PREPARING INCENTIVE STRUCTURE FOR STATES FOR FULFILLING RENEWABLE PURCHASE OBLIGATION TARGETS

FINAL REPORT

Prepared for:

FORUM OF REGULATORS

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ABBREVIATIONS

AD	Accelerated Depreciation
APPC	Average Power Purchase cost
CCGT	Combined Cycle Gas Turbine
CERC	Central Electricity Regulatory Commission
CUF	Capacity Utilization Factor
C-WET	Centre for Wind Energy Technology
EA 2003	Electricity Act 2003
EU	European Union
FiT	Feed in Tariff
GBI	Generation Based Incentive
GHG	Green House Gas
GoI	Government of India
IEGC	Indian Electricity Grid Code
IPPC	Incremental Power Purchase Cost
IREDA	Indian Renewable Energy Development Agency
ISTS	Inter State Transmission System
JCC	Japan Customs-cleared Crude
JNNSM	Jawaharlal Nehru National Solar Mission
LBNL	Lawrence Berkeley National Laboratory
MNRE	Ministry of New & Renewable Energy
MW	Megawatt
NAPCC	National Action Plan on Climate Change
NCEF	National Clean Energy Fund
PoC	Point of Connection
PPA	Power Purchase Agreement
RE	Renewable Energy
REC	Renewable Energy Certificate
RET	Renewable Energy Technology
RLDC	Regional Load Dispatch Centre
ROE	Return on Equity
RPO	Renewable Purchase Obligation
SERC	State Electricity Regulatory Commission
SLDC	State Load Dispatch Centre
STU	State Transmission Utility
UI	Unscheduled Interchange

1. BACKGROUND AND CONTEXT OF THE STUDY

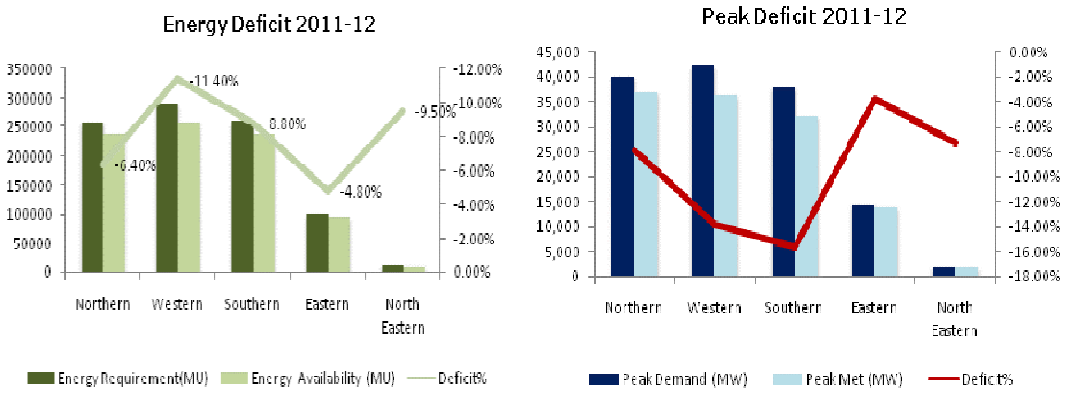
1.1. INTRODUCTION

The world today fulfils its energy requirements through a wide array of energy sources. Fossil fuels continue to remain the dominant sources of energy. This is because they are relatively inexpensive and conveniently available, are energy rich, and the global infrastructure today is well positioned to use them.

Nonetheless, there remain concerns over the possible long-term supply constraints of conventional oil & gas and coal supplies, the geographical distribution of these resources, and the increasing urgency to assuage the green house gas (GHG) emissions. Thus, it is important to explore and understand the various other viable alternatives to conventional energy.

Inspite of significant conventional power capacity addition in India in the XIth plan (2007-12), the gap between demand and supply continued to exist strongly, as is apparent from the charts below.

Figure 1: Energy deficit and peak deficit in 2011-12



Source: Central Electricity Authority Power Supply position 2011

Future demand projections (as per the 18th Electric Power Survey published by the Central Electricity Authority) show a consistent growth in power demand during the XIIth plan.

Table 1: Demand growth projections from 2012 to 2017 as per 18th EPS (billion units)

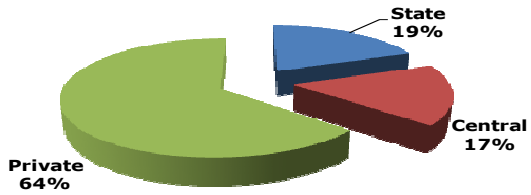
Region	2011-12	2016-17	CAGR (%)	Overall Growth (%)
Northern	276	415	8.5%	50.2%
Western	272	390	7.5%	43.5%
Southern	253	364	7.5%	43.9%
Eastern	106	163	9.0%	53.9%
North Eastern	11	16	7.7%	44.7%
All India	918	1349	8.0%	46.9%

Source: 18th Electric Power Survey, Central Electricity Authority

To meet the above projected energy demand, the Government of India (GoI) has announced a conventional power capacity addition target of 75,785 megawatt (MW) in the XIIth plan, of which 62,695 MW[1] is coal-based capacity. Figure 1 indicates the break-up of the capacity addition expected by the various sectors.

