OVERVIEW OF RPO POLICY OF GUJARAT AND ITS IMPLEMENTATION FOR VPCL LOCATED AT JAMNAGAR"

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This is to certify that the **Mr. Prahlad Sharma** a student of **EMBA (Power Management)**, Roll No.**500024445** of UPES has successfully completed this dissertation report on "**Overview of RPO Policy of Gujarat & Its Implementation for VPCL located at Jamnagar**" under my supervision.

Further, I certify that the work is based on the investigation made, data collected and analysed by him and it has not been submitted in any other University or Institution for award of any degree. In my opinion it is fully adequate, in scope and utility, as a dissertation towards partial fulfillment for the award of degree of MBA.

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LIST OF ABBREVIATIONS

ABT Availability Based Tariff

AD Accelerated Depreciation

CDM Clean Development Mechanism

CEA Central Electricity Authority

CERC Central Electricity Regulatory Commission

CPP Captive Power Plant

CSS Cross Subsidy Surcharge

CUF Capacity Utilization factor

DISCOM Distribution Company

EA Electricity Act 2003

FY Financial Year

GEDA Gujarat Energy Development Authority

GERC Gujarat Electricity Regulatory Commission.

GOI Government Of India

IEX Indian Energy Exchange

IISC Indian Institute of Science

IREDA India Renewable Energy Development Authority JNNSM Jawaharlal Nehru National Solar Mission

KWH Kilowatt Hour

MNRE Ministry of Non-Renewable Energy

Mop Ministry of Power

MW Megawatt

NAPCC National Action Plan for Climatic Change

NEP National Electricity Policy

NLDC National Load Dispatch Centre

NTP National Tariff Policy

OA Open Access

PLF Plant Load Factor

PPA Power Purchase Agreement

RLDC Regional Load Dispatch Centre

ROE Return On Equity

RPO Renewable Purchase Obligation

SEB State Electricity Board

SLDC State Load Dispatch Centre

STU State-Transmission Utility

TERI The Energy and Resources Institute

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Executive Summary/ Abstract

Power is a critical element of infrastructure for economic development and for improving the quality of life, therefore the reach of electricity should be to the rural areas and even to the poorest people of the country. In India where about 70 percent of the population lives in the villages and agriculture is the main occupation, serious efforts are being made to electrify all the villages on priority basis. As these villages are scattered all over the country, this task is found to be stupendous keeping in view the large investment required for providing the infrastructure by putting the transmission and distribution network in place. India is blessed with an abundance of sunlight, water and biomass. Vigorous efforts during the past two decades are now bearing fruit as people in all walks of life are more aware of the benefits of renewable energy, especially decentralized energy in villages and in urban or semi-urban centres

India has the world's largest programmer for renewable energy. Accelerated development of Renewable Energy sources will have a vital role in the development of power infrastructure, especially in the far flung areas and in utilization of sustainable energy.

India has the world's fifth-largest electricity generation capacity which currently stands at 278 GW. The power sector in India is highly diverse with varied commercial sources for power generation like coal, natural gas, hydro, oil and nuclear as well as unconventional sources of energy like solar, wind, bio-gas and agriculture. The demand for power has been growing at a rapid rate and overtaken the supply, leading to power shortages in spite of manifold growth in power generation over the years.

Industrialization, urbanization, population growth, economic growth, improvement in per capita consumption of electricity, depletion of coal reserve, increasing import of coal, crude oil and other energy sources and the rising concern over climate change have put India in a critical position. It has to take a tough stance to balance between

economic development and environmental sustainability. One of the primary challenges for India would be to alter its existing energy mix which is dominated by coal to greater share of cleaner and sustainable sources of energy.

This paper present a welcome light for the RPO (renewable purchase obligation) prospect of the Vadinar Power Company Limited (VPCL) Essar .At present the options available for plant are many which ranges from Coal(imported) , Natural Gas, HSD and Fuel Oil. However the

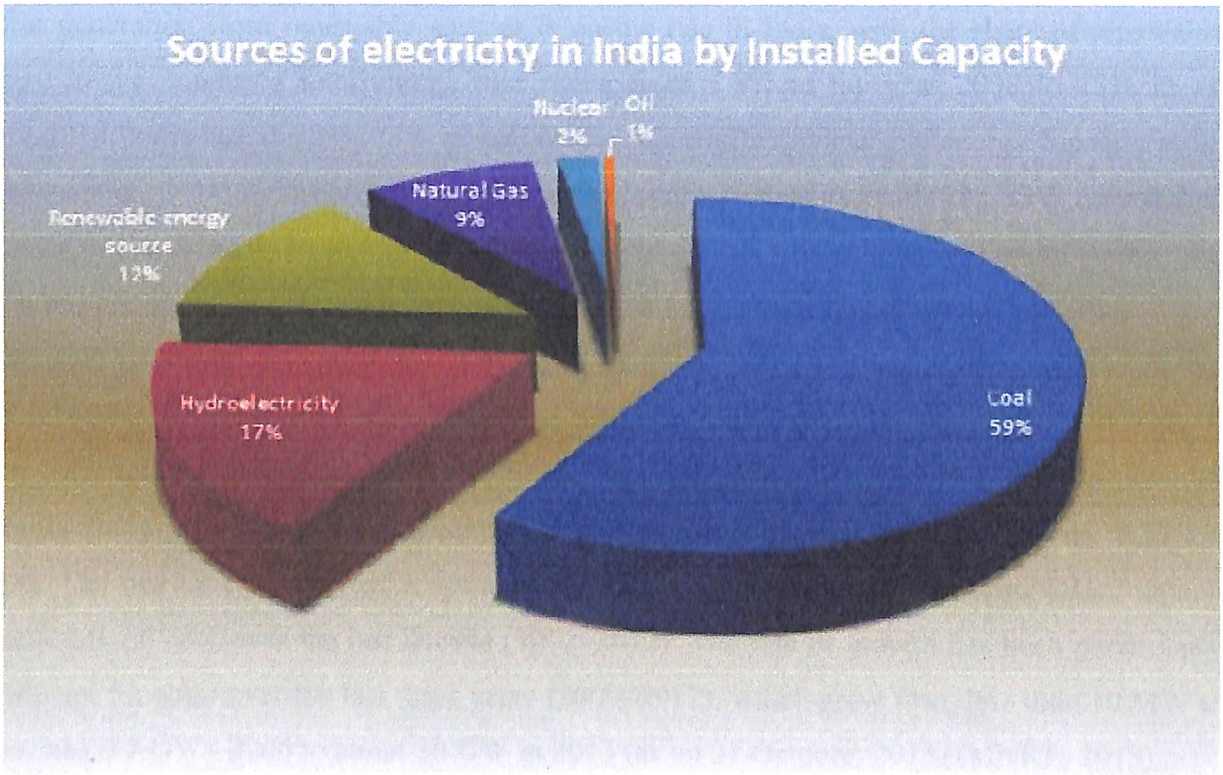
availability of these fuels are constrained by various limitation. For the coal as it is being imported and its international price are increasing day by day which has severely affected the production cost. The NG, HSD and FO availability in India has decreased drastically as they are now fetching now a good price if sold alone. Along with these, the gases emitted by these fuel are a big concern as the plant is located within the village periphery. Hence the pollution concern is also a big deal form environment point of view. Hence it necessitate the production of green energy in this locality which finally concentrate us on the renewable energy generation.

In our country still now we are giving importance to power generation by means of non-renewable sources not by means of renewable source to achieve basic power requirement per person (per capita consumption of our country is still less compared to developed countries in the world).so to meet out our requirement and to keep our country from pollution free and make our country as most visit tourist part in world we should give more preference to renewable source.

Chapter 1 Introduction:

1.1 Overview:-

Power is a critical element of infrastructure for economic development and for improving the quality of life, therefore the reach of electricity should be to all the citizens of the country particularly to the poorest. Accelerated development of Renewable Energy sources such as sunlight, wind, water and biomass will have a vital role in the development of power infrastructure, for sustainable development. Government of India has decided to provide 24 x 7 power to all the citizens of the country. The Government has a great mission of exploiting the Renewable Energy Sources in the country to an optimum level. In line with this mission it has multifaceted plans to tap the huge potential of unharnessed Renewable Energy Resources in an effort not only to supply 24 x 7 power to all but also to reduce the GHG emissions. These plans include about 100 GW of solar power, 60 MW of Wind power, 5 MW of power from small hydro plants and 10 MW from Biomass and Bagasse cogeneration plants by the year 2022.



1.2: Background:-

1.2.1: Renewable energy scenario in India

Renewable energy can make a substantial contribution in each of the above mentioned areas. It is in this context that the role of renewable energy needs to be seen. It is no longer "alternate energy", but will increasingly become a key part of the solution to the nation's energy needs.

Renewable energy has been an important component of India's energy planning process since quite some time. The importance of renewable energy sources in the transition to a sustainable energy base was recognized in the early 1970s. At the Government level, political commitment to renewable energy manifested itself in the establishment of the first Department of Non-Conventional Energy Sources in 1982, which was then upgraded to a full-fledged Ministry of Non-Conventional Energy Sources (MNES) in 1992 subsequently renamed as Ministry of New and Renewable Energy (MNRE). This is the only such Ministry in the world. MNRE is the nodal Ministry of the Government of India at the Federal level for all matters relating to new and renewable energy. The Ministry has been facilitating the implementation of broad spectrum programmes including harnessing renewable power, renewable energy to rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications. In addition, it supports research, design and development of new and renewable energy technologies, products and services.

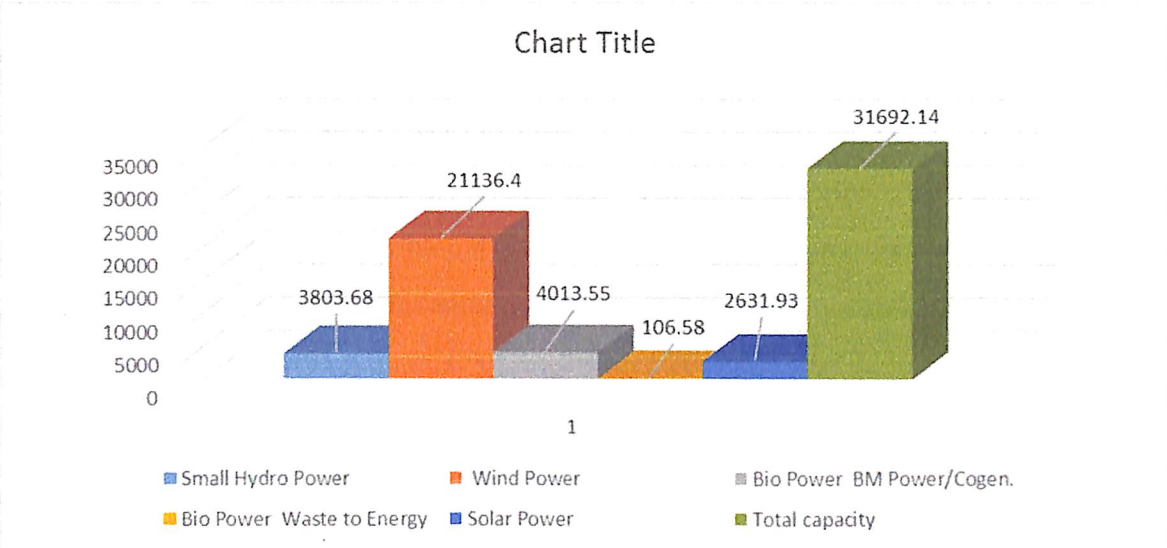
Power generation from renewable sources is on the rise in India, with the share of renewable energy in the country's total energy mix rising from 7.8% in the year 2008 to 13% as on 31.12.2014. India has about 34 GW of grid connected installed renewable energy capacity as on 31 December, 2014. Wind accounts for about 66% of the capacity, with 22.5 GW of installed capacity, making India the world's fifth-largest wind energy producer. Small hydro power (4.0 GW), bio-energy (4.2 GW) and solar energy (3.0 GW) constitute the remaining capacity.

Renewable contribute about 12.3% of the total installed capacity in the country (CEA, 2013). Around 97% of the installed capacity is grid-connected and off-grid power constitutes a small share (MNRE, 2013). Wind continues to be the mainstay of grid connected renewable power in India Globally, India ranks sixth in terms of renewable electric power global capacity (REN21, 2013). The historical growth of renewables has been tremendous with a compounded annual growth rate of 22% over the last decade (2002–2012). The rate of growth has been particularly significant for solar over the last three years (2009–2012), which grew from less than 10 MW to more than 0.7 GW –2006 to about 30 GW in 2013 (as on 31 October, 2013) (MNRE, 2013).

Further, the Government of India has projected capacity addition of 72,400 MW by end of the Thirteenth Plan (2022), of which solar is expected to contribute 28%. The policy thrust to renewable has been significant and specific targets have been announced to accelerate the deployment of renewable energy. The National Action Plan on Climate Change (NAPCC, 2008) envisages a dynamic RPO target of 10% at the national level for 2015 with an annual increase of 1% so as to reach around 15% by 2020.

Small Hydro Power	Wind Power	Bio Power		Solar Power	Total capacity
		BM Power/Cogen.	Waste to Energy		
3803.68	21136.4	013.55	106.58	2631.93	31692.14

Table 1: RE installed capacity break-up (in MW)



1.3: Problem Statement:

India is faced with the challenge of sustaining its rapid economic growth while dealing with the global threat of climate change. This threat emanates from accumulated greenhouse gas emissions in the atmosphere, anthropogenically generated through long-term and intensive industrial growth and high consumption lifestyles in developed countries. While engaged with the international community to collectively and cooperatively deal with this threat, India needs a national strategy to firstly, adapt to climate change and secondly, to further enhance the ecological sustainability of India's development path.

Recognizing that climate change is a global challenge, India will engage actively in multilateral negotiations in the UN Framework Convention on Climate Change, in a positive, constructive and forward-looking manner. Our objective will be to establish an effective, cooperative and equitable global approach based on the principle of common but differentiated responsibilities and respective capabilities, enshrined in the United Nations Framework Convention on Climate

Change (UNFCCC). Such an approach must be based on a global vision inspired by Mahatma Gandhi's wise dictum.

The National Action Plan for Climatic Change (NAPCC) has come into existence by the Union Government and hence by that policy India has to reduce carbon emission. With this action the Central Electricity Regulatory Commission has brought certain regulations and with that the companies having Captive Power Plants, Open Access consumers and Distribution Licensee have to generate a certain percentage of their usage either from renewable energy or by buying Renewable Energy Certificates (RECs) or by paying penalties.

1.4 Solution Domain Program:

1.4.1: CDM

The Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a GHG reduction commitment to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. Under the CDM, a developed country can invest in a GHG mitigation project in a developing country. Developed country would get credit, while developing country would get capital and clean technology. With 795 registered projects, of the 3,930 projects registered with UNFCCC, India ranks second in the number of certified emission reduction (CER) credits, after China.

