RENEWABLE ENERGY CERTIFICATE SCHEME AND RENEWABLE PURCHASE OBLIGATION (RPO) FOR PHOTO VOLTAIC SYSTEM

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***Abstract*- Renewable Purchase Obligation (RPO) regime in India started in 2012 with the announcement of benchmark RPO (BRPO) of states for the Financial Year (FY) 2012 by respective State Electricity Regulatory Commissions (SERC), to promote Renewable Energy (RE). Renewable Purchase Obligation (RPO) mandates that all electricity distribution licensees should purchase or produce a minimum specified quantity of their requirements from Renewable Energy Sources. This is as per the Indian Electricity Act, 2003. Renewable Purchase Obligation (RPO) is the requirement mandated by Central/State Regulatory Commission and is relevant to Distribution Licensee: power distribution companies (DISCOMs); Open Access Consumer: ones acquiring power from power exchanges (IEX/PXIL), from traders, via bilateral agreements and so on. Renewable purchase obligations (RPOs) under the Electricity Act 2003, particularly for distribution companies, have been key policy intervention for scaling up renewables, with the considerations of energy security and environmental aspects. This paper attempts to evaluate all states on a common platform to find BRPO, giving due importance to the state-wise energy demand and RE generation, ensuring minimum change in BRPO of consecutive years and hence less impact of RPO on tariff. To encourage the states into straight line their actual RPO with BRPO, an incentive scheme is proposed giving due level of importance to RE consumption, RE capacity addition and RPO compliance of the states.**

***Keywords*: Renewable Purchase Obligation, Renewable Energy Incentive scheme, Impact of RPO on tariff.**

1. INTRODUCTION:

In India, the renewable energy sector is undergoing changes rapidly – renewable energy has begun to play a significant role in the energy security of the nation as conventional energy sources (e.g., coal) have become scarcer and more expensive to import. Further, India has set ambitious renewable energy targets. The NAPCC, which in addition to India's response to climate change also tackles diverse issues such as energy security and industrial competitiveness, has set a target of 15% of electricity via renewable energy sources by 2020, with a starting target of 7% in 2012, increasing by 1% every year [1]. Under the Jawaharlal Nehru National Solar Mission (JNNSM), the government aims to develop 1,00,000 MW of solar energy by 2022 [2].

India is the only country with a separate ministry for renewable energy called the Ministry of New and Renewable Energy (MNRE). Regulations supporting the development of renewable energy in India are the Electricity Act of 2003 and the National Electricity Policy of 2005. The Electricity Act of 2003 stipulates purchase of a certain percentage of the power procurement by distribution utilities from renewable energy sources. Under this act, implementation of the renewable purchase obligation (RPO) is to be guided by the regulatory provisions issued by the respective State Electricity Regulatory Commissions (SERCs).The National Electricity Policy of 2005 also mandates that the share of electricity from non-conventional sources has to be increased progressively. Several other incentives in the form of generation based incentives (GBI), feed-in-tariffs (FIT), depreciation benefits and tax incentives have also been introduced. Due to a supportive policy environment coupled with abundant resources, India has seen tremendous growth in renewable energy deployment. However, the actual generation of electricity from renewable sources has been only 5.5% of the total electricity generation as of August, 2012 [11], as opposed to the annual target of 7% [1]. Though this is a marked improvement than the share of less than 4% just four years ago [12], renewable energy in India is lagging behind the targets, and it needs a comprehensive and focused effort to catch up.

Energy is a critical foundation for economic growth and social progress. As economy advances and human society requires more energy, the lack of fossil energy and its pollution on the environment has given rise to the ever-serious contradiction among energy providing, environment protection and economic development. Renewable energy, with the availability of its renewability and non-pollution, will prove to be an effective and practical choice to guarantee the future development of the world. As India is among the largest developing countries in the world, with richly

endowed renewable energy potential (India stands 4th globally in Renewable Energy Installed Capacity, 4th in Wind Power capacity and 5th in Solar Power capacity (as per International Renewable Energy Agency - Renewable capacity statistics 2023)), developing renewable energy is its inevitable choice for sustainable economic growth. Renewable energy has been categorized as traditional and new renewable energy. The former includes large hydropower, biomass burnt directly etc; the latter includes small hydropower, solar energy, wind energy, biomass energy, geothermal energy and ocean energy, etc[3]. India saw the highest year-on-year growth in renewable energy additions of 9.83% in 2022. The installed solar energy capacity has increased by 30 times in the last 9 years and stands at 72.31 GW as of November 2023. The installed Renewable energy capacity (including large hydro) has increased by around 128% since 2014.