[1] The 62,695 MW coal-based capacity for the XIIth plan considered in this report is based on figures recently announced by the Government of India. This excludes several other plants which are already at an advanced stage of planning and are likely to be commissioned within the XIIth plan period.

Figure 2: Capacity contribution by various sectors to XIIth plan capacity addition



The coal-based capacity envisaged for the XIIth plan will require an additional 344 million tonnes (MT) of coal, besides the requirement from the existing generating stations (~512 MT), thus taking the total coal requirement to a level of 855 MT by the end of the XIIth plan.

This is a very significant challenge. Our research indicates that production of domestic coal has been insufficient even for the existing plants and incrementally, cannot cater to more than 5-6 gigawatt (GW) per year. Even with blending (which is constrained by technical factors), a large part of the capacity is likely to be stranded, even if built. In all, about 17 GW of coal-based capacity (constructed or under construction) faces the prospect of being stranded. In addition, about 10 GW of gas-based capacity also faces stranding. New capacity based on coal (other than those in the construction pipeline) is unlikely to materialize on the desired scale.

The gap between requirements and likely achievements (or availability after fuel constraints are reflected) sets the stage for other available options. **Renewable energy (RE) has the ability to fill a significant part of the anticipated shortfall.**

Today, India is fast becoming one of the world's most attractive markets for RE investments. India's rise has been due to the effective policy and regulatory support for development of Renewable Energy Technologies (RETs). Various policy measures such as the Jawaharlal Nehru National Solar Mission (JNNSM), feed-in-tariff, accelerated depreciation (AD), generation-based incentives (GBI), renewable purchase obligations (RPO), and renewable energy certificates (RECs) have helped in the rapid growth of RE deployment in the country.

As a result, the country's RE sector has registered a significant growth in the last four years. Year-on-year RE capacity addition has increased from 200 MW- 300 MW in the early 2000s to 2,000MW-3,000MW or more in the last four years.

However, a significant part of the total RE potential is yet to be utilized. A comparison of the wind energy potential at the national level indicated through various studies is shown below.

Table 2: National/state level wind energy potential

Study /source	Potential indicated
MNRE (CWET) – National	102 GW
LBNL - National	219 GW, revised subsequently to 2006 GW–3121 GW at 80 to 120 m hub heights
TERI – Gujarat	304 GW (non-crop land) and 858 GW (only crop land)
WISE – Tamil Nadu	69 GW (80 m hub height) 113 GW (100 m hub height) 169 GW (120 m hub height)

According to Central Electricity Authority (CEA) statistics, only 18,191 MW of wind energy capacity has been commissioned till September 30, 2012. Hence, there is a large potential for development. Similarly in solar energy, the current capacity is only a small fraction of the overall potential in the country.

Even as various studies have indicated significant renewable energy potential and also investor interest, the constraints to renewable energy development are significant. These include supply side

constraints relating to land acquisition, time take in obtaining clearances, access to infrastructure, manufacturing capabilities, logistics, and also commercial constraints that limit the realisable potential. Issues related to availability of balancing energy, commercial arrangements for settlement, and so on also serve as limiting factors. On the demand side, the potential constraints are largely related to the need for electricity and the ability to pay for renewable energy generation. Supply side aspects can be addressed principally through policy and regulation while demand pull can be provided through RPO enforcement and the right kind of incentives.

1.2. 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 emphasizes market expansion by renewables 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 Act, states, over a period of time, have formulated RPOs. Consequent to the National Electricity Policy, 2005 (NEP) and JNNSM 2009, most states have also formulated Solar Purchase Obligations (SPO). Incentives for generation are now less emphasized by GoI policy, and large-scale market creation through RPO/SPO is encouraged. Regulation has created a pan-India market for renewables through the REC trading mechanism to bridge the gulf between RE resource deficit and resource rich states. This trading mechanism is now in operation for more than a year.

The formulation of RPO/SPO has created a new market framework for RE. However, the new market faces several transition challenges that arise due to the relatively higher cost of renewables, variability of generation requiring significant operational flexibility in utilities, transmission availability, and costs. The REC market, while providing a novel platform for propagating RE projects, faces its own challenges in terms of economics of procurement of the RECs by the obligated entities.

The Forum of Regulators (FOR) has been taking steps towards ensuring that provisions in the Electricity Act and policies are properly implemented. Pursuant to the provisions of the Act, the tariff policy stipulates that the appropriate commission shall fix minimum percentage of purchase of power from renewable sources taking into account the availability of renewable sources in the region and its impact on retail tariff. Accordingly, various state electricity regulatory commissions (SERCs) have specified RPO for their licensee distribution companies that vary from state to state.