1.4.2: Carbon Disclosure Project (CDP)

Carbon Disclosure Project (CDP) is a global nongovernmental organization registered in UK. It has released its information disclosure request for Investor CDP 2013 program in February 2013. This year, CDP is requesting climate change information from India's 200 largest companies by market capitalization as listed on the Bombay Stock Exchange. CDP asks to disclose information on greenhouse gas emissions, energy use and the risks and opportunities from climate change from thousands of the world's largest companies.

1.4.3: Renewable purchase obligation (RPO)

The RPOs are imposed on "Obligatory Entities" – distribution licensees, captive consumers and open-access consumers – to consume certain % of their total energy consumption through renewable energy sources. They can buy RECs from the market equivalent to the short fall in their RE purchase.

"Pursuant to provisions of Section86 (1) (e) of EA 2003, Appropriate Commission shall fix minimum percentage for purchase of power from RE sources taking into account availability of such sources in the region and its impact on retail tariff." The Renewable Purchase Obligation

(RPO) has been notified by different SERCs for respective states. The Renewable Purchase Obligation (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. RE procurement obligation specifies in terms of purchase of energy and not in terms of installed RE capacity. Besides, the RPO is increased progressively as envisaged in the National Electricity Policy. The RPO is related to energy input in the system of distribution licensee, after adjustment of transmission losses, and not the energy (sales).

Wind, solar and small hydro are considered as 'non-firm' power sources and cannot be scheduled whereas the generation from biomass and bagasse is considered as firm power and can be scheduled.

1.5: Purpose of study

"How to meet Renewable Purchase Obligation of (CPP) VPCL, Jamnagar as per Gujarat Electricity regulatory Commission"

CPP is one of the obligated entities to meet RPO as per CERC regulation renewable purchase. Obligation can be fulfil by three ways:

- Generate it yourself.
- Purchase it from RE generators or licensees.
- Purchase RECs from IEX or PXIL

In India, RPO varies from one state to others depending on their respective Regulatory commissions. Gujarat electricity regulatory commission classified RE sources into Solar, Wind and Others to meet RPO.

In this report I restrained myself to present the research and analysis done by me on government policy of Renewable Purchase Obligations (RPO), which is the demand driver presently due to high cost of solar power and other solar state policy and the huge Power Deficit in India.

This report includes:

- Renewable Purchase Obligation as per Gujarat Policies.
- Status of Solar and Non- Solar Component in RPO.
- RPO for VPCL.
- Financial Comparison and recommendation for suitability to go for RE plant or REC for fulfilling of RPO.
-

1.6: Scope of Work

The Study is restricted to the brief analysis of Policy laid down by CERC and SERC pertaining to RPO and REC Mechanism of Gujarat.

To address the barriers to implementation of the REC framework, VPCL is required to undertake the following activities:

1. Identifying and weighing pros and cons of co-existence of multiple routes of renewable energy trading and renewable purchase obligation (RPO) compliance, including preferential tariff, renewable energy certificates (RECs), open access, direct purchase etc.
2. Comparing REC mechanism and preferential tariff as viable options from the point of view of various stakeholders (developers, buyers regulators, others).
3. Analysing and making recommendations on the following REC design aspects (including implementation and operational aspects of feasible alternatives):
    - Eligibility: Generator only and PPA at a price not exceeding APPC; captive power producers (CPPs); distribution companies (Discoms); Off-grid generators; others
    - Trading platforms: Power exchange only; forward markets; secondary markets, hedging, aggregators; other service providers and other option
    - Provider of last resort
    - Pricing of RECs: Relevance of floor and forbearance price; Basis of determining floor and forbearance price (if required) in view of rising trend of APPC and reduction of RE tariff; Long-term visibility of REC price bands; Balancing between and safeguard against supernormal profits and negative cash flow.

4 Recommend suggestions and way forward on all above aspects.

5. Illustrating the proposed alternatives/mechanisms with the help of case studies.

1.7: Research hypotheses:

During the process of this project following hypothesis has been consider:-

- We have considered an uniform intensity of the solar. However the intensity of the solar radiation varies with the climatic conditions.
- We have assumed the unavailability of the geo-thermal or the waste heat recovery system like bagasse, husk.
- We have assumed unavailability of water for feasibility of the small hydro plant.
- We have assumed uniform wind velocity for the wind power generation. However it varies with the season.

Chapter 2 Literature Review:

2.1: company overview

The 21st century for Essar has been all about consolidating and growing the businesses, with mergers and acquisitions, new revenue streams and strategic geographical expansion.

Essar is a multinational corporation with annual revenues of US$35 billion and investments in Steel, Energy, Infrastructure and Services. With operations in more than 29 countries, it employs over 60,000 people.

Essar Energy, a first mover among the private-sector players in the Indian power industry, currently has a total installed generation capacity of 3,940 MW.

Essar Energy is one of India's leading private power producers with a 17-year operating track record. The company's power business currently has seven operational power plants in India and one operational power plant in Algoma, Canada, with a total installed generation capacity of 3,940 MW.

- Captive power plant of Essar oil
- Vadinar P2 power plant consists of a multi-fuel (coal, naphtha, oil) co-generation power plant with 325 MW of power capacity and 900 tons per hour (TPH) of steam capacity.
- Steam from the facility is be provided to Essar Oil's Vadinar refinery and power supplied to Essar Oil, Essar Steel and the merchant market.

Fuel for Vadinar P2 is provided by Essar Oil and Essar Steel in line with

2.2: Critical Assessment of the Organization

Strengths

- Core Team of expert professionals.
- Excellent work Culture
- Knowledge management
- Intellectual capital
- Reporting performance
- Technical expertise

Weaknesses

- Relatively new organization
- Small Workforce

Opportunities

- Global shift towards Renewable energy
- Liberalising Government perspective towards RE generators
- Young and talented workforce of India
- More stress on renewable energy

Threats

- High degree of openness may lead to information leakage
- Capture of efficient windy sites by older and bigger players in the wind power sector their purchase requirements.

2.3: Study context

The Electricity Act, 2003 (the Act) has brought about a substantial change in the way India approaches the expansion of RE in the electricity supply mix in the country. As compared to a framework driven by fiscal incentives and subsidies for generation projects, the Act emphasises market expansion by renewable by creating a quota for RE in the electricity procurement mix in the areas of the distribution licensees. Section 86 (1) (e) of the Act requires the State Commission to fix the RPO in this regard.

Subsequent to the EA 2003, the National Action Plan on Climate Change (NAPCC) aims to derive 15% of India's energy requirements from renewable energy sources (non-solar) by the year 2020, and the National Tariff Policy requires SERCs to set solar RPO (SPO) targets starting from 0.25% by 2012-13 to 3% by 2022. Subsequently, most of the states have come up with RPO regulations for both solar and non-solar technologies. Hence, incentives for generation are not only driven from supply side, but also from demand side for large scale market creation through RPO/SPO.

To provide an alternative route (in addition to direct purchase of power from RE sources) for compliance of RPO, Central Electricity Regulatory Commission (CERC), in January 2010, introduced REC regulations to create a pan-India market for renewables through REC trading mechanism. This mechanism also aimed to help Obligated Entities especially RE resource deficit states, and captive consumers to fulfil their RPO obligation. REC trading mechanism has been in operation for more than two years.

The formulation of RPO/SPO has created a new market framework for RE; the REC market in particular. The REC market, while providing a novel platform for propagating RE projects, faces several transition challenges which emanates from the relatively higher cost

of power procurement from renewables, variability of generation requiring significant operational flexibility in utilities, transmission availability and costs. Some power-starved states as well as utilities are willing to buy power instead of purchasing RECs. Financial institutions are also hesitant in lending to projects based on RECs. There have also been cases where the REC mechanism has given way to extra/ supernormal profits to certain generators. Thus, in the current format, applicability of this mechanism is a matter that requires attention.

2.3.1: National Tariff Policy Para 6.4 of National Tariff Policy on Non-conventional sources of energy generation including Co-generation:

1. Pursuant to provisions of section 86 (1) (e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs. Such percentage for purchase of energy should be made applicable for the tariffs to be determined by the SERCs latest by April,2006.

It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.

2. Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act within suppliers offering energy from same type of non- conventional sources. In the long-term, these technologies would need to compete with other sources in terms of full costs.

3. The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from non–conventional sources, to be followed in cases where such procurement is not through competitive bidding.

2.3.2: Renewable Purchase Obligation:-

The RPOs are imposed on "Obligatory Entities" – distribution licensees, captive consumers and open-access consumers – to consume certain % of their total energy consumption through renewable energy sources. They can buy RECs from the market equivalent to the short fall in their RE purchase.

The legislative support for RPO comes from section 86 (1) (e) of the Electricity Act,-2003 which says: "to promote co–generation and generation of electricity through renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any persons, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee." Table 3 shows RPO level set by different states.

2.3.3: CDM Benefits:-

The Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a GHG reduction commitment to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. Under the CDM, a developed country can invest in a GHG mitigation project in a developing country. Developed country would get credit, while developing country would get capital and clean technology. With 795 registered projects, of the 3,930 projects registered with UNFCCC, India ranks second in the number of certified emission reduction (CER) credits, after China.

2.3.4: National Action Plan for Climatic Change:

On June 30, 2008, Prime Minister Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight core "national missions" running through 2017 and directs ministries to submit detailed implementation plans to the Prime Minister's Council on Climate Change by December 2008.

Dynamic Minimum Renewable Purchase Standard (DMRPS) may be set, with escalation each year till a pre-defined level is reached, at which time the requirements may be revisited. Emphasizing the overriding priority of maintaining high economic growth rates to raise living Standards, the plan "identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively." It says these national measures would be more successful with assistance from developed countries, and pledges that India's per capita greenhouse gas emissions "will at no point exceed that of developed countries even as we pursue our development objectives."

Procurement of renewable based power by the State Electricity Boards/other power utilities should, in so far as the applicable renewable standard (DMRPS or SERC specified) is concerned, be based on competitive bidding, without regard to scheduling, or the tariffs of conventional power (however determined).

Renewable based power may, over and above the applicable renewable standards, be enabled to compete with conventional generation on equal basis (whether bid tariffs or cost-plus tariffs),without regard to scheduling (i.e.) renewable based power supply above the renewable standard should be considered as displacing the marginal conventional peaking capacity). All else being equal, in such cases, the renewable based power should be preferred to the competing conventional power.

2.3.5: Eight National Missions:-

In dealing with the challenge of climate change we must act on several fronts in a focused manner simultaneously. The National Action Plan hinges on the development and use of new technologies. The implementation of the Plan would be through appropriate institutional mechanisms suited for effective delivery of each individual Mission's objectives and include public private partnerships and civil society action. The focus will be on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for a "Green India"
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

2.3.6: National Solar Mission:

The NAPCC aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar competitive with fossil-based energy options. The plan includes:

- Specific goals for increasing use of solar thermal technologies in urban areas, industry, and commercial establishment.
- A goal of increasing production of photovoltaic to 1000 MW/year; and
- A goal of deploying at least 1000 MW of solar thermal power generation.

Other objectives include the establishment of a solar research centre, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

The NAPCC also describes other ongoing initiatives, including:

- **Power Generation:** The government is mandating the retirement of inefficient coal-fired power plants and supporting the research and development of IGCC and supercritical technologies.
- **Renewable Energy:** Under the Electricity Act 2003 and the National Tariff Policy 2006, the central and the state electricity regulatory commissions must purchase a certain percentage of grid-based power from renewable sources.
- **Energy Efficiency:** Under the Energy Conservation Act 2001, large energy-consuming industries are required to undertake energy audits and an energy labelling program for appliances has been introduced.

As per Tariff Policy, the solar power purchase obligation for states may start with 0.25% in Phase I (by 2013) and go up to 3% by 2022.RE resources are unequally distributed in the country with some states having abundant supply. This makes it difficult for the RE deficit states to meet their RPO targets. To counter this issue, REC mechanism was introduced. Discoms could buy REC"s from power exchanges and fulfil their RPO.NAPCC envisages a national level 10% RPO level to be achieved by 2015 increases 1% every year up to 15% till 2020.

2.3.7: Gujarat Electricity regulatory commission on RPO

The Commission has notified GERC (Procurement of Energy from Renewable Sources) Regulations, 2010 and GERC (Procurement of Energy from Renewable Sources) (First Amendment) Regulations, 2014 which, inter-alia, stipulates the Renewable Purchase Obligation (RPO) to be fulfilled by the Distribution Licensees in the State of Gujarat during the period 2010-11 to 2016-17.

2.3.8:"Quantum of Renewable Purchase Obligation (RPO)

Each distribution licensee shall purchase electricity (in kWh) from renewable energy sources, at a defined minimum percentage of the total consumption of its consumers including T&D losses during a year.

Similarly, Captive and Open Access user(s) / consumer(s) shall purchase electricity (in kWh) from renewable energy sources, at a defined minimum percentage of his/her total consumption during a year.

Regulation 4 of the GERC (Procurement of Energy from Renewable Sources) (First Amendment) Regulations, 2014 as under: **Minimum Quantum of purchase (in %) from renewable energy sources (in terms of energy in kWh)**

	Minimum Quantum of purchase (in %) from renewable energy sources (in terms of energy in kWh			
Year	**Total**	**Wind**	**solar**	**Others (Biomass, Bagasse, MSW, etc.)**
2010-11	**5**	**4.5**	**0.25**	**0.25**
2011-12	**6**	**5**	**0.5**	**0.25**
2012-13	**7**	**5.5**	**1**	**0.25**
2013-14	**7**	**5.5**	**1**	**0.25**
2014-15	**8**	**6.25**	**1.25**	**0.25**
2015-16	**9**	**7**	**1.5**	**0.25**
2016-2017	**10**	**7.75**	**1.75**	**0.25**

If the above mentioned minimum quantum of power purchase from solar and other renewable energy sources is not available in a particular year, then in such cases, additional wind or other energy, over and above that shown in column 3 and 5, shall be utilized for fulfilment of the RPO in accordance with column 2.

Provided further that such obligation to purchase renewable energy shall be inclusive of the purchases, if any, from renewable energy sources already being made by the obligated entity concerned. Provided also that the power purchases under the power purchase agreements for the purchase of renewable energy sources already entered into by the distribution licensees shall continue to be made till their present validity, even if the total purchases under such agreements exceed the percentage as specified here in above.

The Commission may, suo-motu or at the request of a licensee, revise the percentage targets for a year keeping in view supply constraints or other factors beyond the control of the licensee.

Further, the Commission has notified GEDA as the State Agency to monitor the compliance of the RPO vide notification No. 3 of 2010. Thus, it is the duty of the GEDA to monitor the fulfilment of the RPO by the obligated entities and in case of non-fulfilment of the RPO it should inform to the Commission to enable the Commission to take necessary actions against the entity concern as provided in the regulations.

2.3.9: applicability of renewable purchase obligation

These Regulations shall apply to:

1) Distribution licensee

2) Any other person consuming electricity

i. generated from conventional Captive Generating Plant having capacity of 5 MW and above for his own use and / or

ii. Procured from conventional generation through open access and third party sale.