2. ADVANTAGES OF REC MECHANISM

2.1. Interstate Transmission

RECs issued for quantum of electricity generated from renewable sources do not require scheduling over long distances. Such electricity can be consumed locally and only RECs need to be transferred to the obligated entities. Renewable obligation by preferential tariff may make it uneconomical and technologically difficult to transmit electricity from renewable sources located outside the States.

2.2. Promotion of stand-alone systems

Since trade in RECs does not require transmission of electricity, the additional revenue from sale of RECs could help to improve viability of standalone systems. In usual scenario it may not be economical to transmit electricity from such regions.

2.3. Competition in Electricity Market

Separating RECs from electrical energy allows near cost effective renewable energy to participate in the power exchange in a competitive manner. Revenue from RECs may be helpful to address the cost disadvantage for such renewable energy technologies.

2.4. Overcoming the barrier of natural diversity

Renewable Purchase obligation limits participation to the obligated entities, the distribution licensees in the Indian context. Additional cost due to such obligation is effectively allocated to all consumers in the area of a distribution licensee. Environmentally concerned consumers may be willing to consume higher proportion of green electricity. Such consumers can purchase RECs. Tradability of RECs would allow wider participation by NGOs, development agencies as well as the corporate sector that may purchase RECs as a part of their social corporate responsibility.

2.5. Alternative to Meet Renewable Purchase Obligation

National level tradability of RECs would allow obligated entities/distribution licensees to fulfill their obligation despite natural diversity. RECs may be purchased from generators located in other states. Limited resource endowments in a particular state may only permit lower renewable obligation.

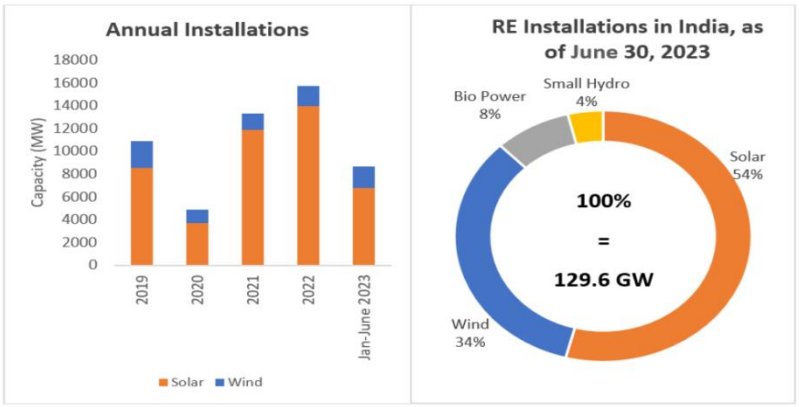
2.6. Attract Investment

REC market would provide appropriate opportunities for development of renewable energy based electricity generation. Through unbundling of RECs from electrical energy, the later can also effectively participate in a competitively traded market for electricity. This would also allow investors in renewable energy technologies to hedge electricity price risk through electricity futures. This, in combination with RECs would provide adequate risk hedging and hence encourage investment in renewable energy.