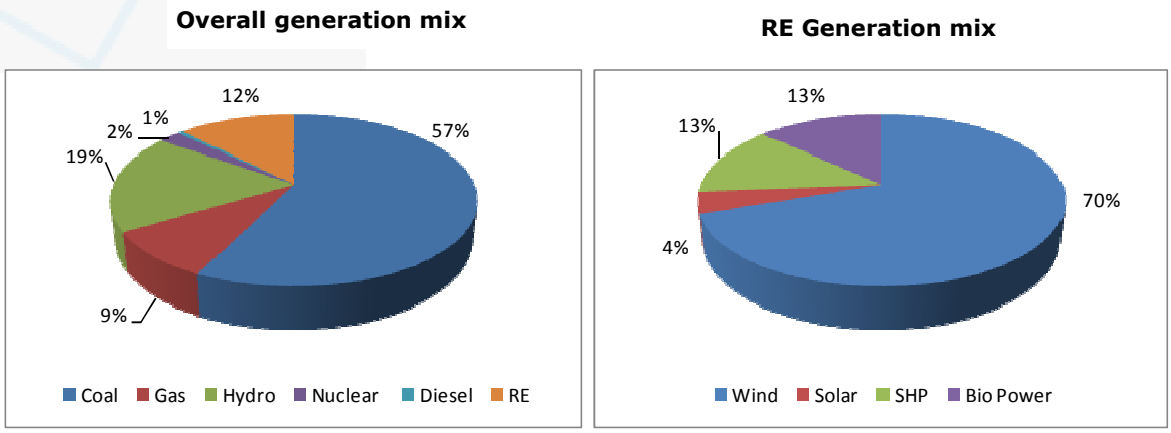
However, most of the states are reluctant to fulfill their RPO target and go beyond it due to the extra cost incurred for procuring balancing power due to the variable nature of RE sources, cost associated with transmission infrastructure development, and the higher perceived cost of buying renewable power. Clearly, the nascent market needs some transition support to address the implementation issues that a new market inevitably faces. For this purpose, FOR has appointed AF-Mercados Energy Markets India Private Limited to study these issues and propose an incentive framework for both resource rich and resource deficient states to encourage RPO compliance. Our study evaluates various incentive structures and options.

2. ASSESSMENT OF CURRENT RENEWABLE ENERGY DEPLOYMENT

2.1. CURRENT STATUS OF RE DEVELOPMENT

The total installed capacity of power generation projects in India (as on November 30, 2012) was 2, 10,937 MW, of which 67% is contributed by thermal power (which includes coal, gas, and diesel). Renewables contribute about 12% (~25,856 MW), as shown in the figure below.

Figure 3: Generation mix



Source: CEA (as on November 30, 2012)

A snapshot of the current development trends of the various RE resources has been given below.

Wind (73%): Wind power contributes to 70% of the total RE installed capacity. The wind sector has received continuous state and central government support in the form of preferential feed-in-tariff, accelerated depreciation, GBI, RPOs, and so on. . Wind turbine technology is well commercialised. The equipment manufacturing of wind turbines has many players in India such as Enercon, Suzlon, Gamesa, Vestas, Shriram EPC, and Regen Powertech that manufacture turbines with capacity ranging from 250 kilowatt (KW) to 2.1 MW.

Solar (4%): Solar power in India has received a huge boost with the JNNSM. This has resulted in a total solar installed capacity of ~1,045 MW[2] (as on September 30, 2012) from two batches of competitive procurement of solar-based power by NTPC Vidyut Vitran Nigam (NVVN) and through state policies. Other factors that have contributed are semiconductor policy, solar special economic zone (SEZ), separate RPO for solar, feed-in-tariff, and so on. Some of the barriers to the development of solar energy are development of an evacuation system, land acquisition, bankable Power Purchase Agreement (PPA), and lack of reliable solar data.

Small hydro (14%): Small hydro power (SHP) is a well-established and commercialised technology and has a low running cost. However, development has been relatively slow because of difficulty in acquiring land as these projects are usually located in hilly areas. In addition to this, forest clearance procedures, lack of clear policy for private sector participation in some states, and delay in getting project clearances has been responsible for slow growth.

Biomass and bagasse-based co-generation (13%): Even though biomass generation has the highest plant load factor (PLF) amongst all RE technologies, barriers such as increased use of biomass by other industries, seasonal availability of biomass, reduction in cultivable agriculture land, loss of moisture due to poor storage facility, absence of well-defined supply contracts, and high biomass price present a challenge.

Even though most of the states have declared both solar and non-solar targets through state RPO regulations, many states have not complied with these targets. Resource-rich states such as Tamil Nadu, Gujarat, and Maharashtra have exceeded their RPO targets while resource-deficient states are yet to catch up with targeted RPO levels.