2.3.10: Certificates under the Regulations of the Central Commission

Subject to the terms and conditions, the Certificates issued under the Central Electricity Regulatory Commission's (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, 2010 shall be the valid instruments for the discharge of the mandatory obligations set out for the obligated entities to purchase electricity from renewable energy sources. Provided that in the event of the obligated entity fulfilling the renewable purchase obligation by purchase of certificates, the obligation to purchase electricity from generation based on renewable energy other than solar can be fulfilled by purchase of non-solar certificates and the obligation to purchase electricity from generation based on solar as renewable energy source can be fulfilled by purchase of solar certificates only. If solar certificates are not available in a particular year, then in such cases, additional non-solar certificates shall be purchased for fulfilment of the RPO in accordance with Table.

Subject to such direction as the Commission may give from time to time, the obligated entity shall act consistent with the Central Electricity Regulatory Commission's (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, 2010 notified by the Central Electricity Regulatory Commission with regards to the procurement of the certificates for fulfilment of the Renewable Purchase Obligation.

The Certificates purchased by the obligated entities from the power exchange in terms of the regulation of the Central Commission shall be deposited by the obligated entities with the Commission within 15 days of the purchase.

2.3.11: RPO: Key Features

RPO refers to regulations that require large consumers/ distributors of electricity to consume a certain minimum percentage of electricity from renewable sources.

- RECs are similar to Carbon credits in International market. They are tradable and will be available to RE power producer and are traded domestically.
- Specify some percentage of renewable energy every utility need to purchase:
- Period is up to five years,
- Not applicable to OA/Captive in only three States and they are Arunachal Pradesh, Sikkim, West Bengal
- Purchase of RE from outside the State has not been permitted,
- Silent on mode of procurement, competitive or cost based
- Implementation mechanisms need further refinement
- Weak on enforcement methodology.

2.4: Critical factor to success the study

Development Constraints (Land Acquisition, Clearances, Access Logistics, Transmission, Human Resources, etc) The issues related to development constraints are more severe for wind as compared to solar. There are significant issues related to land acquisition, consents and clearances (particularly where forest clearances are involved), access logistics, etc. Even as India has an apparently large wind potential, the quality of wind varies considerably across the country and across areas in various states. The relatively superior sites (e.g., in Karnataka) are in forest areas. Apart from clearances, access to these sites for large capacity trailers and cranes is difficult. This places considerable limitations on the scale of development in such areas. Remote areas also have relatively poor grid access, limiting development. These aspects have been analysed in several reports, and have not been specifically addressed as a part of our work (which principally focuses on issues related to REC framework). We have however consulted various entities involved in project development, and the interactions reveal that the issues can be addressed progressively if there is a steady development pipeline. In other words, *the* constraints can slow down the growth trajectory, but does not present an intractable challenge.

2.4.1: Financing and credit related issue:-

The renewable energy sector has been witnessing considerable financing interest, and lenders and investors (developers, private equity) have been favourably considering the sector. The principal issues contended are those of creditworthiness of utility off-takers.

In this context it is important to take note of the framework for sale of RE, which affects project revenues and cash flows. At the moment the following are in vogue

- How to meet RPO for Vpcl
- Open Access and Captive Sale (typically in the home state)
- Combination of revenues from sale of power and Renewable Energy Certificates (REC).

The REC mechanism is new, but is fast gaining popularity. However it also faces some important challenges that need to be understood. Some of these issues are discussed in subsequent section in this report. It needs to be noted that the three methods indicated above largely retain the energy produced in the host state. However newer approaches are emerging that could cause the power generated to flow out of the host state as well. Typical examples include:

- Sale through competitive power markets, including power exchanges
- Purchase under PPAs from other states where physically the energy is also delivered to the procuring state

2.4.2: Infirm & seasonal nature

Renewable power is characterized by extreme variations in output within a short period of time. At modest penetration levels, the variability (both short term & long term) of wind is dwarfed by the normal variations of the load. Electric power systems are inherently variable in terms of both demand and supply, but they are designed to cope effectively with these variations through their configuration, control systems and interconnection. Variation is not an issue for power system reserves used for balancing as long as variation in supply is much smaller than variation in demand i.e. at lower penetration levels.

However, at higher penetration levels, the infirm nature of renewable energy resource calls for adequate quick response back-up power to be available without which, power system integrity cannot be maintained. Such nature of wind and solar can disturb the day ahead economics and affect the power system operation in the grid in terms of voltage control, congestion management, transmission efficiency etc. With increase in variable energy penetration,

maintaining grid stability will be a significant challenge which needs to be addressed. Some of the possible solutions for managing the greater integration of variable resources may pertain to better forecasting & planning procedures, planning for and charging for integration of variable resources, sharing of cycling costs, scheduling and dispatch of renewable sources, creation of larger control areas, establishment of developed Ancillary Services market, imbalance settlement mechanism, creation of robust transmission infrastructure in resource rich areas and redesign of system operations.

2.4.3: High Capital Cost

Initially, high cost of renewable power was considered as a deterrent to the development of renewable energy. Over time the cost of RE has become competitive (and at instances cheaper) than some of the conventional alternatives. This is true for wind, small hydro and biomass. Even for solar, with growth in installed capacity and market development, the prices have come down significantly. With phase II of competitive bidding under JNNSM and impending competitive bidding in RE, the *tariffs are* further expected to come down and should not be a barrier in future

Also, most of the wind resource assessment has used meteorological masts up to 50 m height. These heights are suitable for sub MW range turbines. As a first step in realizing wind potential, improved wind assessment needs to be carried out at heights more than 100m which would act as the basis for determination of suitable turbine size and design for optimum resource utilization.

In summary, the supply side issues are primarily linked to the certainty of the off-take pipeline, commercial arrangements and creditworthiness of off-takers. These are aspects to be addressed principally through policy and regulation.

However, addressing supply side barriers alone may not help us in achieving the RE growth targets and address various issues in creating a sustainable market for Renewable Energy. These efforts need to move along with efforts towards addressing demand side related

Chapter 3: Research, Methodology and Plan

3.1: Policy framework

The Government of India (GoI) has enacted several policies which support the expansion of renewable energy. The National Electricity Policy 2005 allows the SERCs to establish a preferential tariff for electricity generated from renewable sources to enable them to be cost-competitive. The Tariff Policy 2006 requires fixation by SERCs of a minimum percentage of

RPO from such sources taking into account availability of such resources in the region and its impact on retail tariffs. The Tariff Policy also states that procurement of renewable power for future requirements shall be done through a competitive bidding process and in the long-term, renewable energy technologies would need to compete with other sources in terms of full costs. To this effect, the MNRE brought out the guidelines and standard bidding documents for grid-connected renewable energy in December 2012 after several rounds of consultations with stakeholders. The guidelines for competitive procurement have been framed under Section 63 of the Electricity Act, 2003 which states: Notwithstanding anything contained in Section 62, the Appropriate Commission shall adopt the tariff if such tariff has been determined through transparent process of bidding in accordance with the guidelines issued by the Central Government.

The flagship policy initiative for solar energy in India is the Jawaharlal Nehru National Solar Mission (JNSSM) launched in 2010, which has set ambitious goals on generation capacity additions from solar technology — solar thermal and solar photovoltaic — in terms of both grid-connected and offgrid applications. The

Mission has adopted a three-phase approach, spanning the period of the Eleventh Plan and the first year of the Twelfth Plan (up to 2012–13) as Phase I. The remaining four years of the Twelfth Plan (2013–17) has been marked as Phase II and the Thirteenth Plan (2017–22) will be Phase III of the project.3 The JNNSM establishes a national-level policy framework for solar energy utilization including power generation in India. The first phase of the mission has seen significant progress in the deployment of utility-scale solar projects enabled by the reverse bidding mechanism introduced by the Government of India. To achieve 500 MW of PV and 500 MW of solar thermal, the central government conducted two batches of reverse auctions (Batch 1 and Batch 2) (See Box 1). Phase I of the mission has been concluded, though not all projects have been commissioned. Post the launch of JNNSM, several significant regulatory and policy developments have taken place. The National Tariff Policy was amended in January 2011 prescribing solar-specific RPOs to be increased from a minimum of 0.25% in 2012 to 3% by 2022. The Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs) have issued various regulations including solar RPOs, Renewable Energy Certificates (REC) framework, tariff, grid connectivity, forecasting, etc., for promoting solar energy.

JNNSM in many ways is a first of its kind national-level programme for solar energy in India. The process of price discovery in JNNSM was unique, discovered through a process of reverse bidding carried out in two successive batches. This was introduced mainly because of the

overwhelming response from developers who had bid for more than 30 times of the capacity on offer. Applications were received for more than 5,000 MW much higher than 1,100 MW on offer. Project developers were selected based on discounts offered on CERC-determined tariffs. It was executed through NTPC Vidyut.

Vyapar Nigam (NVVN) which acted as the nodal agency to purchase 1,000 MW of solar power from the project developers, bundle it with the unallocated power available from the NTPC coal-based stations, and sell this 'bundled' power to the

Distribution Utilities. This new concept called Bundling was introduced to keep the cost of bundled power low compared to the cost of only solar power. Reverse bidding resulted in steep fall in prices to as low as Rs 5.45/kWh. Batch 1 saw a 32% reduction in solar PV tariffs and a 25% reduction in solar thermal prices (from the CERC-determined tariffs). In Batch 1, around 150 MW solar PV projects and 470 MW solar thermal projects were allocated. In Batch 2, the remaining 350-MW solar PV projects were allotted. Batch 2 saw an ever steeper reduction in prices, which were approximately 43% lesser than the CERC-determined prices. Most of the solar PV projects have been commissioned while all the solar thermal projects,

Except one 50 MW project which was commissioned recently, are running behind schedule. Some state projects which were already at different stages of development were also given the option of migrating to the JNNSM, scheme subject to the interest of developers and state governments. A total of 16 projects of 84-MW capacity were selected under the migration scheme. Apart from these large-scale grid-connected plants, small rooftop plants — of capacity less than 2 MW each —totalling to 88MW capacity, were also allotted under Generation based incentive (GBI) scheme in the Rooftop PV and Small Solar Power Generation Programme (RPSSGP).

While initially there were concerns regarding the bidding process which allowed some small inexperienced players to quote aggressive prices, this was allayed with all but one project coming online. Furthermore, with stringent penalty clauses and guidelines set by the govt. stating that firms that do not commission their projects within the stipulated time (12 months for photovoltaic and 28 months for CST) stand to lose significant amounts of money relative to their initial capital investments, the process ensured that checks and balances were in place. Also since tariffs are generation based, any underperformance results in losses to the project developer, therefore incentives are in place to ensure appropriate performance (Deshmukh et al. 2011b).

3.2: Gujarat Solar Policy 2009

A state specific policy dedicated to solar was first envisioned by Gujarat in 2009 The outlines were given under the policy titled "Solar Power Policy -2009". The policy was the first solar specific policy introduced in the country predating the National Solar Mission. The Gujarat Solar Policy is operative till 31st March 2014.Any Solar Power Generator (SPG) commissioned during the operative period shall become eligible for incentives declared under this policy for a period of 25 years.

Salient Features: ⎫

Capacity:

- Only new plants and machinery will be eligible under this Policy. No fossil fuel shall be allowed for Solar Thermal Project.
- The minimum capacity of for Solar PV and Solar Thermal projects will be 5 MW each. A total of 500MW SPG shall be allowed for installation during the operative period of this policy.

Cross-subsidy charge:

Cross subsidy surcharges shall not be applicable for Open Access obtained for third party sale within the state.

Wheeling Charges:

As determined by GERC from time to time. ⎫ Electricity Duty: - Exempted from payment of electricity duty for sale through all modes (self-consumption/sale to third party/sale to licensee) - Exemption from demand cut to the extent of 50% of installed capacity ⎫

PPA:

PPA duration will be 25 years ⎫ Bank Guarantee: Developer to furnish a BG @Rs 50Lakhs/MW at the time of PPA signing with Distribution Licensee.BG to be refunded if the developer commissions the project in time as per PPA. ⎫

Metering of Electricity: Electricity generated would be metered jointly on a monthly basis by GEDA/GETCO. Metering to done at sending sub-station of 66 kV or above, located at the site. ⎫ Reactive power charges: As per GERC order. ⎫ Transmission infrastructure: Transmission line from SPG switch yard to GETCO sub-station shall be laid by GETCO.SPG to inject power at 66kV. ⎫ Sharing of CDM benefit: SPG will pass 50% of CDM benefit to DISCOM with whom PPA is signed. ⎫ Forecasting & Scheduling: SPG based generation shall not be covered under

scheduling procedure for Intra-state ABT.] Nodal Agencies for facilitation and implementation of Solar Power Policy- 2009:

3.3: Gujarat Solar Policy 2015

Gujarat came up with its new solar power policy on 13th August 2015, which would be operative up to March 31, 2020. This new policy intends to facilitate and promote large scale promotion of the solar power generation capacities in the state and the interests of all the investors, developers, consumers and various other stakeholders.

The main features of the Policy are as follows:

- The minimum size of a MW scale project shall be 1 MW and 1 Kw for KW scale projects.
- Any company or group of individuals shall be eligible for setting up a solar generating plant, irrespective of whether they or not fall under REC mechanism in accordance with Electricity Act 2003.
- There are project based provisions and incentives provided for Rooftop solar PV systems with net metering depending on the type of consumers. The same are listed in the table below (Click on the table for a larger view) :

Categories	Residential & Government under net metering	Industrial & commercial under net metering	Captive Consumption	Sale of power to DISCOMS at competitive bidding	REC with sale of power to DISCOMS at APPC rates	Sale of power under NSM	Sale of power to Third party under Open Access
Metering	As per CEA installation regulations 2014.	For Type -1 – Bi-directional meters For Type – 2- ABT compliant meter	Using ABT compliant meters	Using ABT compliant meters	Using ABT compliant meters	Using ABT compliant meters	Using ABT compliant meters
Transmission charge	Not applicable	Not applicable	As applicable under OA Regulation	As applicable under OA Regulation	As applicable under OA Regulation	As applicable under OA Regulation	As applicable under OA Regulation
Transmission Loss	Not applicable	Not applicable	Same as above	Same as above	Same as above	Same as above	Same as above
Wheeling Charge	Not applicable	Not applicable	For REC Projects – 100% For Non-REC Projects – 50%	Same as above	Same as above	Same as above	Same as above
Wheeling Loss	Not applicable	Not applicable	Same as above	Based on 15min time block	Same as above	Same as above	Same as above
CSS	Exempted on the generated solar energy	Exempted on the generated solar energy for both.	Exempted on the generated solar energy.	Exempted on the generated solar energy for both.	Not Applicable	-NA if sale of power outside state. - Sale within state: For REC Projects – 100%.For Non-REC Projects – 50%.	For REC Projects – 100% For Non-REC Projects – 50%
Electricity Duty	Exempted	Exempted	Exempted	Exempted	Exempted	Exempted	Exempted

Categories	Residential & Government under net metering	Industrial & commercial under net metering	Captive Consumption	Sale of power to DISCOMS at competitive bidding	REC with sale of power to DISCOMS at APPC rates	Sale of power under NSM	Sale of power to Third party under Open Access
RPO	100% towards DISCOMS RPO.	Type – 1 100% towards DISCOMS RPO. Type – 2 Consumed energy towards Consumer RPO, and surplus energy towards DISCOMS RPO	Case 1 If not under REC: 100% towards DISCOMS RPO. Case- 2 a) Consumed energy towards Consumer RPO, and surplus energy towards DISCOMS RPO. Case- 2 b) If under REC: NA	100% towards DISCOMS RPO.	Not Applicable	Case 1a): Sale of power outside state: As per MNRE scheme. Case 1b): Sale of Power to DISCOM within state: As specified. Case 2: If not under REC: 100% towards DISCOMS RPO. Case- 3 a) Consumed energy towards Consumer RPO, and surplus energy towards DISCOMS RPO. Case- 3 b) If under REC: NA	Case 1 If not under REC: 100% towards DISCOMS RPO. Case- 2 a) Consumed energy towards Consumer RPO, and surplus energy towards DISCOMS RPO. Case- 2 b) If under REC: NA
REC	Not Applicable	Type 1- NA Type 2-SPG may avail RECs	If not registered under REC –NA. If registered- RECs shall be claimed by developer	Not Applicable	Shall be claimed by solar developer/SPG	For sale outside state- as specified in the scheme. Sale to consumer within state: If not under REC mechanism – NA If registered -REC claimed.	If not registered under REC –NA. If registered- RECs shall be claimed by developer
CDM	100% retained by the consumer.	100% retained by consumer /generator	100% retained by developer.	The SPG shall retain 100% of CDM benefits	As per GERC Order as amended from time to time	For sale to outside states or discoms within states :as specified in scheme Sale within state: as per mutual agreement.	As per the mutual agreement between developer and consumer.