3. Renewable Purchase Obligation (RPO)

Central Electricity Regulatory Commission (CERC) has notified Regulation on Renewable Energy Certificate (REC) in fulfillment of its mandate to promote renewable sources of energy and development of market in electricity. The framework of REC is expected to give push to RE capacity addition in the country. The REC regulations in India specify the validity of REC to be 365 days (now 730 days) from the date of issuance. There is no safeguard in case of oversupply of RECs. In India, if the obligated entity fails to fulfill its obligation, it has to pay a penalty at the rate of forbearance price. The funds collected in this process can be used to buy the RECs from the open market. In India, there are currently two alternate revenue schemes available for investors in RE projects-(i) FiT Scheme and (ii) Renewable Energy Certificate Scheme. The present scheme of REC does not allow certificates being issued to those projects which are registered under FiT mechanism. The REC will be exchanged only in the Power Exchanges approved by CERC within the band of a floor price and a forbearance (ceiling) price to be determined by CERC from time to time. The distribution companies, Open Access consumer, Captive Power Plants (CPPs) will have option of purchasing the REC to meet their Renewable Purchase Obligations (RPO). Pertinently, RPO is the obligation mandated by the State Electricity Regulatory Commission (SERC) under the Act, to purchase minimum level of renewable energy out of the total consumption in the area of a distribution licensee.. The value of REC will be equivalent to 1 MWh of electricity injected into the grid from renewable energy sources .The RE generators will have two options - either to sell the renewable energy at preferential tariff fixed by the concerned Electricity Regulatory

Commission or to sell the electricity generation and environmental attributes associated with RE generation separately. On choosing the second option, the environmental attributes can be exchanged in the form of REC. Price of electricity component would be equivalent to weighted average power purchase cost of the distribution company including short-term power purchase but excluding renewable power purchase cost.



Source: CEA, JMK Research

Note: Solar capacity includes utility-scale solar, rooftop solar and off-grid/distributed solar capacity.

Fig .1 RE installation trends in India

4. Target in India

- Each State Commission specifies RPO target for its own State.
- No national level RPO target specified in the Act.
- RPO is fixed based on the resources available in the States.
- RPO across the country varies in the range of 1.5% to 10%
- RPO is specified for the maximum period of 3 to 5 years only
- No long-term certainty for investors

5. Renewable Energy Certificate And Renewable Purchase Obligation

The renewable energy sources are not uniformly distributed and are concentrated in certain parts of the country. REC address the mismatch between availability of RE sources and the requirement of the obligated entities to meet their Renewable Purchase Obligation (Soonee et al., 2011). Cost of electricity generation from renewable energy sources can be considered as the sum of cost of electricity generation equivalent to conventional energy sources and the cost for environmental attributes. The environmental attributes can be exchanged in the form of REC. There shall be two categories of certificates, viz. solar and non-solar. REC will be issued to the RE generators for every 1 MW h of electricity injected into the grid from renewable energy sources. Purchase of REC would be deemed as purchase of RE for RPO compliance. For example, State Agency for Renewable Purchase Obligations Purchase Obligations (RPO) and Renewable Energy Certificates (RECs) in Kerala. Earlier the KSERC had specified a total RPO of 3% for distribution licensees in 2010. Of this, 2.75% is to be met from non-solar sources and 0.25% from solar energy. The RPO increases by 10% of 3% every year, up to a maximum of 10%. Designating the State Agency to undertake functions of accreditation and recommending the renewable energy projects for registration and to undertake functions under KSERC (Renewable Energy and Net Metering) Regulations, 2020. (RPO) and Renewable Energy Certificates (RECs) in Kerala. ANERT is designated as the State Agency for Renewable energy in Kerala.

Table 1 REC Summary

Month, Year	Opening Balance (A)	REC Issued (B)	No. of REC Redeemed			Total E=(C1+C2+D)	Closing Balance (F=A+B-E)
			RECs Redeemed through Power Exchanges(C1)	RECs Redeemed through Traders (C2)	RECs retained by RE Generators(D)		
Mar,	18158461	372548	976637	90049	44394	1111080	17419929