[2] Source: MNRE

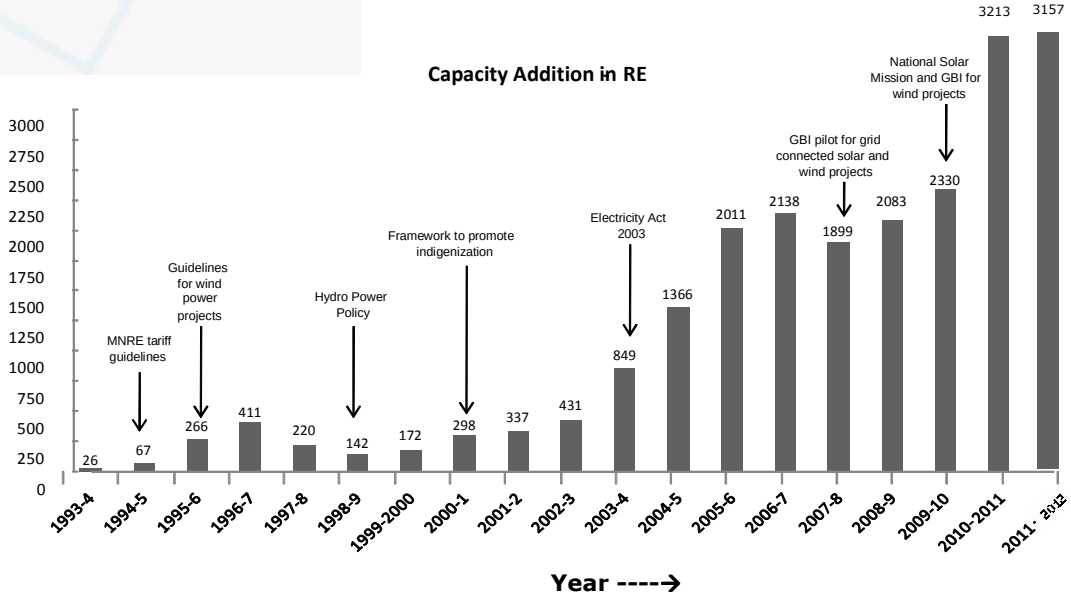
2.2. GROWTH TRENDS

In order to meet the demand supply gap and reduce reliance on conventional fossil fuel based power generation, the GoI has introduced several policies to increase renewable energy capacity addition.

Also, to provide demand side push, EA 2003 requires states to specify, for purchase of electricity from renewable sources, a percentage of the total consumption of electricity in the area of a distribution licensee[3]. Consequently, RECs have been introduced to enable resource poor states to comply with their RPO targets.

The following chart shows the historical growth of RE (including wind, biomass, co-gen and SHP) since 1993-94 till 2011-12.

Figure 4: Historical growth in grid-based renewable energy in India



As can be seen from the table below, the renewable energy sector has been growing at a healthy rate. RE capacity addition during the 10th plan itself was nearly twice the cumulative capacity added till 9th Five year plan. As it is evident from the table below, ***capacity addition till January 31, 2012 surpassed the target set for 11th plan.***

Table 3: MNRE capacity addition target and achievement

		Capacity Addition				
Resource	**Potential (MW)**	**Upto 9th plan - Achievement**	**During 10th plan - Achievement**	**Target for 11th Plan**	**Achievement during 11th plan**	**Cumulative achievement upto 31.01.2012**
Wind Power	48,500	1,667	5,427	9,000	9,085	16,179
SHP	15,000	1,438	538	1,400	1,324	3,300
Bio-Power*	23,700	390	795	1,780	1,985	3,170
Solar Power	20-30MW/Km^2	2	1	50	481	482
Total		**3,497**	**6,761**	**12,230**	**12,871**	**23,129**

**Bio-power includes biomass power, bagasse cogeneration, urban & industrial waste to energy*

Source: MNRE Annual Report 2010-11

The above growth trend indicates the scope for large scale RE development. However, in energy terms, the contribution has been relatively low at about 4%-5% for 2011-12.

[3] Section 86 (1) (e) of Electricity Act, 2003

According to Working Group Report on New and Renewable Energy for the XIIth plan, the GoI is also considering very aggressive plans to add about 6,000MW (on average) of RE capacity on an annual basis during the plan period.

Table 4: MNRE capacity addition plans

Resource	2012-13	2013-14	2014-15	2015-16	2016-17	Total 12th Plan
Wind	2,500	2,750	3,000	3,250	3,500	15,000
Solar	1,000	1,000	2,000	2,500	3,500	10,000
Biomass	350	625	825	950	1,300	4,050
SHP	350	400	400	450	500	2,100
Waste-to-energy	40	60	100	100	200	500
Tidal/Geothermal	1	2	3	4	4	14
Total	**4,241**	**4,837**	**6,328**	**7,254**	**9,004**	**31,664**

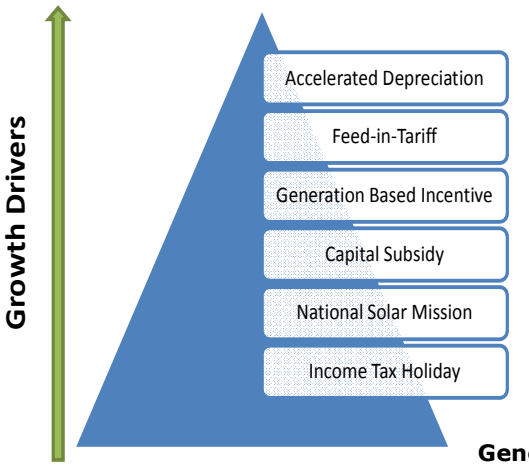
Source: Working Group Report on New and Renewable Energy for the 12th plan

To be able to fulfill such target capacity addition, the barriers associated with RE deployment needs to be removed and issues associated with large scale integration of renewable energy also needs to be handled.