Table- Gujarat Solar Policy 2015

Gujarat Energy Development Agency (GEDA) - Gujarat Power Corporation Limited (GPCL).

3.4: Strategy to meet RPO:-

The Electricity Act and National Action Plan on Climate Change (NAPCC) provides a roadmap for increasing the renewable energy in total generation.

• Renewable Purchase Obligation (RPO) is the obligation mandated by Central/State Regulatory Commission and is applicable to,

1) Power distribution companies (DISCOMs),

2) Open Access Consumer i.e. users of IEX/PXIL/Bilateral Agreement.

3) Captive consumer: those generating and consuming Power from captive power plants. (Essar Oil Ltd)

As per GERC notification No.3 of 2010, RPO for Captive and Open access users / consumers shall come in to force from a date notified by commission separately.

• On 13th May 2015, the Supreme Court pronounced a land mark judgement on the applicability of RPO for the case between Hindustan Zinc and RERC.

• It says that

- Imposing RPO is desirable in the larger public interest.
- RPO applicability to Captive and Open access consumer's id well within the ambit of the Electricity Act 2003.
- Cost of fulfilling the obligation cannot be held above the larger public interest.

On 12th March 2015, the Gujarat high court gave its judgement in the case of Hindalco (Birla copper) and others,

• It Say that

- CPP and open access consumers are liable to fulfil RPO.
- With reference to EA 2003, Sec 86(1)(e), Co-generation should not be considered "stand alone" because only on the basis of being co-generation it is not the same as renewable source of energy.
- As of now, the RPO regulations of Gujarat are not notified with
- Respect to CPP and OA. This was due to the pending court case.

Now that the judgement is delivered, these regulations are likely to be made applicable to CPP and OA.

- **Applicability of Renewable Purchase Obligation**

1. Distribution licensee
2. Any other person consuming electricity

3 Generated Form conventional captive generating plant having Capacity of 5 MW and above for his own use and / or

4 Procured from conventional generation through open access and third party sale.

- **Quantum of Renewable Purchase Obligation (RPO)**

Note : The Target Set by Govt. is 15% by 2022 with the increase of 1% every year. If power purchase from Solar and other renewable sources is not available in a particular year, then in such cases, additional wind or other renewable energy shall be utilized.

- **RPO Obligation can be fulfilled in two ways,**

1) By Consuming Renewable Power.

2) By the Way of REC Mechanism

- Renewable Energy Certificate (REC) mechanism is a market based instrument to promote renewable energy and facilitate renewable purchase obligations (RPO)

3.5 REC mechanism

3.5.1: Introduction

India has sustained one of the most detailed and comprehensive renewable energy sectors since a very long time. As far back as the 1980s, solar thermal and solar photo voltaic technology and biogas was available in the market, for consumption of the masses and the focus was primarily the rural sector because of, perhaps two major reasons: firstly the requirement for power was substantially lower in the rural sector and secondly, rural sectors" demand for a consistent supply was also not too strict. In many ways, the effect of this policy was salutary to the nascent Indian renewable energy market. A primary focus on the rural sector, which lacked grid connectivity allowed the technologies to grow and also focused the research efforts of many leading institutions like IISC and TERI towards developing new renewable energy technologies and improving upon the existing ones.

By nature renewable energy is geography dependent, thus early on, its development and use were both confined to the areas producing it. Rajasthan was end owed with abundant isolation, Tamil Nadu with wind and Maharashtra owing to extensive sugarcane farming with bagasse. The generation and consumption were both localized in nature and no plans were in place for its transmission and distribution. Being costlier in nature, without any incentives, there would have been no reason for a distributor to buy any renewable energy to supply to his customers.

But with the progression of time and subsequent development in the country, starting from the final decade of the previous century, several factors have started contributing to a sudden emphasis on the development and consumption of renewable energy. The most important factor is the spectra of global warming and consequent environmental fallouts that the traditional sources of energy have. Thermal power plants based on coal, belch out pollutants in the atmosphere which have cause irreparable damage to the fragile ecosystems that sustain all life

on earth. The requirement of energy cannot be practically reduced, so the only way out seems to reduce the dependence on the traditional sources of energy. This is where renewable energy scores as a viable option. Second major factor is the highly fluctuating nature of oil prices in the international markets. Most nations especially developing countries found their development plans completely thrown off-gear during the last price spurt

Another major contributing factor is the quest for energy security which the policy makers of the country have been pursuing right from the time of independence and as has been formally stated in the Integrated Energy Policy 2006.

These three, together have laid the ground work for renewable energy to become available option in terms of both sound policy and economic viability. Most renewable energy technologies are still in a developing phase and in order for them to compete with established sources of energy there needs to be, a policy support mechanism in its favour to allow it to mature technologically and achieve economies of scale that are so essential for duction in its price versus fossil fuels.

In India, the ElectricityAct2003 is one such legislation which envisions a developed market for renewable energy in future and took the first steps towards the development of a comprehensive demand supply mechanism for it. The EA allows the generation to be delicensed and gives a frame work for its procurement by the distributors. So it"s a „carrot and stick" policy as incorporated into the legal framework of EA2003.There are several incentives that are allowed to the generators of renewable energy and there are statutory requirements for its procurement and supply to the end consumers. As the generation of renewable energy is fairly decentralized in both nature and form, the act rests the responsibility of its promotion on the SERCs.

According to EA, it is the mandate of SERCs to ensure that the electricity mix in the irrespective states has a fixed percentage of renewable energy. This mechanism is known as the Renewable Purchase Obligation or the RPO. But there is an inherent flaw in this mechanism. As each state has its own potential, different states have different RE potentials and thus supply mixes. Also as the RPO mechanism concentrates mainly on the intra-state use, a state devoid of any potential didn"t have either incentive for using renewable energy nor was there any mechanism for interstate sale of RE. Without such a mechanism, the entire effort can turn into sham as RE would still be generated and used in isolated pockets only. Also, as RE is a costlier form of power, states would not want to generate any more than the irrespective RPOs and those states with a meagre RE potential also do not use any RE in absence of any mechanism promoting its interstate purchase.

The National Action Plan for Climate Change announced by the Prime Minister of India in the

year 2008 advocates a greater use of RE in the country. It targets a minimum of 5% RE in the supply mix of the entire country by 2010, 15% by 2015
and 20% by 2020. To carry its objectives out, a mechanism has been formed which, the states generating the RE would be able to use to ensure, that the cost they incur to produce and use RE is spread though out the system and also to those who cannot or will not produce RE. This mechanism was essential because the existing RPO mechanism is not enough to ensure that the vision of NAPCC comes to life.

To remove this anomaly, there was a need for an incentive mechanism, which would result in commercial benefits for the RE generators on the one hand and which would ensure that even those states which are deficient in RE generation are able to meet their individual RPOs, thereby facilitating interstate RE transactions. This mechanism would allow even the SERCs of RE deficient states to increase the RE component in their electricity mix without having to actually generate it.

To address all these challenges and to turn the environmental celebrity of renewable energy in to a marketable entity, the concept of Renewable Energy Certificates was developed. Apart from facilitating inter-state RE transactions, RECs also have some other objectives as well, which can be identified as:

- Effective implementation of RPO obligations across all states.
- Creating competition among competing RE technologies.
- Protecting the local distribution licensee selling RE.
- Overcoming geographical impediments to use RE.
- Reduce the costs for RE transactions.

Renewable Energy Certificate (REC) represents the green attribute of electricity generated from renewable energy sources. These attributes are unbundled from the physical electricity and the two products- the green attribute embodied in the form of a certificate and the commodity electricity – are traded separately. One REC represents 1MWh of energy generated from renewable sources. REC is now positioned as the currency of renewable energy markets because of its flexibility and the fact that it is not subjected to the geographic and physical limitations of the underlying commodity, electricity. The obligated entities purchase RECs to fulfil their Renewable Purchase Obligation (RPO). There are two categories of RECs:

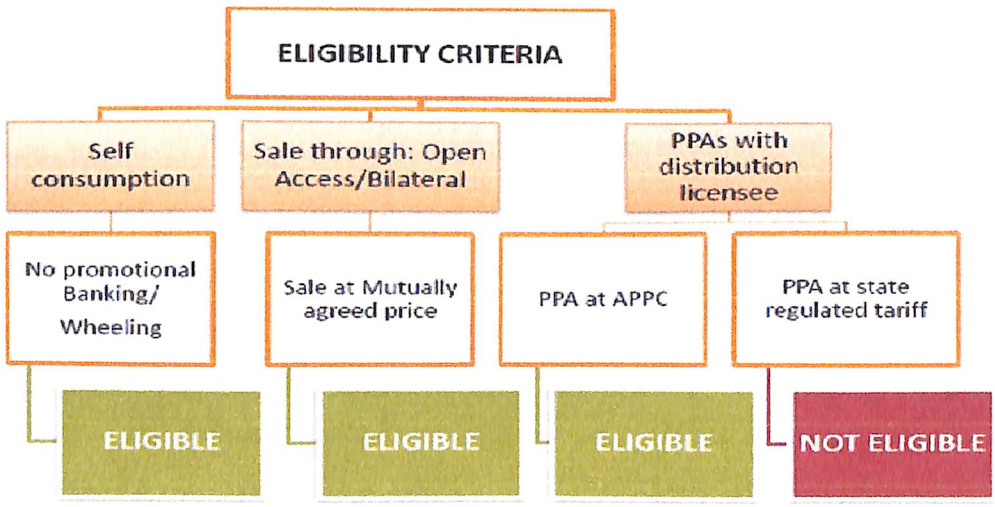
- Solar
- Non-Sola

3.5.2: REC Participants

- Wind
- Solar
- Small Hydro
- Biomass, Bio-fuel Cogeneration
- Municipal Waste

- Black Liquor
  - Source approved by MNRE

3.5.3: Eligible Entity



3.5.4: REC Buyers

- **Obligated Entities**
  - Distribution Companies
  - Open Access Consumers
  - Industries consuming Captive Power
- **Voluntary Entities**
  - Corporate under CSR
  - Individuals

3.5.5: Salient features of RE Mechanism

Participation	Voluntary
REC Denomination	1 REC = 1 MWh
Validity	1095 Days after issuance*
Categories	1. Solar REC 2. Non-Solar REC
Trading Platform	Power Exchanges only
Banking/Borrowing	Not Allowed
Transfer Type	Single transfer only , repeated trade of the same certificate is not possible
Solar RECs	*Floor Price: Rs 3,500 /MWh *Forbearance Price: Rs 5,800/MWh
Non Solar RECs	Floor Price: Rs 1,500/MWh Forbearance Price: Rs 3,300/MWh
Penalty for Non-compliance	'Forbearance' Price (Maximum Price)
Price Guarantee	Through 'Floor' Price (Minimum Price)

*CERC Order dated: 30 Dec'14

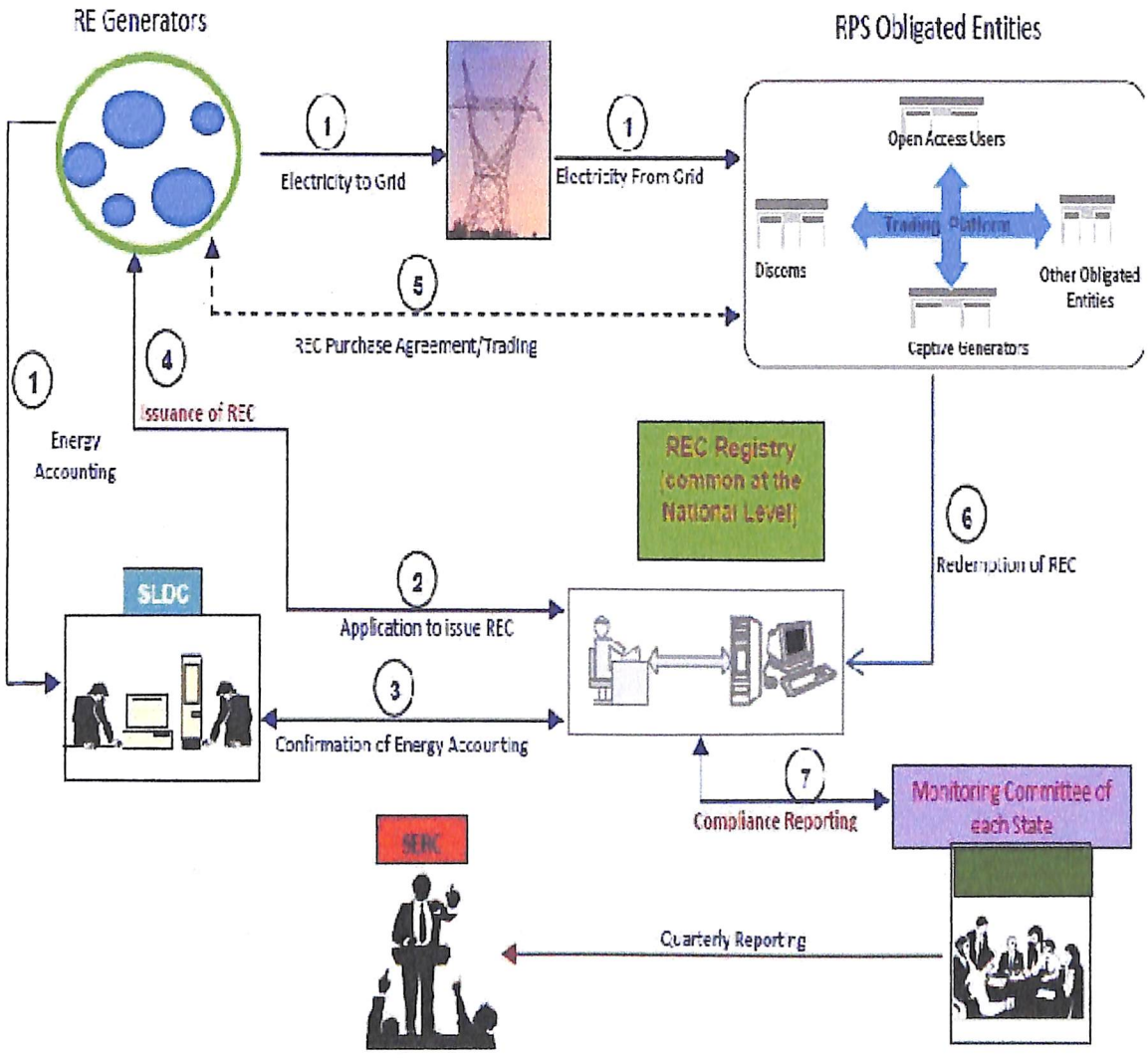
3.5.6: REC Price Calculation

These prices are calculated as under:

- Forbearance Price = Maximum (Preferential Tariff- Average Pooled Power Cost)
- Floor Price = Market Equilibrium Price (Minimum requirement for project viability of RE technologies – Average Pooled Power Cost)

	Non-Solar REC (Rs/MWh)	Solar REC (Rs/MWh)
Forbearance Price	3300	5800
Floor Price	1500	3500

3.5.7: Operational framework of the REC mechanism:



In the Indian context, generation of 1MWof RE allocates a REC to the generator, which can be sold in an energy exchange to an "obligated entity" which cannot find a RE generator to fulfil its RPO obligations, there by overcoming the geographical constraints the transaction of RE poses. There are some important points of note here. REC mechanism is not an incentive scheme. It is simply a market mechanism to enable various obligated entities to meet their RPO norms asset by their respective SERCs. The mechanism co-exists with all the current incentive schemes as, these schemes offer incentives for generation only. Also it is not related to carbon credits. The two mechanisms operate parallel to each other for the benefit of RE generators.
As can be seen from the figure above, the easiest route of selling RE to the obligated entities is through the grid, as established by the connection(1).
The accounting of the RE produced by the generators is carried out by the SLDCs(1) the information of which is forwarded to the national registry(3).
If the generator chooses to sell their RE electricity through the REC route, he makes an application to the national registry(2),after which a RECs is issued to the generators(4) as per the amount of power generated, which they can trade in the power exchanges.
If these obligated entities cannot achieve their RPOs, they buy RECs in the exchange to make up for whatever is the deficit in their supply mix (5), which are redeemable at the national registry itself (6). The compliance reporting is done to the monitoring committee of each state (7), which submits a quarterly report to each state"s SERC.
CERC has issued detailed outline of various activities related to issuance and trading of RECs, along with the fees for the same. According to the commission, the central agency has to issue a registration to the generating company within a period of three months unless it finds a discrepancy in the application. The generating company has to meet one of the eligibility criteria, as defined by the CERC, and given below, to be designated as an "Eligible Entity" before the central agency can grant it registration.

I. RE Generator does not have any power purchase agreement for the capacity with any entity which is still in force at the time of his making an application for selling of RECs against the RE power that produces.
II. The applicant RE generator does not have a PPA with another entity, which has been terminated within a period of three years prior to his submission of application. Even if the PPA has been terminated due to non-compliance with

the contractual obligations by the RE generator, RE generator is not eligible to sell his power through the REC route for a period of three years.

III. Only if the PPA has been terminated with mutual consent of both the RE generator and the obligated entity or if the contract has been terminated due to a breach of contract by the obligated entity to which the RE generator is selling, the RE generator may submit his application inside a period of three years from the date of termination of the PPA.

IV. RE generator has not availed or does not propose to avail any benefit in the form of concessional/promotional transmission or wheeling charges, banking facility benefit and waiver of electricity duty(this is not related to the generation based incentives that he gets). A period of three years has elapsed from the date off or going the benefits of concessional transmission or wheeling charges, banking facility benefit and waiver of electricity duty.

V. The benefits of concessional transmission or wheeling charges, banking facility benefit and waiver of electricity duty has been withdrawn by the State Electricity Regulatory Commission and/or the State Government.

The NLDC has been nominated by it to act as the central agency

3.5.8: Role of various entities in the REC mechanism

The functions of the various parties involved in the mechanism are:

- **CERC**: Rule making and transaction charge fixation. The fee and charges payable by the Eligible Entities(approved RE generators)to participate in the REC Mechanism include:
    i. One time Registration fee and charges-Rs. 1000 as the application fee, along with Rs.5000 on acceptance of the registration application, payable to the central agency.
    ii. Annual fee and charges, of Rs.1000 payable by April10 of each year, payable to the central agency.
    iii. Transaction fee and charges for issue of certificate-charges for issuance of each certificate is Rs.10, payable to the central agency.
    iv. Charges for accreditation-accreditation application charges of Rs.5000 payable to the state agency. On acceptance of the application a further one-time charge of Rs. 30000 payable to the state agency. The eligible entity is to also pay a annual charge of Rs. 10000 per application and in case, are validation is required-a fee of Rs. 15000 for a validation

period of 5 years or such a period as determined by the commission.

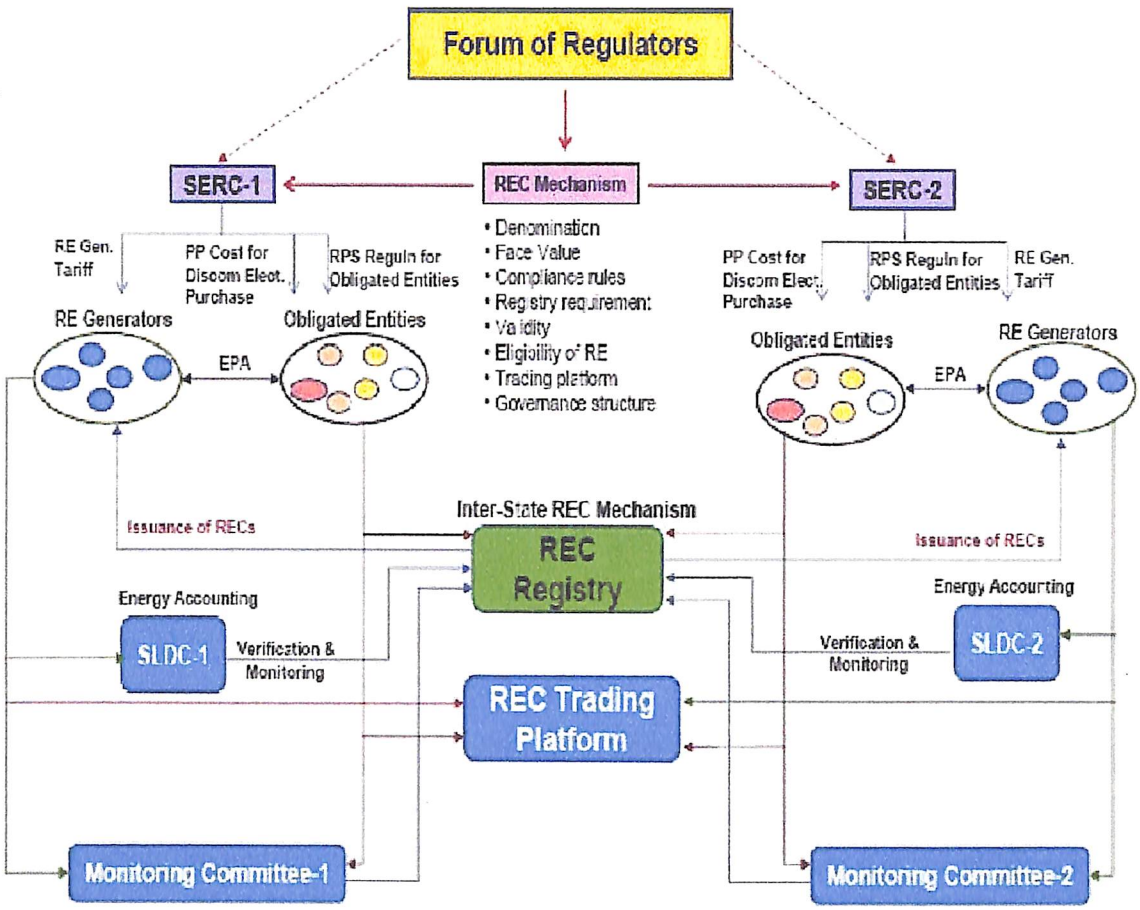
Also, as per the CERC- "REC Regulation clearly specifies that certain percentage of the proceeds from the sale of certificates and not from the transaction fees, shall be utilized for the purpose of training and capacity building of the State Agencies and other facilitative mechanisms for the implementation and monitoring of the detailed procedures issued by the Central Agency."**NLDC**: The NLDC has been nominated by it to act as the central agency. The CERC REC Regulations envisage functions of the Central Agency as follows:

" Registration of Eligible Entities, Issuance of Certificates, Maintaining and Settling Accounts in respect of certificates, Repository of Transactions of Certificates and such other functions incidental to the implementation of Renewable Energy Certificate Mechanism as maybe assigned by the Commission."

- **SLDCs**: Certification–they will account for the amount of accredited RE injected into the grid by each of the eligible entities with in a state to the central agency and also to the state agency.
- Power Exchanges: Actual Trading of REC
- Compliance Auditors: comply with the duties as specified by the CERC. In case of a revocation of the license of any eligible entity, submit a detailed investigation report to the central agency/CERC.
- State Nodal Agencies: Accreditation of the RE generators for the grant of their registration applications as eligible entities.

3.5.9: Institutional framework:

The diagram above shows the interaction of the SERCs, RE generators and obligated entities of various states and the roles they play in the mechanism. In the mechanism, the forum of regulators comprising of the SERCs of the various states and CERC decide upon the RE tariffs, the power purchase cost for the DISCOMs, and the renewable power supply regulations for the obligated entities. This forum of regulators also decides upon critical issues related to RECs like denomination, face value, compliance rules, registry requirements, validity, eligibility of RE, trading platforms to be used and the governance structure required by the mechanism.


Forum of Regulators
SERC-1
REC Mechanism
SERC-2
RE Gen. Tariff
PP Cost for Discom Elect. Purchase
RPS Regulr for Obligated Entities
• Denomination
• Face Value
• Compliance rules
• Registry requirement
• Validity
• Eligibility of RE
• Tracing platform
• Governance structure
PP Cost for Discom Elect. Purchase
RPS Regulr for Obligated Entities
RE Gen. Tariff
RE Generators
Obligated Entities
EPA
Obligated Entities
RE Generators
EPA
Inter-State REC Mechanism
Issuance of RECs
REC Registry
Issuance of RECs
Energy Accounting
SLDC-1
Verification & Monitoring
Verification & Monitoring
SLDC-2
Energy Accounting
REC Trading Platform
Monitoring Committee-1
Monitoring Committee-2

3.5.10: TRADING OF RECs

- Bids and Sell of RECs can be done only in IEX and PXIL
- IEX transaction fee: Rs 20/REC
- Member Service Fee: As mutually agreed
- Registration Fee: Annual Client registration Fee is waived off for voluntary Clients till furth

The REC mechanism has some constraints. These can be given by:

- RECs are not bankable.
- Most renewable projects other than Wind are unviable with REC floor prices, because of this most of the renewable energy generators are selling their power to the discoms at preferential tariff without going for REC.
- Average Pooled Purchase Cost of Power for discom is low due to the surfeit of dirty power (Coal).
- The mechanism is there in only few countries and has suffered many issues/changes Prone to market uncertainty.
- Investors aren't yet comfortable with the risks.
- Cash flows are neither guaranteed nor predictable.
- No clarity on what happens if RECs remain unsold especially as they are valid only for 1 year.

To overcome these problems a new kind of market can be developed where the renewable energy producers can trade their energy through the power exchanges to the renewable energy obligated entities.

3.5.11: Why REC a better option than 'buying renewable power' ?

Schedulability	• Less predictable • Less controllable • Require better prediction tools over one-day • Scheduling changes till one-hour before
High Overheads	• More System imbalances • Discoms to spend on more reserves to avoid UI • More reserves required to balance
Open Access costly	• Payment of Transmission, Wheeling Charges, Losses and Scheduling Charges to LDCs(50-100p/kWh) vis-à-vis 7p/kWh in RECs

3.5: Requirements of Renewable Power Generation:-

To Comply to the RPO, we need to Consume Power Generated through renewable Sources i.e. Wind, Solar Power etc.

Description	Wind+ Other	Solar	Total	Unit	Remark
Generation Required	10.73	2.28	13.00	MW	Considering130MW Consumption of Refinery
Capacity Utilization Factor	25	18	NA	%	
Capacity of Plant Required to be installed	45.16	12.64	57.80	MW	Considering 95% availability + CUF
Total Capacity of Plant Considered	50	13	63	MW	
Approximate Cost of Plant	350	91	441	Cr Rs.	Considering 7 Cr. /MW

Table-5 Requirements of Renewable Power Generation for vpcl

3.6: Wind Power Policy wind Price in India:

	Maharashtra	Karnataka	Gujarat	Rajasthan	Tamil Nadu	Madhya Pradesh	Andhra Pradesh
FIT (Rs/kWh)	Up to INR 5.70	INR 4.50	INR 4.15	Up to INR 5.67	INR 3.59	INR 5.92	INR 4.70
Duration of PPA	13 years	10 /20 years	25 years	25 years	20 years	25 years	25 years
RPO Target	8.5%	7-10%	7%	5.7%	8.95%	4.75%	4.75%
APPC Tariff	NA	INR 3.07	INR 2.64	INR 2.75	INR 2.64	INR 2.48	INR 2.69
GB Incentive	INR 0.5 pkWh, Cumulative cap of INR 10 million pMW (Federal incentive, independent of FIT)						
REC Price	Between INR 1.5 to 3.30 pkWh (Price determined thru' trading of RE certificates on exchange)						

Table-6 Wind Power Price overview in India

Gujarat – Wind Policy:-

Wind Energy

Wind Power as an energy source is a non-polluting, environment-friendly, reasonably priced energy with shorter project gestation period. State of Gujarat recognizing the need for long term energy security in current scenario of volatile fossil fuel costs, global warming & climate change has been promoting wind power generation in the State.

The State Government by and time has revisited its Wind Power policy to encourage Wind Generation in the state. The State blessed with long coast line and good wind speeds for harnessing of the Wind Energy has successfully installed more than 3000 MW Wind capacity. To accelerate the investment in Renewable sector, need for further investment in Clean and Green Energy sources is observed. With the revised estimated potential of more than 35000 MW from Wind energy sources in the State, it was under consideration of the Government to review the present wind power policy.