2023							
Apr, 2023	**17419929**	**258234**	**376132**	**111567**	**0**	**487699**	**17190464**
May, 2023	**17190464**	**505759**	**234711**	**65713**	**0**	**300424**	**17395799**
Jun, 2023	**17395799**	**417231**	**655430**	**36532**	**0**	**691962**	**17121068**
Jul, 2023	**17121068**	**551447**	**725212**	**133367**	**43198**	**901777**	**16770738**
Aug, 2023	**16770738**	**569697**	**333917**	**169548**	**7656**	**511121**	**16829314**
Sep, 2023	**16829314**	**372593**	**1071838**	**29999**	**7979**	**1109816**	**16092091**
Oct, 2023	**16092091**	**683200**	**313819**	**14609**	**22094**	**350522**	**16423034**
Nov, 2023	**16423034**	**3138586**	**1349601**	**465342**	**14764**	**1829707**	**17731913**
Dec, 2023	**17731913**	**13220860**	**1279141**	**409073**	**2332**	**1690546**	**29262227**
Jan, 2024	**29262227**	**3000007**	**2649304**	**20500**	**0**	**2669804**	**29592430**
Feb, 2024	**29592430**	**24102**	**0**	**357**	**0**	**357**	**29616175**
Total		**123032594**	**85111689**	**1546656**	**3132012**	**89790357**	

6. Floor/forbearance prices in practice

While the rationale behind the need for floor and forbearance prices is clear, studies to study effect of these on actual system performance are few. Simulation experiments by Amundsen et al. [2], using a rational expectations model, show that introducing price bounds on top of banking further reduces price volatility by 1/3rd. Similarly, in climate policy context, in the absence of banking, price caps on emission prices are shown to decrease cost of abatement [28]. Some countries have implemented explicit floor and forbearance prices for RECs. Belgium has minimum and maximum prices set for RECs, which vary by technology and geographical region. Romania also has technology-agnostic floor and ceiling prices, which are revised every year. In the US, long-term price floors have been implemented in Massachusetts and New Jersey for solar RECs [4].

Several US states have put upper bounds on the burden, though it is not clear how this is enforced in practice. Most REC markets around the world (e.g., UK, Sweden, Italy, and Norway) do not have any explicitly-fixed floor and ceiling prices—these markets do set penalty prices in case of non-compliance, which act as the ceiling prices as obligated entities would prefer paying penalties for meeting RPOs instead of buying RECs in the market. These penalty prices and/or the forbearance prices can be derived from cost caps on Renewable Portfolio Standard (RPS) compliance [51,64]. The cost cap is further derived from the maximum allowed rate-increase and the size of the electricity market – as the product of the two; and the penalty price is derived from the cost cap and the size of the REC market – by dividing the former by the latter.

Table 2.Floor/forbearance prices in India

	Non solar REC (₹/MWh) w.e.f. - 01.04.12 - 31.03.17	**Solar REC (₹/MWh) w.e.f. - 01.01.12 - 31.03.17**	**Non solar REC (₹/MWh) w.e.f. - 01.04.17**	**Solar REC (₹/MWh) w.e.f. - 01.04.17**	**Non solar REC (₹/MWh) w.e.f. – 31.03.20**	**Solar REC (₹/MWh) w.e.f. – 31.03.20**
Forbearance Price	3,300	5,800	3,000	2,400	1000	1000
Floor Price	1,500	3,500	1,000	1,000	0	0

7. Risk Analysis from REC from the generator perspective

In the preceding section, the REC market data were analysed from the perspective of the buyers. In this section, analysis is done from the RE generators' perspective. It attempts to find out how RE generators view REC as an option for investment.

7.1 Bankability and Financing Risk

In most part of Asia as well as India, there is a real concern about the bankability of RE projects under the REC route because of high risks as perceived by financiers. The key constraint identified is the lack of visibility of pricing and regularity of cash flows. In India's REC case, there is a shorter visibility of the REC price band as the current floor and forbearance price determined by the central commission are valid only until FY 2021. Above forbearance price and floor price fixed in the said order shall be effective from 01.07.2020 and shall remain in force till 30.06.2021 or until further orders of the Hon'ble Commission. Thus, there is uncertainty over the REC revenue after the period. Another revenue source under the REC mechanism is the sale of electricity component to local distribution licensees at the Average Power Purchase Cost (APPC). The CERC regulations provide that the electricity component can be purchased by the local licensee at a price not exceeding the APPC, other could be a viability gap for the RE projects, especially in the event of the REC price discovered in the power.