2.3. DRIVERS OF GROWTH

The growth of RE in India has been catalysed by several Acts[4], policies and institutional measures that have been implemented over the past few years especially post EA 2003.

Figure 5 : Growth drivers



The following are major drivers of growth of renewable energy in India.

Accelerated Depreciation: The GoI allowed renewable energy based power producers to claim accelerated depreciation (AD) at the rate of up to 80% in the first year on a written-down value (WDV) basis under Section 32, Rule 5 of the Income Tax Act. This was the most significant driver of renewable energy capacity addition in the past. However, this has resulted, to some extent, in mushrooming of players with the purpose of off-setting income from other business to claim tax benefits rather than actual production of electricity. However, AD for wind power projects has been withdrawn recently to attract attention from more serious players for development of Renewable Energy.

Generation based incentives: The GoI along with Indian Renewable Energy Development Agency (IREDA) as the nodal agency, had introduced a scheme for grid interactive wind power projects which provided an incentive of Rs 0.50 per kilowatt-hour (kWh), with a cap of Rs. 15 lakh per MW per year, totalling Rs. 62.5 lakh per MW to be availed for a minimum of four years and maximum of 10 years. The scheme was however limited to a capacity of first 4,000 MW commissioned through GBI on or before 31 March, 2013. Recently the central government withdrew AD benefit for wind projects. This has slowed down wind energy capacity addition by almost 50% on year-on-year basis. However, there is a possibility of reinstatement of GBI to attract investments in wind sector.

Subsidy in equipment imports: Some technologies like small hydro, biomass and solar PV (off-grid) systems are provided support through capital subsidy based on installed capacity. For example, Ministry of New and Renewable Energy (MNRE) provides a capital subsidy of 30% for off-grid and decentralized solar photovoltaic (SPV) applications.

[4] Details of Acts/policies given in Annexure 1

National Solar Mission: The Mission has set an overall target of 20,000 MW in three phases: first phase up to 2012/13, second phase from 2013 to 2017, and the third phase from 2017 to 2022. The mission targets capacity of grid-connected solar power generation to 1,000 MW by 2013 and 4,000 MW by 2017. It is further envisioned that the solar capacity addition could reach 10,000 MW by 2017 and 20,000 MW by 2022. JNNSM targets, including grid connected, off-grid application and for solar collectors, are provided in the table below.

Table 5: JNNSM targets

S.No.	Application segment	Targets		
		Phase-1 (2010-13)	Phase-2 (2013-17)	Phase-3 (2017-22)
1	Utility grid power, including roof top	1,000-2,000 MW	4,000-10,000 MW	20,000 MW
2	Off grid solar applications	200 MW	1,000 MW	2,000 MW
3	Solar collectors	7 million m^2	15 million m^2	20 million m^2

Income Tax Holiday: Section 80 IA of the Income Tax Act offers a 10-year consecutive tax holiday period within a block of first 15 years during the life cycle of all infrastructure projects which also includes renewable energy power generation projects.

Feed-in-tariff: Central and state electricity regulatory commissions (CERCs and SERCs) have notified wind-specific feed-in-tariff for electricity generated from wind. Also, state-specific tariff for solar energy in states such as Rajasthan, Gujarat, Madhya Pradesh, and Karnataka have been announced. Such preferential tariffs have provided attractive returns to investors leading them to set up projects in various states.

All the above policy measures that have been largely driven by fiscal incentives and subsidies have resulted in growth of RE supply. However, such measures do not help in large scale development of RE.

For development of renewable energy markets it is important to create demand pull as well which will result in better pricing of power from RE. Hence, market creation remains the overwhelming emphasis of the policy makers. In this regard, mechanisms such as Renewable Purchase Obligation (RPO) and Renewable Energy Certificates (REC) have been introduced through policies and regulations.

Renewable Purchase Obligation: Section 86 (1) (e) of Electricity Act requires SERCs to determine and implement RPOs. Subsequent to the Electricity Act (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 Solar Mission requires SERCs to set solar RPO targets starting from 0.25% by 2012-13 to 3% by 2022.

A number of states have specified solar and non-solar RPO for their distribution licensees and have also notified regulations or orders pertaining to determination of tariff for RE sources.

Renewable Energy Certificates : There are two routes that can be taken for fulfilment of RPO.

- Feed-in-tariff route, and
- REC route

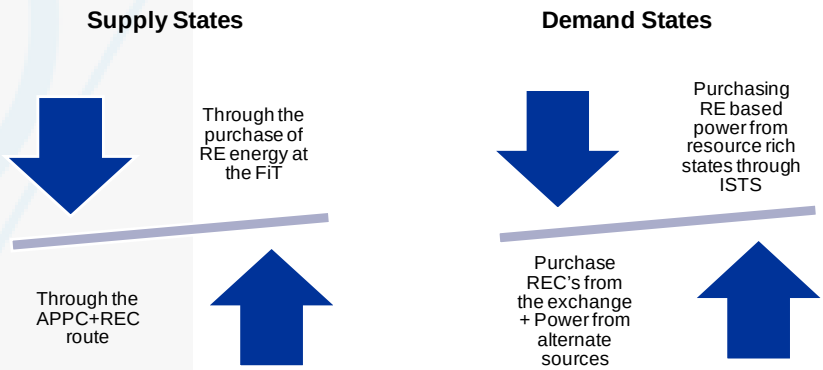
Under the FiT route, RPO obligation is satisfied through purchase of electricity at FiT. Under REC framework, obligated entities can fulfil their RPO by purchasing RECs through the power exchange.