In order to optimize the Wind Energy potential in the State, the State Government has decided to pronounce a New Wind Power Policy – 2013

Tariff calculation:-

- Tariff for Wind Power : Rs. 4.15 per kWhr
- Plant Life Considered (PPA Duration) : 25 years
- Banking : WEGs are eligible for one month banking for the electricity generated during the month
- Transmission and Wheeling Charge (For Captive Use)

➢ **Consumption site at 66kV voltage level and above:**

- Transmission Charges(FY 13-14) - Rs. 2721/MW/Day
- Transmission Loss : ~4.2% as per SLDC

➢ **Consumption Site below 66kV Voltage Level :**

- Transmission Charges (FY 13-14) Rs. 2721/ MW / Day
- Investors having more than 1 WTG
  - Transmission and wheeling Loss : 10%
  - Loss to be shared between Transmission & Distribution Licensee : 4:6
- Investors having 1 WTG
  - Transmission and wheeling Loss : 7%
  - Loss to be shared between Transmission & Distribution Licensee : 4:3
- **Wheeling at more than two locations :** 5 paisa per unit on energy fed in the Grid
- **Purchase of Surplus Power :** After adjustment of energy against consumption, surplus power from WEGs to be purchased by Distribution Companies @85% of tariff of GUVNL i.e. Rs. 4.15 / kWh
- **Exemptions :**
- Exemption from Electricity Duty for 25 years.
- Exemption from Demand Cut up to 30% of the installed capacity
- **CDM Sharing :** CDM benefits should be shared from 100% to developers in the first year after commissioning, and thereafter reducing 10% every year, till sharing becomes 50 : 50 in the sixth year.
- **Reactive Power :**
- 10 paisa / KVARH : for drawl of reactive energy at 10% or less of the net energy exported.

25 paisa / KVARH : for drawl of reactive energy at more than 10% of net energy exported

- **Third Party Sale & Cross subsidy Surcharge**
    - Third Party Sale allowed under open access transmission.
    - No Cross subsidy surcharge
    - Set off against consumption in each 15 minute time block
    - Excess generation over & above set off against consumption shall be treated as Sold to DISCOM

Key trend in WTG Design:-

Turbine rating

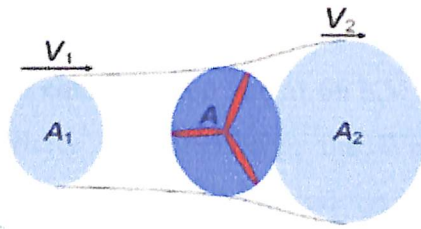
Table 3-6: Segmentation of product sizes 2009-2011

Year	2009	2010	2011
Total MW supplied	37.117	40.377	40.142
Product (Size range)	% of total MW		
"Small WTGs" <750 kW	1.1%	0.2%	0.5%
"One-MW" 750-1499 kW	12.0%	8.3%	6.6%
"Mainstream" 1500-2500 kW	81.9%	83.1%	85.7%
"Multi-MW Class" >2500 kW	5.1%	8.4%	7.2%
Total	100.0%	100.0%	100.0%

Source: BTM Consult - A Part of Navigant - March 2012

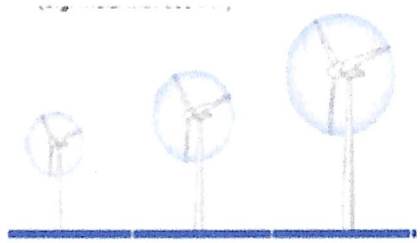
While the quest for bigger generator continues in offshore wind, for onshore the market is settling at 2-2.5 MW bands, depending upon the wind regime and logistics

Rotor diameter



Major WTG suppliers moving to larger rotor diameter; Logistics and local manufacturing to act as limiting factor for further up-scaling

Hub Height



Higher hub heights help in optimum utilization of low wind sites. To help with cost and logistics, different tower design innovations are being explored

3.7.1 Operative Period:

This policy will come into force with effect from the date of issue of this resolution and shall remain in operation up to 31st March 2016, which will be the operative period of the scheme. Wind Turbine Generators (WTGs) installed and commissioned during the operative period shall become.

Eligible for the incentives declared under this policy, for a period of twenty five years (25) from the date of commissioning or for the life span of the WTGs , whichever is earlier.

3. Eligible Unit:

Any company or body corporate or association or body of individuals, whether incorporated or not, or artificial juridical person, will be eligible for setting up of WTGs, either for the purpose of captive use and /or for selling of electricity, in accordance with the Electricity Act 2003, as amended from time to time. Explanation: The use of electricity for own consumption at his end use location/s by the owner of WTGs shall be considered as Captive use.

4. Eligible Sites:

The WTGs may be set up at sites notified by Gujarat Energy Development Agency (GEDA) and/ or any other sites identified as potential site, within the State by the Nodal Agency or Developer/s.

5. Wheeling of Electricity

5.1. For Captive Consumption:

a) **Wheeling of power to consumption site at 66 KV voltage level and above.**

The wheeling of electricity generated from the Wind Power Generators, to the desired location(s) within the State, shall be allowed on payment of transmission charges and transmission losses applicable to normal Open Access Consumer.

b) **Wheeling of power to consumption site below 66 KV voltage level.**

i. The wheeling of electricity generated from the Wind Power Generators, to the desired location(s) within the State, shall be allowed on payment of transmission charges, otherwise applicable to normal Open Access Consumer and transmission and wheeling losses @ 10% of the energy fed to the grid. The above loss is to be shared between the transmission and distribution licensee in the ratio of 4:6. This provision shall be applicable to the WEGs who are having more than one WTGs.

ii. The wheeling of electricity generated by smaller investors, having only one WTG in the State, to the desired location(s), shall be allowed on payment of transmission charges, otherwise applicable to normal open access consumer, and transmission and wheeling losses @ 7% of the energy fed to the grid. The above losses are to be shared between the transmission and distribution licensee in the ratio of 4:3.

5.2. For Third party sale : The Wind Power Projects availing open access for third party sale shall be liable to pay open access charges and losses as applicable to normal open access

consumers. Set off of wheeled energy at recipient unit(s) shall be carried out in the same 15 minute time block. Banking facility shall not be available for third party sale of energy.

5.3 Wheeling at Multiple Locations

Wind Energy Generator owner, who desires to wheel electricity at more than two locations, shall pay 5 paise per unit on energy fed into the grid to the Distribution Company concerned in whose area power is consumed in addition to the above mentioned transmission charges and losses, as applicable.

6. Exemption from payment of Electricity Duty and Cross Subsidy charges:

The electricity generated from the Wind turbine generator/s shall be exempted from payment of Electricity Duty, in accordance with the provisions of the Gujarat Electricity Duty Act 1958 and its amendments from time to time.

Wheeling of wind energy for third party sale and captive use shall be exempted from cross subsidy charge.

7. Sale of Energy to Distribution Utilities:

7.1 Sale under Preferential tariff :

(i) The electricity generated from the WTGs commissioned from 8.08.2012, may be sold to GUVNL and / or any Distribution Licensee within the state, at a rate of Rs. 4.15 per unit of electricity as per GERC order. The requisite Power Purchase agreement (PPA) shall be done between the power procurer and the eligible unit.

(ii) GUVNL and /or any Distribution licensee may purchase surplus power from WTGs wheeling power for their captive use after adjustment of energy against consumption at recipie

nt unit(s) at a rate of 85% of tariff applicable to WTGs (Commissioned during the Control Period of Hon'ble GERC's Wind tariff order.) WTGs opting for captive use of energy generated shall be eligible to get set off against the energy during peak and normal hours as specified by the GERC in its tariff order. The WTGs under captive use shall be eligible for one month banking for the electricity generated during the same calendar month.

8. Third party sale of Energy:

The sale of electricity generated from the WTGs shall also be allowed to a third party, in accordance with the GERC Regulations / order, as amended from time to time.

Chapter 4: Findings and Analysis

4.1: Descriptive Statistics:

Consumption in MW to Consumption in MU

Conversion:

$$\text{Consumption} = \frac{\text{Consumption in MW X 24 Hours X 365 Days}}{1000} \text{ Million Units}$$

Example: Consumption =100 MW

$$\text{Generation} = \frac{100 \text{ MW X } 24 \text{ X } 365}{1000} = 876 \text{ Million Units}$$

4.1.1 Important facts to calculate RPO:

1. Renewable purchase obligation is calculated for its own consumption as in case of captive power plant, RPO exempted for Auxiliary consumption of CPP.
2. Vadinar Power Company Ltd has capacity of 1010 MWe i.e.600MW, while Auxiliary consumption is 6.5 %.
3. Annual consumption of Essar Oil Ltd (EOL) is 1401.6 MUs.
4. Here we calculated RPO & no. of RECs by taking consumption of EOL as per PPA with VPCL .
5. For calculating RPO, Capacity Utilization Factor play very important role for RE Sources. The net capacity utilization factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity indefinitely. To calculate the capacity factor, take the total amount of energy the plant produced during a period of time and divide by the amount of energy the plant would have produced at full capacity.

6. The Renewable Purchase Obligation (RPO) is calculated on the basis of the consumption of Essar Oil Ltd i.e. 1401.6MUs. By using conversion formula as per GERC predetermined percentage individually for Solar, Wind, Others

   (Biomass, Bagasse, MSW, etc.) RECs can be calculated.

7. As we know that as per GERC, any obligated entities have to fulfil their RPO

(Minimum quantum of Renewable Energy purchase in % of total Energy consumption in the State) individually by **Solar, Wind & Others.**

8. Here we can see from table given below Solar RPO increases every financial year by 0.25%, Wind RPO by 0.75% & others remains same.

Renewable Purchase Obligations from FY 2010-11 to FY 2016-17

	Minimum Quantum of purchase (in %) from renewable energy sources (in terms of energy in kWh)			
Year	*TOTAL*	*Wind*	*Solar*	*Others (Biomass, Bagasse, MSW, etc.)*
2010-11	*5.0*	*4.5*	*0.25*	*0.25*
2011-12	*6.0*	*5.0*	*0.5*	*0.5*
2012-13	*7.0*	*5.5*	*1.0*	*0.5*
2013-14	*7.0*	*5.5*	*1.0*	*0.5*
2014-15	*8.0*	*6.25*	*1.25*	*0.5*
2015-16	*9.0*	*7.0*	*1.5*	*0.5*
2016-17	*10.0*	*7.75*	*1.75*	*0.5*

Table- 7 Renewable Purchase Obligations from FY 2010-11 to FY 2016-17

9. So as per going trend, future year wise RPO % can be shown by below table

Year	Total	Wind	Solar	Others *(Biomass, Bagasse, MSW, etc.)*
2017-18	11	8.5	2	0.5
2018-19	12	9.25	2.25	0.5
2019-20	13	10	2.5	0.5
2020-21	14	10.75	2.75	0.5
2021-22	15	11.5	3	0.5

4.1.2 Solar Power calculation for vpcl:-

Solar Power Year ---->

Units Generation	**Unit**	**Levellised**	1	2	3	4	5
Installed Capacity	MW		12	12	12	12	12
Gross Generation	MU		18.92	18.92	18.92	18.92	18.92
Aux. Consumption	MU		0.05	0.05	0.05	0.05	0.05
Net Generation	MU		18.87	18.87	18.87	18.87	18.87
Refinery power consumption	MW		130	130	130	130	130
Refinery Energy consumption	MU / Year		1138.8	1138.8	1138.8	1138.8	1138.8
% sharing of Solar power in EOL cons.			1.66%	1.66%	1.66%	1.66%	1.66%
Cost							
O&M Expenses	Lac Rs.	**176.3**	132.0	136.0	140.0	144.2	148.6
Depreciation	Lac Rs.	**319.2**	319	319.2	319.2	319.2	319.2
Loan interest	Lac Rs.	**348.9**	758.1	708.8	633.2	557.6	483.3
Interest on working capital	Lac Rs.	**0.0**	0.0	0.0	0.0	0.0	0.0
Return on equity	Lac Rs.	**315.0**	315.0	315.0	315.0	315.0	315.0
Insurance	Lac Rs.	**12.0**	12.0	12.0	12.0	12.0	12.0
Forecasting	Lac Rs.	**6.0**	6.0	6.0	6.0	6.0	6.0
Income tax	Lac Rs.	**0.0**	0.0	0.0	0.0	0.0	0.0

Total cost of Generation	Lac Rs.	**1177.3**	1542.3	1497	1425.5	1354.1	1284.0
Saving for EOL:							
Electricity Duty	Lac Rs.	**103.8**	103.81	103.8	103.8	103.8	103.8
Fuel cost	Lac Rs.	**415.2**	415.23	415.2	415.2	415.2	415.2
Additional capacity utilization	Lac Rs.	**237.0**	237.01	237	237	237	237
Tax benefit due to AD	Lac Rs.	**180.3**	1410.9	282.2	56.44	11.29	2.257
Total Saving	Lac Rs.	**936.4**	2167	1038	812.5	767.3	758.3
Net Cost to EOL	Lac Rs.	**241.0**	-624.7	458.8	613.0	586.7	525.7
Levellised tariff corresponding to useful life							
Per unit cost generation							
O&M Expenses	Rs./KWh	**0.93**	0.70	0.72	0.74	0.76	0.79
Depreciation	Rs./KWh	**1.69**	1.69	1.69	1.69	1.69	1.69
Loan interest	Rs./KWh	**1.85**	4.02	3.76	3.35	2.95	2.56
Interest on working capital	Rs./KWh	**0.00**	0.00	0.00	0.00	0.00	0.00
Return on equity	Rs./KWh	**1.67**	1.67	1.67	1.67	1.67	1.67
Insurance	Rs./KWh	**0.06**	0.06	0.06	0.06	0.06	0.06
Forecasting	Rs./KWh	**0.03**	0.03	0.03	0.03	0.03	0.03
Income tax	Rs./KWh	**0.00**	0.00	0.00	0.00	0.00	0.00
Total cost of Generation	Rs./KWh	**6.24**	8.17	7.93	7.55	7.17	6.80
Levellised tariff	**6.24**	**Rs./KWh**					
Saving for EOL:							
Electricity Duty	Rs./KWh	**0.55**	0.55	0.55	0.55	0.55	0.55
Fuel cost	Rs./KWh	**2.20**	2.20	2.20	2.20	2.20	2.20
Additional capacity utilization	Rs./KWh	**1.26**	1.26	1.26	1.26	1.26	1.26
Tax benefit due to AD	Rs./KWh	**0.96**	7.48	1.50	0.30	0.06	0.01
Total Saving	Rs./KWh	**4.96**	11.48	5.50	4.30	4.07	4.02

Net Cost to EOL	Rs./KWh	**1.28**	-3.31	2.43	3.25	3.11	2.79
Discount factor	0.9036		1	0.904	0.816	0.738	0.667
Accelerated Depreciation rate	80%		80%	16%	3%	1%	0%
Accelerated Depreciation	Lac Rs.		6720	1344	268.8	53.76	10.75
Tax benefit	Lac Rs.		1410.9	282.2	56.44	11.29	2.257

Impact to VPCL

Additional Return (ROE diff)	Lac Rs.	**21.0**	21	21	21	21	21
Additional Power sell	Lac Rs.	**245.4**	245.37	245.4	245.4	245.4	245.4
Loss in Addl. Capacity charge	Lac Rs.	**237.0**	237.01	237	237	237	237
Net	Lac Rs.	**29.4**	29.36	29.36	29.36	29.36	29.36