7.2 Assessing Environmental Risks

RE generators provide cleaner and more sustainable power but may have limitations regarding power output and availability. Renewable energy sources like solar power have gained significant attention due to their potential to mitigate climate change and reduce greenhouse gas emissions. Renewable energy sources do not produce harmful emissions or pollutants during operation. Additionally, the abundance and availability of renewable energy sources make them a reliable and constant power supply. Factors such as natural disasters, infrastructure requirements, and maintenance costs should be carefully considered to maximize the benefits of these RE generators. It is important to assess these risks and implement appropriate measures to mitigate any negative effects on the environment.

8. RESULT DISCUSSION

The result discussion to be promotion of renewable sources of energy emerges as a favorable option. Increasing the share of renewable energy in the total fuel-mix of the country is in India's long-term interest. To evaluating the importance of REC scheme for Photovoltaic System and Renewable Purchase Obligation (RPO) is shown as below.

RPO trajectory from April 2024 to March 2030

Year	Wind energy (%)	Hydro energy (%)	Distributed renewable energy (%)	Other renewable energy (%)	Total renewable energy (%)
2024-25	0.67	0.38	1.50	27.35	29.91
2025-26	1.45	1.22	2.10	28.24	33.01
2026-27	1.97	1.34	2.70	29.94	35.95
2027-28	2.45	1.42	3.30	31.64	38.81
2028-29	2.95	1.42	3.90	33.10	41.36
2029-30	3.48	1.33	4.50	34.02	43.33

Source: Ministry of Power

Fig. 2 RPO Trajectory in India.

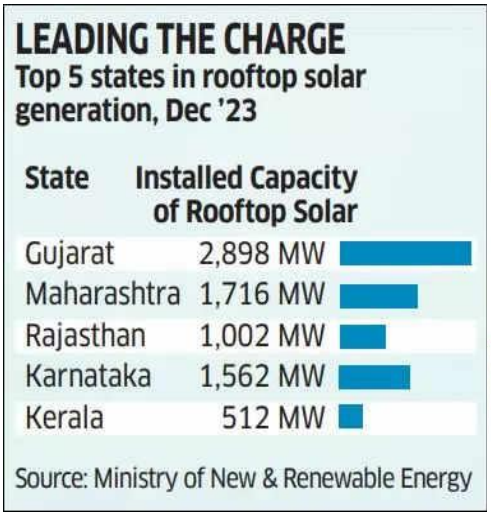


Fig.3 Solar growth chart in various states in India.

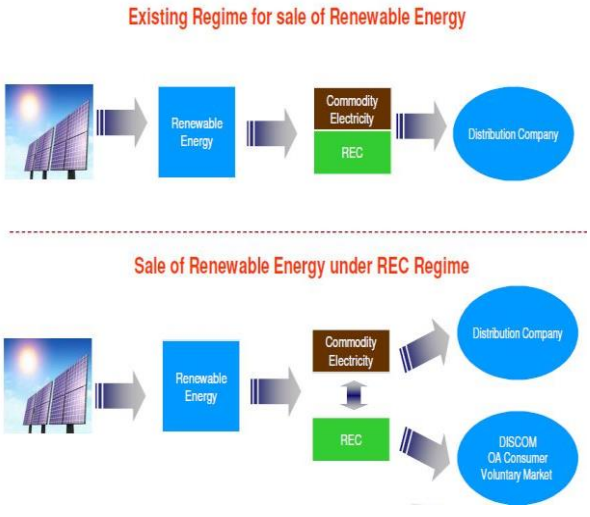


Fig. 4 Sale of renewable energy under REC regime

9. CONCLUSIONS

RECs are expected to encourage efficient investment and operation of renewable projects in India. At the outset it is expected that the design of the system should be based on sound economic principles. A look into the actual performance of REC market trading in the first year shows that though volume of trading increased in the last few trading sessions, and prices of RECs rose, less than 4.5% of the estimated REC demand could be met through the market. While no "best practices" were discovered in many cases, we have identified that several trade-offs exist in choosing the elements of an effective REC design. While banking and price bounds are recommended for stable markets, best-of-class methods for determining the optimal length of banking, the level of floor and forbearance prices, and the values of credit/vintage multipliers are not resolved completely. In particular, empirical studies relating REC market design elements to the actual effectiveness of REC markets are scarce.