For the purpose of this study, all states in the country have been divided into resource rich and resource deficient states according to the availability of renewable energy resource in these states. Resource rich states are the renewable energy resource rich states, whereas resource deficient states are the renewable energy resource deficient states.

These states have been differentiated based on the potential of renewable energy in the state. States with RE potential of more than 1,500 MW have been categorized under resource rich states and states with less than 1,500 MW of RE potential have been classified under resource deficient states.

The different options available to resource rich and resource deficient states for meeting their respective RPO targets have been indicated in the figure below.

Figure 6: Resource rich and resource deficient states



RPO and REC mechanism have resulted in the creation of markets for trading of certificates. As can be seen below, RECs trading on the exchange has increased considerably since its inception in March 2011. However, the size of the REC market is still very small.

Table 6: REC (includes solar and non-solar) issued and redeemed

Month, Year	REC Issued	REC Redeemed
Dec, 2011	88,055	111,621
Jan, 2012	102,348	171,524
Feb, 2012	200,736	206,188
Mar, 2012	203,819	199,737
Apr, 2012	122,369	71,226
May, 2012	230,697	168,685
June, 2012	259,125	236,827
Jul, 2012	382,712	158,399
Aug, 2012	474,784	274,272
Sep, 2012	569,567	265,606
Oct, 2012	621,358	224,491
Nov,2012	394,088	133,571
Total	**3,649,658**	**2,222,147**

Source: recregistryindia.in

REC market presently contributes to about 0.5% of India's overall electricity basket and about 10% of RE-based electricity generation that is very significant. However, as the penetration of RE increases, RPO compliance in general will face a greater challenge which needs to be overcome. The following chapter discusses the barriers to RE deployment and RPO compliance.

3. BARRIERS IN RE DEPLOYMENT AND RPO COMPLIANCE

The need for enacting policies to support growth and development of renewable energy is often attributed to a variety of barriers that prevent investments in such technologies. These barriers lead to renewable energy being subject to an economic, regulatory, or institutional disadvantage relative to other forms of energy supply.

Such barriers include, but are not limited to, transmission constraints for evacuation of renewable power, large gestation period for getting approvals and clearances, concentration of supply in few pockets, infirm and seasonal nature of the resource, higher initial capital costs, imperfect resource assessment, imperfect markets, technology prejudice, poor credit health of the utilities, financing risks, and a variety of regulatory and institutional factors.

3.1. BARRIERS TO RE DEPLOYMENT

Various forms of renewable energy demonstrate different characteristics, which make it imperative to design the policy, regulatory, and commercial framework around these characteristics. The technical approaches to support renewable energy technologies (RETs) also need to be aligned to the nature of the resource, and the barriers encountered in the deployment of these resources. The following table identifies some of the barriers that affect the large-scale deployment of the key RETs in India.

Table 7: Barriers affecting large-scale deployment of renewable energy

Parameter	Wind	Solar	SHP	Biomass
Transmission constraints	XXX	X	X	-
Supply concentration	X	X	X	-
Infirm nature	XXX	X	X	-
Seasonal	X	-	X	-
Access to site	X	-	X	-
Logistics	X	-	-	-
Clearances	X	-	-	-
Resource quality and reliability	X	X	X	XXX
Cost of power delivered	-	XX	-	X
Improper resource utilization	XX	-	-	X

Note – "XXX" denotes a very significant barrier, "X" indicates lesser barriers. Depending on the developments on technology and policy, these barriers evolve over time.

- **Transmission constraints:** Most of the renewable energy generation facilities are located at remote locations far away from load centres. Further, grid infrastructure is insufficient at most places to transport the renewable power (especially wind power since they are of relatively higher capacity) to the load centres as state utilities are unwilling to create sufficient infrastructure for variable power. *Hence, construction of new intra state and interstate transmission network is critical to meet the needs of large scale renewable energy deployment.*