Loan instalment (EMI)	Lac Rs.	**771.6**	1115	1115	1115	1115	1115

Cash flow

Depreciation	Lac Rs.	**319.2**	319	319	319	319	319
ROE	Lac Rs.	**315.0**	315.0	315.0	315.0	315.0	315.0
Loan Instalment	Lac Rs.	**1433.0**	0	2,292	2,292	2,292	2,292
Net Cash flow	Lac Rs.	**-798.8**	634	-1657	-1657	-1657	-1657

Table- 9 Solar Power calculation for vpcl

CUF	EOL	VPCL
25%	1.24	34
26	1.04	4.8

4.1.3
Wind Power calculation

Year ---->

Units Generation	**Unit**	**Levellised**	1	2	3	4	5
Installed Capacity	MW		44.1	44.1	44.1	44.1	44.1
Gross Generation	MU		96.58	96.58	96.58	96.58	96.58
Refinery power consumption	MW		130	130	130	130	130
Refinery Energy consumption	MU / Year		1138.8	1138.8	1138.8	1138.8	1138.8
% sharing of Wind power in EOL cons.			8.48%	8.48%	8.48%	8.48%	8.48%
Cost							
O&M Expenses	Lac Rs.	**593.6**		529.2	545.1	561.4	578.3
Depreciation	Lac Rs.	**1161.1**	1161	1161.1	1161.1	1161.1	1161.1
Loan interest	Lac Rs.	**1269.0**	2757.5	2578.4	2303.4	2028.4	1757.9
Interest on working capital	Lac Rs.	**0.0**	0.0	0.0	0.0	0.0	0.0
Return on equity	Lac Rs.	**1145.8**	1145.8	1145.8	1145.8	1145.8	1145.8
Insurance	Lac Rs.	**44.1**	44.1	44.1	44.1	44.1	44.1
Forecasting	Lac Rs.	**22.1**	22.1	22.1	22.1	22.1	22.1
Income tax	Lac Rs.	**0.0**	0.0	0.0	0.0	0.0	0.0
Total cost of Generation	Lac Rs.	**4235.7**	5130.5	5481	5221.5	4962.9	4709.2
Saving for EOL:							
Electricity Duty	Lac Rs.	**531.2**	531.18	531.2	531.2	531.2	531.2
Fuel cost	Lac Rs.	**2124.7**	2124.7	2125	2125	2125	2125
Additional capacity utilization	Lac Rs.	**1212.8**	1212.8	1213	1213	1213	1213
Tax benefit due to AD	Lac Rs.	**655.9**	5132.3	1026	205.3	41.06	8.212
Total Saving	Lac Rs.	**4524.5**	9000.9	4895	4074	3910	3877
Net Cost to EOL	Lac Rs.	**-288.8**	-3870.4	585.5	1147.5	1053.1	832.3

Levellised tariff corresponding to useful life							
Per unit cost generation							
O&M Expenses	Rs./KWh	**0.61**	0.00	0.55	0.56	0.58	0.60
Depreciation	Rs./KWh	**1.20**	1.20	1.20	1.20	1.20	1.20
Loan interest	Rs./KWh	**1.31**	2.86	2.67	2.38	2.10	1.82
Interest on working capital	Rs./KWh	**0.00**	0.00	0.00	0.00	0.00	0.00
Return on equity	Rs./KWh	**1.19**	1.19	1.19	1.19	1.19	1.19
Insurance	Rs./KWh	**0.05**	0.05	0.05	0.05	0.05	0.05
Forecasting	Rs./KWh	**0.02**	0.02	0.02	0.02	0.02	0.02
Income tax	Rs./KWh	**0.00**	0.00	0.00	0.00	0.00	0.00
Total cost of Generation	Rs./KWh	**4.39**	5.31	5.67	5.41	5.14	4.88
Levellised tariff	**4.39**	**Rs./KWh**					
Saving for EOL:							
Electricity Duty	Rs./KWh	**0.55**	0.55	0.55	0.55	0.55	0.55
Fuel cost	Rs./KWh	**2.20**	2.20	2.20	2.20	2.20	2.20
Additional capacity utilization	Rs./KWh	**1.26**	1.26	1.26	1.26	1.26	1.26
Tax benefit due to AD	Rs./KWh	**0.68**	5.31	1.06	0.21	0.04	0.01
Total Saving	Rs./KWh	**4.68**	9.32	5.07	4.22	4.05	4.01
Net Cost to EOL	Rs./KWh	**-0.30**	-4.01	0.61	1.19	1.09	0.86
Discount factor	0.9036		1	0.904	0.816	0.738	0.667
Accelerated Depreciation rate	80%		80%	16%	3%	1%	0%
Accelerated Depreciation	Lac Rs.		24444	4889	977.8	195.6	39.11
Tax benefit	Lac Rs.		5132.3	1026	205.3	41.06	8.212

Impact to VPCL

Additional Return (ROE diff)	Lac Rs.	**76.4**	76.387	76.39	76.39	76.39	76.39
Additional Power sell	Lac Rs.	**1255.5**	1255.5	1256	1256	1256	1256
Loss in Addl. Capacity charge	Lac Rs.	**1212.8**	1212.8	1213	1213	1213	1213
Net	Lac Rs.	**119.2**	119.16	119.2	119.2	119.2	119.2

Loan instalment (EMI)	Lac Rs.	**2806.8**	4055.8	4056	4056	4056	4056

Cash flow

Depreciation	Lac Rs.	**1161.1**	1161	1161	1161	1161	1161
ROE	Lac Rs.	**1145.8**	1145.8	1145.8	1145.8	1145.8	1145.8
Loan Installment	Lac Rs.	**1433.0**	0	2,292	2,292	2,292	2,292
Net Cash flow	Lac Rs.	**873.9**	2307	15	15	15	15

Table- 10 wind power calcula

for vpcl

CUF	EOL	VPCL
25%	1.24	34
26	1.04	4.8

4.2 Correlation/ Regression Analyses:-

4.3 SOLAR RPO :

- CUF for solar sources varies based on technology, as we can see from table that it is lowest for solar PV while highest for solar thermal.

Solar Source	**CUF %**	**Total Project Cost (in Crores)/MW**
Solar PV (KW Scale)	19	8.5
Solar PV (MW Scale)	19	6.5
Solar THERMAL	23	14

- Here is table below that shows the levelised tariff decided by the GERC for solar.

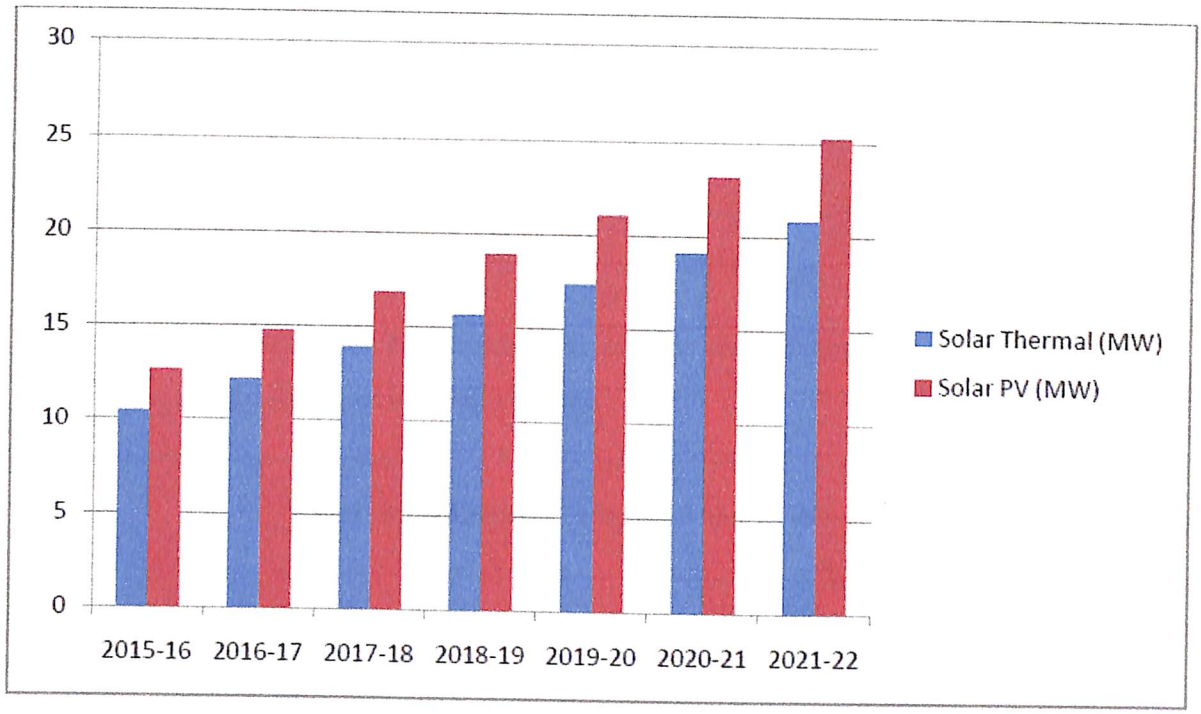
Tariff as per GERC		Including accelerated depreciation	Excluding accelerated depreciation
RE Sources		**Rs/Kwh**	**Rs/Kwh**
PV Solar	(MW Scale)	6.41	7.15
PV Solar	(KW Scale)	8.23	9.2
Solar Thermal		10.09	11.27

- As the capacity utilization factor increases requirement of plant in term of MW decreases, on that basis we can say that capacity of solar plant will be minimum. Here a table is given below which shows the requirement in term of MW for respective year based various technologies.

Required Installed Capacity (in MW)

Year	Solar PV	Solar Thermal
2015-16	12.63158	10.43478261
2016-17	14.73684	12.17391304
2017-18	16.8421053	13.91304348
2018-19	18.9473684	15.65217391
2019-20	21.0526316	17.39130435
2020-21	23.1578947	19.13043478
2021-22	25.2631579	20.86956522

- Below, there is a graph between required capacity (MW) VS solar Technologies for FY2015-16 to 2021-22 which will give clearer picture.



4.4 Wind RPO

- CUF for Wind Power Plant as per Regulation is 23%.

- Here a table that shows the levelised tariff and Project cost for Wind power plant.

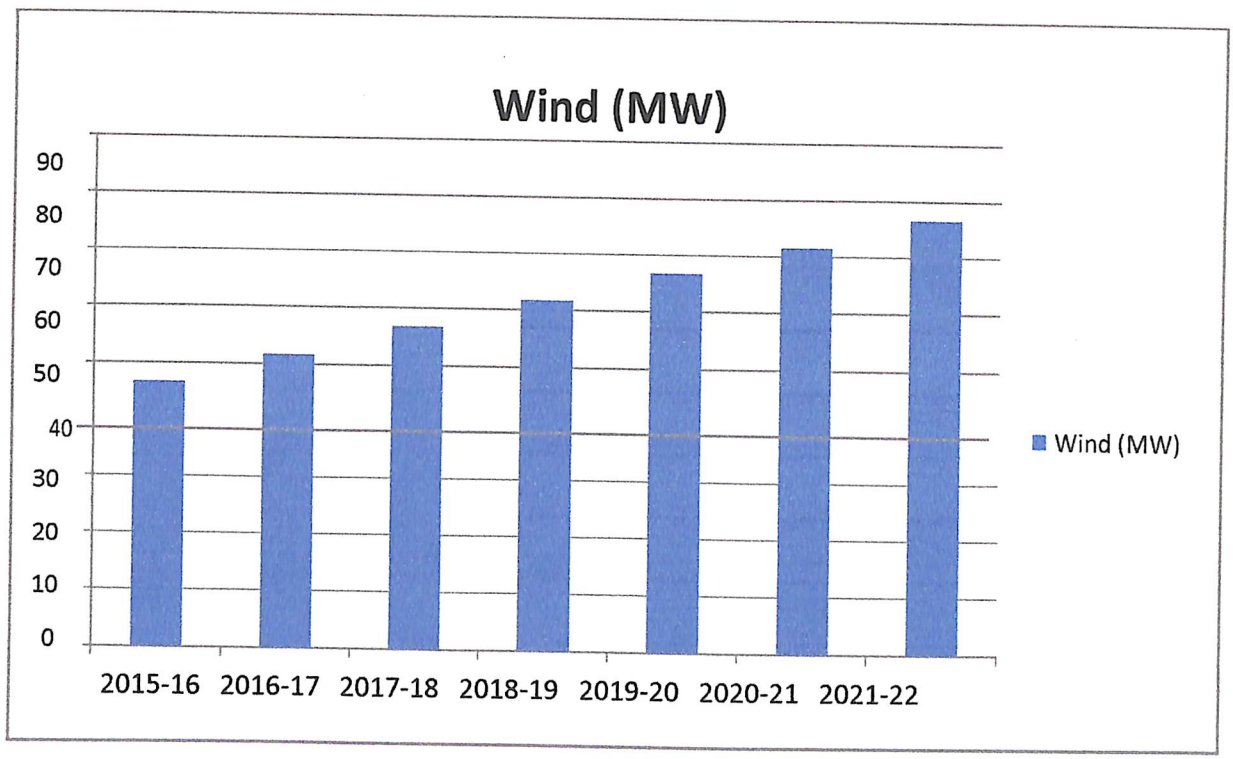
Tariff as per GERC	Including accelerated Depreciation	Excluding accelerated depreciation	Total Project Cost (in Crores)/MW
RE Sources	Rs/Kwh	Rs/Kwh	
Wind	4.23	4.61	6.06

- Here a table is given below which shows the requirement in term of MW for respective year based on Wind Power.

Required Installed Capacity (in MW)	
Year	**Wind Power Plant (in MW)**
2015-16	46.67
2016-17	51.67
2017-18	56.6666667
2018-19	61.6666667
2019-20	66.6666667
2020-21	71.6666667
2021-22	76.6666667

- To meet Wind RPO, below graph shows year wise addition which give clearer picture.

Wind Power (MW)



4.5 REC Calculation:

4.5.1 Consumption into Number of RECs Conversion:

1. We can find the number of RECs by finding the of annual consumption of captive plant in case of Solar RECs & for Non-Solar RECs for FY 2015-16 to FY 2021-22.
2. Number of RECs = Consumption in Million Units X1000
3. 1 REC = 1 MWh of electricity Consumed.
4. REC market has two price first one is "FLOOR PRICE" (Minimum price) & other is "FORBEARANCE PRICE" (Which is maximum price of REC),which applied for both in case of Solar & Non-Solar RECs.
5. Consumption in Million Unit is 1401.6, then total no. of RECs become 1401600.