REFERENCES:

1. Agnolucci P. The effect of financial constraints, technological progress and long-term contracts on tradable green certificates. Energy Policy 2007;35 (6):3347–59.
2. Amundsen E, Fridrik S, Baldursson M, Mortensen JB. Price volatility and banking in green certificate markets. Environmental and Resource Economics 2006;35:259–87.
3. S.K.Soonee, CEO*, MinaxiGarg, DGM #, and SatyaPrakash, Engineer, Renewable Energy Certificate Mechanism in India, 16th NATIONAL POWER SYSTEMS CONFERENCE, 15th-17th DECEMBER, 2010.
4. Bird L, Heeter J, Kreycik C. Solar renewable energy certificate (SREC) markets: status and trends. National renewable energy laboratory technical Report NREL/TP-6A20-52868; 2011.
5. Burtraw D, Szambelan SJ. , U.S. emissions trading markets for SO2 and NOx discussion paper 99-25. Washington DC. Resources for the future; 2009.
6. Business Line, 2010, Govt hopes to add 4700 MW renewable power by 2012. October 26 2010.
7. http://www.thehindubusinessline.com/todayspaper/tpeconomy/article1007689.ece?ref=archive.
8. Cason TN, Gangadharan L. Emissions variability in tradable permit markets with imperfect enforcement and banking. Journal of Economic Behavior & Organization 2006;61(2):199–216.CERC. Central electricity regulatory commission, New Delhi, determination of forbearance and floor price for the REC framework to be applicable from 1st April 2012. Petition no. 142/2011 (Suo Moto) date of order: 23rd August, 2011; 2011.
9. CEA. Annual Energy Statistics 2022–23. Central Electricity Authority; 2023.
10. CEA. Monthly generation Report August 2022. Central Electricity Authority; 2022.
11. CEA. Annual Energy Statistics 2020–21. Central Electricity Authority; 2021.
12. Chan G, Stavins R, Stowe R, Sweeney R. , The SO2 allowance trading system and the Clean Air Act Amendments of 1990: reflections on twenty years of policy innovation. Cambridge, Mass: Harvard Environmental Economics Program, January 2012; 2012.
13. Chattopadhyay M, Chattopadhyay D. Analysis of Indian Renewable Energy Policy using climate data. Electricity Journal 2012;25(3):81–93.
14. CRISIL. Assessment of various renewable energy resource potential in different states, Determination of RPO trajectory and its impact on tariffs. (http://www. forumofregulators.gov.in/Data/HomePage/RPO%20&%20Impact%20Assess ment-%20Final.pdf⟩; 2010.
15. CRS. Summary report on tradable renewable certificates (TRC): The potential and the pitfalls. San Francisco: Center for Resource Solutions; 2001.
16. CSERC. Renewable purchase obligation and REC framework implementation regulations, 2019 Chhattisgarh State Electricity Regulatory Commission; 2019.
17. Danthine JP. Information, futures prices and stabilizing speculation. Journal of Economic Theory 2010;17:79–98.
18. Deaton A, Laroque G. Competitive storage and commodity price dynamics. Journal of Political Economy 1996;104:896–923.
19. Ellerman AD, Joskow PL. The European Union's emissions trading system in perspective. Pew Center on Global Climate Change; 2008.
20. ECN. Review of international experience with renewable energy obligation support mechanisms. Energy Research Centre of the Netherlands ECN-C-05- 025. ⟨http://eetd.lbl.gov/ea/ems/reports/57666.pdf⟩; 2005.
21. G. Shrimali, S. Tirumalachetty / Renewable and Sustainable Energy Reviews 26 (2013) 702–716 715