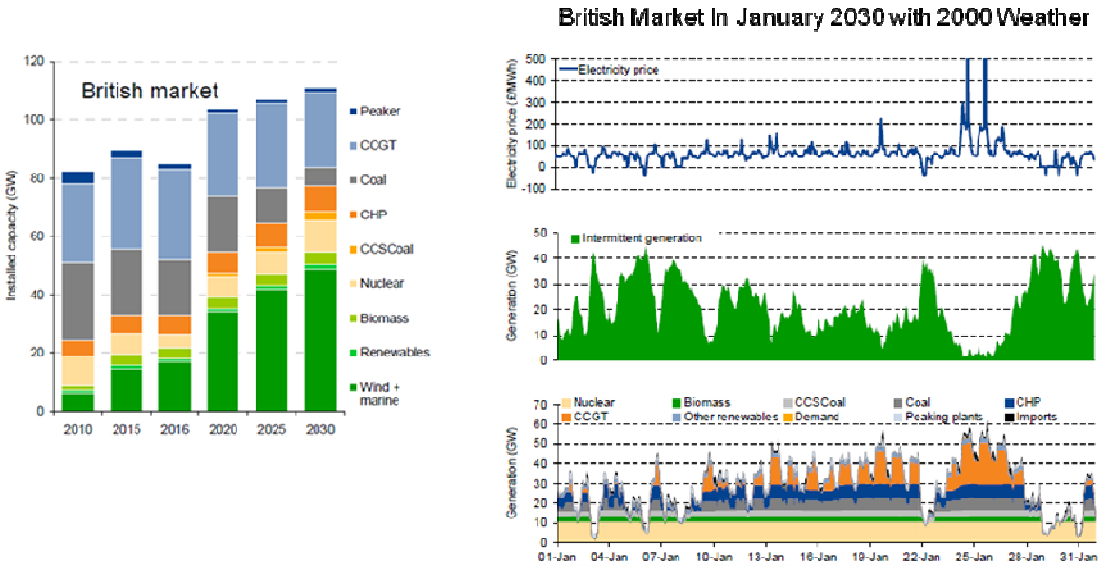
- **Supply concentration:** Renewable energy is mainly concentrated in a few states, and within the state, is confined to a few generation pockets. Geographical distribution of wind farms, which are not pooled, into several pockets results in greater variability of resource which causes problems in integrating renewable energy in the grid. For instance, wind power is

primarily confined to the states of Karnataka, Gujarat, Maharashtra, Tamil Nadu, and Andhra Pradesh. In Tamil Nadu, it is concentrated in the regions of Coimbatore, Thirunelveli, Theni, and Ramanathapuram. Solar resource is mainly present in states of Rajasthan and Gujarat. Due to supply concentration, there *arises need, depending upon demand-supply scenario, for strengthening/developing intra-state (if power can be consumed within the state) and inter-state network (if power cannot be consumed within the state)*.

- **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, that is, 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.* Lower generation may cause instability in the grid by lowering the frequency and hence may result in higher spot price.

The following graphs illustrate this point in the context of a simulation undertaken on the British wind market where, large scale ingress of variable renewable energy (VRE) is anticipated in the next two decades based on the EU objectives of renewable energy and energy efficiency.

Figure 7: Impact of intermittent resources: simulations from the British market



Source: Impact of Intermittency (Poyry 2009)

The above charts illustrate that the variable nature of the energy will cause rapid fluctuations of supply in the markets, causing widespread needs for "cycling" other resources, including Coal, CCGT, and at times nuclear energy. It will also cause sharp spikes in power market prices. The simulations show that to accommodate large-scale VRE, the following are necessary.

a. A strong transmission framework
b. Robust balancing arrangements (including pumped storage and open cycle gas)
c. Strong commercial arrangements to prevent price spikes and uncertainty

However, seasonality in RE per-se is not a serious issue from a system management perspective as high and low wind seasons in a state are known in advance, and demand and dispatch can be planned accordingly.

- **Access to site and logistics:** Access to site and logistics is a significant challenge. However, these issues are taken care of in the market mostly by the equipment suppliers. For example, most of the wind farm developers address such issues by developing approach roads to transport wind equipments to remote locations, (during the construction period) and entering into shared services agreement with the power producer for the maintenance of the shared infrastructure during the operation of the wind farm.

- **Clearances:** Getting clearances such as, but not limited to, evacuation approval, Airports Authority of India (AAI) approval, capacity allocation approval are typically handled by the equipment suppliers. However, getting *forest clearance is a major deterrent in wind power development* as majority of good sites are located in remote locations with some amount of forest cover. Getting forest clearance is a very time-consuming, two-stage process – Stage 1 forest clearance (at state government level) and Stage 2 forest clearance (at central government level, MoEF) – as it requires several government approvals and may take anything between 6 months -15 months, or even more.

- **Resource availability and reliability:** In case of biomass, *resource availability poses a serious concern as only the balance biomass after agricultural use is available as fuel for power plants*. In wind, reliability of the resource has been an issue with the developers since *wind resource forecasting is a complex issue* as it is location, and terrain dependent.

- **Cost of power:** Initially, high cost of renewable power was considered a deterrent to the development of renewable energy. However, with growth in installed capacity and market development, the prices have reduced significantly. Solar PV project cost has come down from Rs. 18-20 crore/MW to ~ Rs 10 crore/MW while wind project cost has come down to ~Rs 5.8-6.0 crore/MW, which is not significantly higher than thermal plant cost of Rs 5.1-Rs 5.4 crore/MW. However, solar power still is relatively costlier than other sources of power. However, with competitive bidding under JNNSM, the tariffs have reduced considerably in the range of Rs 7.5/unit to Rs 8.5/unit. Tariffs associated with these levels of project cost are enough to enable investors earn a Return on Equity (RoE) of ~15%-16% to sell power at competitive rates. However, *with advancements in technology, these costs may come down further.*

- **Improper resource utilization:** Efficient resource utilization is an issue mainly in wind power. For instance, in India, most of the wind resource assessment has used meteorological masts of up to 50 m height. These heights are suitable for sub-megawatt range turbines. As a first step in realizing wind potential, *improved wind assessment needs to be carried out at heights more than 100 m which would act as the basis for determination of suitable turbine size* and design for optimum resource utilization.