6. Currently floor price of Solar RECs is 3500 & forbearance price is 5800,

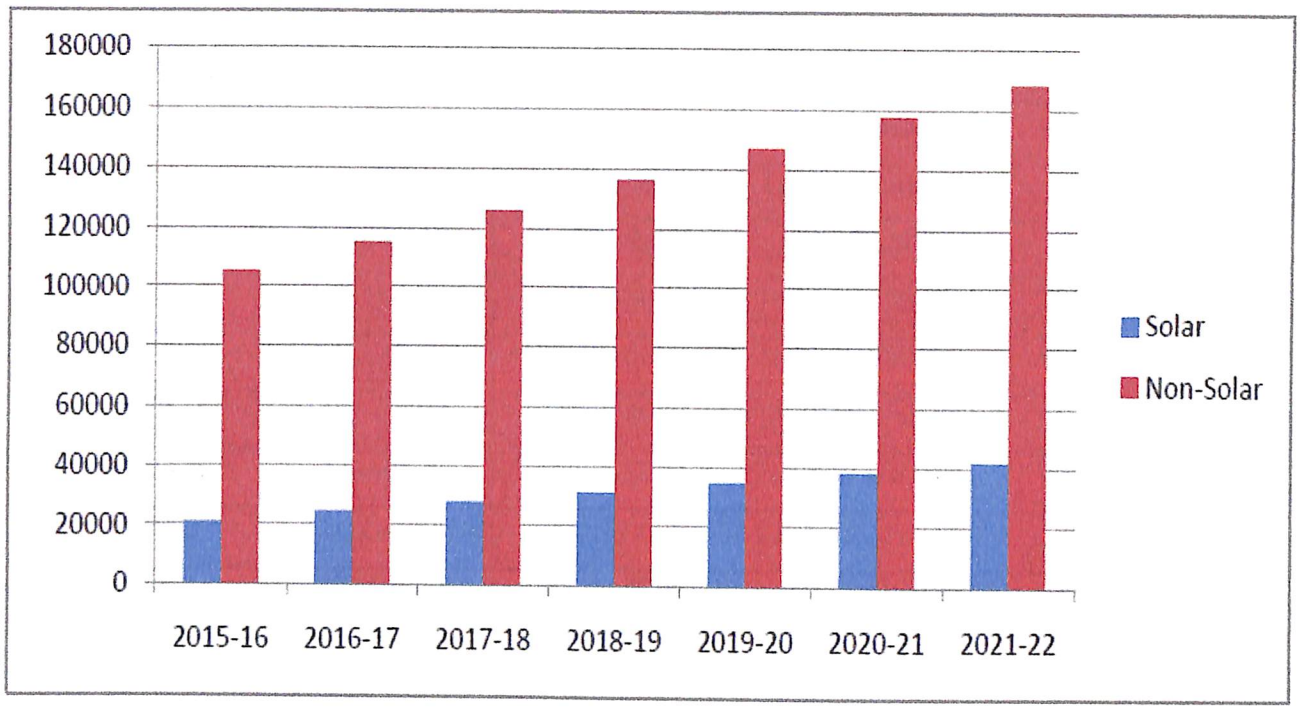
Year	Solar	Non-Solar
2015-16	21024	105120
2016-17	24528	115632
2017-18	28032	126144
2018-19	31536	136656
2019-20	35040	147168
2020-21	38544	157680
2021-22	42048	168192

ice of Non-Solar RECs is 1500 & forbearance price is 3300.

7. Below table and graph shows the year-wise number of REC requirement from Solar and Non-Solar.

REC = 1 MWH

Number of REC Required		
Year	**Solar**	**Non-Solar**
2015-16	21024	105120
2016-17	24528	115632
2017-18	28032	126144
2018-19	31536	136656
2019-20	35040	147168
2020-21	38544	157680
2021-22	42048	168192


180000
160000
140000
120000
100000
80000
60000
40000
20000
0
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
Solar
Non-Solar

8 : Thus Cost Incurred in REC can be shown by below table ,

Year	REC Cost in Rs			
	Solar (Floor)	Non-Solar (Floor)	Solar (Forbearance)	Non-Solar (Forbearance)
2015-16	735,84,000	1576,80,000	1219,39,200	3468,96,000
2016-17	85848000	173448000	1422,62,400.00	3815,85,600.00
2017-18	98112000	189216000	1625,85,600.00	4162,75,200.00
2018-19	110376000	204984000	1829,08,800.00	4509,64,800.00
2019-20	122640000	220752000	2032,32,000.00	4856,54,400.00
2020-21	134904000	236520000	2235,55,200.00	5203,44,000.00
2021-22	147168000	252288000	2438,78,400.00	5550,33,600.00
Total Cost incurred in RPO				
2015-22	7726,32,000.00	14348,88,000.00	12803,61,600.00	31567,53,600.00

Challenges faced by RPO

- RPO being fixed keeping in mind availability of RE resources in State instead of availability of RE resources in the country as a whole
- Need for National level RPO
- Need for specifying RPO as a percentage of "total consumption" of electricity in the area of a distribution licensee
- Need to recognise REC as valid instrument for compliance of RPO by the obligated entities
- iv. Applicability of RPO on Captive user, Open Access users and captive cogeneration : Regulations challenged in various High Courts
- Lack of Long Term RPO Trajectory
- Need for Long Term RPO Trajectory: At least for next 5 to 10 years
- Lack of enforcement of RPO
- Financial conditions of distribution utilities

- Higher RPO level leads to higher impact

➢ Section 86(1) (e) of the Act mandates SERCs to promote RE in the State

- Traditionally, RPO being fixed based on the resources available in the States

Chapter 5: Interpretation of results.

5.1 Interpretation of Results:-

Various option available for RPO in VPCL:-

Option :1

- Synchronize With Our CPP:
- These Plants does not give continuous generation.
- Availability of Generation is highly dependent on varying weather conditions
- Thus, we need to vary our generation according to the generation of Renewable Source. Which is not practical.
- Hence this Option cannot be considered

Option:-2

- Consumption through Wheeling:
- Total Generation can be export power to Grid via additional Grid Connection
- Power to be import from 220KV existing line.
- We need to pay for the wheeling & Transmission losses.
- This option is not feasible since we are always in export mode.

Option:-3

- Selling at APPC rate + REC
- We can make PPA at APPC Rate and REC can be obtained.
- APCC rate is approximately 2.5 to 3.0 Rupees/ Unit.
- The Plant can be installed at our Site or at other location where PLF (Plant Load Factor) is higher.
- Options of Available Land banks are offered by some Market Leaders.

Option:-4

- Outright Purchase of REC equivalent to the Requirement:
- We can purchase Out right REC (Renewable Energy Certificate) from centralized issues agency from open market.
- In this option we don't need to install any plant.

5.2 Comparison of Results with Assumptions

5.2.1 RE Power Comparison:-

REC Purchase			
Particular		REC Cost in Cr. Rs.	
		At Floor Price	At Forbearance Price
EOL Energy Consumption in MWh	1138800	(Considering 130MW average load)	
Non Solar REC (8.25%)	93951	14.09	31.00
Solar REC (1.75%)	19929	6.98	11.56
Total Cost Per Year		21.07	42.56
Capital Investment in RE Power			
Particular	Debt (70%)	Equity (30%)	Total
Capital Cost (Cr. Rs.)	280	120	400
Interest Rate (%)	12%	14%	
Annual Interest (Cr. Rs.)	33.6	16.8	50.4
Units Generated (MU)			106
Unit rate			2.5

Revenue (Cr. Rs.)			26.50
O&M Expenses (Cr. Rs.)			8
Net Cost per Year			31.90
	Solar	Wind	
Cost of Generation per unit	7.22	5.32	Rs. / Kwh
Coal Plant + REC cost per unit	5.5 - 7.8	3.5 - 5.3	
Coal Plant unit cost	2	2	
Floor Price (REC)	3.5	1.5	
	5.50	3.5	
Coal Plant unit cost	2	2	
Forbearance price (REC)	5.8	3.3	
	7.8	5.3	

5.2.2 Wind Power calculation for vpcl

Power Generation	**Unit**	
Capacity	MW	44.10
Capacity Utilization factor	%	25%
Useful life	Years	25
Project Cost	LacRs/MW	692.86
Total Project cost	LacRs	30555
Debt	%	75%
Equity	%	25%
Debt Component		
Loan Amount	LacRs.	22916.250
Repayment period	Years	10
Interest rate	%	12.00%
Equity Component		
Equity amount	LacRs.	7638.750
ROE for 1st 10 year	%	15%
ROE for 11th year onwards	%	15%
Discount rate	%	10.67%
Income tax	%	21.00%
Depreciation		SLM
Depreciation rate for first 12 year	%	3.80%
Depreciation rate for 13 year onwards	%	3.80%
Interest on working capital		
O&M Charges	months	1
Maintenance spare(% of O&M Exp.)	%	10.00%
Receivable for debtors	months	2
Interest on working capital	%	0.00%
O&M expenses		
O&M expenses (FY 14-15)	LacRs/MW	12.00
Escalation in O&M expenses	%	3.00%
Total O&M Exp. (FY 14-15)	LacRs	529.20

Insurance	1 Lac Rs/MW	1
Total insurance charges		44.1
Forecasting	Lac / MW	0.5
Total Forecasting charges		22.05
Electricity Duty	Rs./Unit	0.55
CFB Fuel cost	Rs./Unit	2.2
Escalation factor for CFB fuel cost	%	0
Additional capacity utilization charge	Rs./Unit	1.26
Base rate for ROE	%	14%
Additional Power sell average cost	Rs./Unit	1.3
		25%

Assumptions

1 Aux. consumption not considered

2 O&M will be done by OEM

3 UI Charges not considered for variation in generation

4 Plant installation considered inside EOL complex

5 Impact on current operation due to variation in RE Gen. need to study

6 Sensitivity analysis not done

7 Refinery consumption is higher than entitlement from Ph-2

8 Actual negative UI charge will be reimbursed.

9 ROE 15% considered as operanal risk of current plant will increase

10 EOL to pay the maximum of actual profit or difference of 1.3 Rs. /unit and actual profit/unit for the power sold as merchant upto the power generated from RE
EOL has to pay for unsold power @ 1.3 Rs/Unit upto power generated from RE

5.2.3 Solar Power calculation for vpcl

Power Generation	Unit	
Capacity	MW	12.00
Aux. Consumption	%	0.25%
Capacity Utilization factor	%	18%
Useful life	Years	25
Project Cost	LacRs/MW	700.00
Total Project cost	LacRs	8400
Debt	%	75%
Equity	%	25%
Debt Component		
Loan Amount	LacRs.	6300.000
Repayment period	Years	10
Interest rate	%	12.00%
Equity Component		
Equity amount	LacRs.	2100.000
ROE for 1st 10 year	%	15%
ROE for 11th year onwards	%	15%
Discount rate	%	10.67%
Income tax	%	21.00%
Depreciation		SLM
Depreciation rate for first 12 year	%	3.80%
Depreciation rate for 13 year onwards	%	3.80%
Interest on working capital		
O&M Charges	months	1
Maintenance spare(% of O&M Exp.)	%	10.00%

SL M AD

Receivable for debtors	months	2
Interest on working capital	%	0.00%
O&M expenses		
O&M expenses (FY 14-15)	LacRs/MW	11.00
Escalation in O&M expenses	%	3.00%
Total O&M Exp. (FY 14-15)	LacRs	132.00
Insurance	1 Lac Rs/MW	1
Total insurance charges		12
Forecasting	Lac / MW	0.5
Total Forecasting charges		6
Electricity Duty	Rs./Unit	0.55
CFB Fuel cost	Rs./Unit	2.2
Escalation factor for CFB fuel cost	%	0
Additional capacity utilization charge	Rs./Unit	1.26
Base rate for ROE	%	14%
Additional Power sell average cost	Rs./Unit	1.3
Inverter replacement cost on 13th year	% of CC	3.81%

Assumption:-

- Duration factor for solar cell was not considered.
- O&M will be done by OEM / O&M Contractor.
- UI Charges not considered for variation in generation
- Plant installation considered inside EOL complex
- Impact on current operation due to variation in RE Gen. need to study.
- Refinery consumption is higher than entitlement from Ph-2
- Actual negative UI charge will be reimbursed.

- ROE 15% considered as operational risk of current plant will increase
- EOL to pay the maximum of actual profit or difference of 1.3 Rs. /unit and actual profit/
  unit for the power sold as merchant upto the power generated from RE
- EOL has to pay for unsold power @ 1.3 Rs/Unit upto power generated from RE

Chapter 6: Conclusions and Scope for Future Work:

This paper present a welcome light for the RPO (renewable purchase obligation) prospect of the Vadinar Power Company Limited (VPCL) Essar .At present the options available for plant are many which ranges from Coal(imported) , Natural Gas, HSD and Fuel Oil. However the availability of these fuels are constrained by various limitation. For the coal as it is being imported and its international price are increasing day by day which has severely affected the production cost. The NG, HSD and FO availability in India has decreased drastically as they are now fetching now a good price if sold alone. Along with these, the gases emitted by these fuel are a big concern as the plant is located within the village periphery. Hence the pollution concern is also a big deal form environment point of view. Hence it necessitate the production of green energy in this locality which finally concentrate us on the renewable energy generation.

In our country still now we are giving importance to power generation by means of non-renewable sources not by means of renewable source to achieve basic power requirement per person (per capita consumption of our country is still less compared to developed countries in the world).so to meet out our requirement and to keep our country from pollution free and make our country as most visit tourist part in world we should give more preference to renewable source.

- VPCL can initially go REC purchasing for fulfilling RPO since REC rates are traded at floor price.
- Since the Solar potential of Vadinar region is high, it can be suggested that VPCL, Jamnagar can meet its RPO by installing a Solar Power Plant.
- Also the Wind potential of Vadinar region is also high, it can be suggested that VPCL, Jamnagar can meet its RPO by installing a Wind Power Plant.

- The amount of electricity generated from the RE sources can be used for the power used either inside EOL, or can be used for REC Purchasing and selling the power to any third party.
- It is suggested that VPCL should install its own Solar Power Plant in Surplus than its RPO requirement, So that the surplus quantity can fetch Solar RECs which can be exchanged with Non-Solar RECs or can be sell in market for profit.
- VPCL can also use a Hybrid RE plant in which they can put a combination of Solar and Wind Power Plant.
- GERC has declared RPO requirements for entities inside Gujarat till the FY2016-17.So VPCL should plan for meeting its current as well as future RPO. Before installing any RE based plant it should take care in mind for further capacity expansion of these power plants.
- .For RPO compliance from other sources i.e. Biomass, Bagasse, MSW, etc. Can be compensated by Solar RPO or Wind RPO due to non-availability.
- Penalty charged every year by OERC at forbearance price (Solar RECs-Rs.5800, Non-Solar RECs- Rs 3300).Hence it is better to install its own power plant or purchase electricity from RE generator. Otherwise it can also purchase some quantities of RECs and the remaining can be fulfilled by the other ways.

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Appendix

REC Calculation:-

REC Purchase			
Particular		REC Cost in Cr. Rs.	
		At Floor Price	At Forbearance Price
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Unit rate			2.5
Revenue (Cr. Rs.)			26.50
O&M Expenses (Cr. Rs.)			8
Net Cost per Year			31.90
	Solar	Wind	
Cost of Generation per unit	7.22	5.32	Rs. / Kwh
Coal Plant + REC cost per unit	5.5 - 7.8	3.5 - 5.3	

Coal Plant unit cost	2	2	
Floor Price (REC)	3.5	1.5	
	5.50	3.5	
Coal Plant unit cost	2	2	
Forbearance price (REC)	5.8	3.3	
	7.8	5.3	