public Awareness and Outreach:** Promotes awareness campaigns and educational programs to educate consumers, industries, and stakeholders about the importance of energy conservation.

Green Energy Open Access Rules

- **Key Highlights:**

1. **Introduction of Green Open Access:** Allows consumers to procure renewable energy directly from generators, bypassing distribution utilities.
2. **Facilitating Renewable Energy Consumption:** Enables industries, commercial establishments, and bulk consumers to access green energy from renewable sources such as solar, wind, and biomass.
3. **Promotion of Renewable Energy Projects:** Encourages investment in renewable energy projects by providing market access and revenue streams beyond government subsidies.
4. **Grid Connectivity:** Ensures seamless integration of renewable energy generators with the grid, facilitating the transmission and distribution of clean energy.