- **Off-taker credit status:** The mismatch between power tariffs and the cost of generating electricity, and huge amount of cross-subsidy to agriculture at the cost of commercial and industrial consumers, is hurting the financial health of power distribution companies. Estimates show that electricity distribution losses touched about Rs 70,000 crore in 2010-11. Also, the *belief that renewable power is costlier than conventional thermal power and the fact that it is infirm in nature also acts as an impediment* in the Discom's acceptance to buy such variable power.

3.2. ISSUES FOR RPO COMPLIANCE

Based on the current status of RPO compliance, and our discussions with key stakeholders and experts, the following issues emerge that act as roadblock for RPO compliance by obligated entities.

- **Under achievement of RPO targets**: Most of the states have come up with RPO targets for solar and non-solar RPO.
  - **Resource-rich states** such as Tamil Nadu, Karnataka, and Gujarat have almost fulfilled their non-solar RPO obligations. **Resource-deficient states** like Delhi, Haryana, Bihar, Madhya Pradesh, Punjab Orissa, Uttar Pradesh, and West Bengal have not been able to achieve their RPO targets.
  - None of the states (except Gujarat and Rajasthan) have been able to meet solar RPO even though solar capacity reached 1,045 MW by 31 September, 2012. Also, there is no clear RPO trajectory with states following varying level of RPO trajectory.

  Hence, despite existence of mechanism such as REC, resource-deficient states have set a relatively lower RPO targets and have not been able to achieve their targets. This indicates that the concept is not attractive enough in its current form or has not been appreciated by the implementing authorities.

- **Lack of enforcement:** As per regulations in most states, **i**f the obligated entity does not fulfil the RPO during any year, the Commission may direct the obligated entity to deposit into a separate fund (created and maintained by the state agency) an amount on the basis of the shortfall in units of RPO and the forbearance price. However, enforcement of these provisions is weak.

- **Restricted market forces:** Current REC regulation allows only for generating company to register for RECs. It doesn't allow REC for sale of power to traders, through bilateral contract or for off-grid applications. These may restrict the growth of REC market and hence RPO compliance.

- **No incentivization for RPO compliance:** On account of infirm nature, resource-rich states will need to incur additional cost for balancing power and transmission infrastructure to be able to absorb power generated from RE. There is little or no recognition of such costs.

The states – both resource rich and resource deficient– do not have any incentive structure in place for RPO compliance. In light of poor financial health of state utilities, resource-rich states do not have any incentive to fulfil their own RPO and help resource-deficient states in fulfilling their RPO compliance. Also, resource-deficient states do not have any incentive to fulfil their RPO as RE is perceived to be costly source of power.

Therefore, to encourage states to promote RE generation in order to achieve the NAPCC target of 15% by 2020, an incentive scheme (monetary incentive and potential policy interventions) to encourage states for higher RPO and procurement of RE through open access and/or purchase of REC is required.

To arrive at incentivisation needs, greater understanding of true cost of RPO compliance is needed. The following section makes an assessment of the same.

3.3. ASSESSMENT OF LIKELY RPO ACHIEVEMENT

The NAPCC and tariff policy have set non-solar and solar RPO target respectively at national level. Hence, there is a need to assess whether the proposed renewable energy capacity development based on assessed potential is sufficient for achieving the set RPO target. This will also act as an indicator for the growth potential of REC market provided the economic, institutional, and commercial issues around development of REC market are addressed.

Since the distribution of renewable energy resource is not uniform in the country, separate analysis is done for resource rich and resource deficient states for assessing the sufficiency of renewable generation to meet RPO targets. Also, as there are varying estimates of resource potential, the analysis has been carried out for two scenarios of RE potential.

Methodology

For carrying out the analysis for assessing RPO achievement under MNRE-assessed potential case and Lawrence Berkeley National Laboratory (LBNL)-assessed potential case, the following steps are followed.

i. Future renewable energy capacity addition is assessed based on logistic curves[5] and corresponding generation is arrived at by using technology-wise CUF provided by CERC.

ii. Electricity demand is projected using 18th EPS data and state-specific RPO is applied on the demand to arrive at the units required for RPO compliance.

   a. RPO levels applied on projected demand are based on NAPCC target and an alternative case where RPO of 10% by 2016-17 has been considered.

iii. This is then compared with the renewable energy generation available (computed in step i) to assess the level of RPO compliance/non-compliance in the projected period.

3.3.1. RESOURCE RICH STATES

For assessing the RPO compliance in the projected period (till 2016-17)[6], two supply scenarios and two demand scenarios have been considered.

I. Supply scenarios

Two supply scenarios have been considered for likely RE capacity addition.

- MNRE-assessed potential of RE, and
- LBNL-assessed potential of wind. For this case, assessed potential for biomass/co-gen and SHP is considered same as that for MNRE case as the LBNL-assessed potential includes only wind.

II. Demand scenarios

Two demand scenarios have been considered.

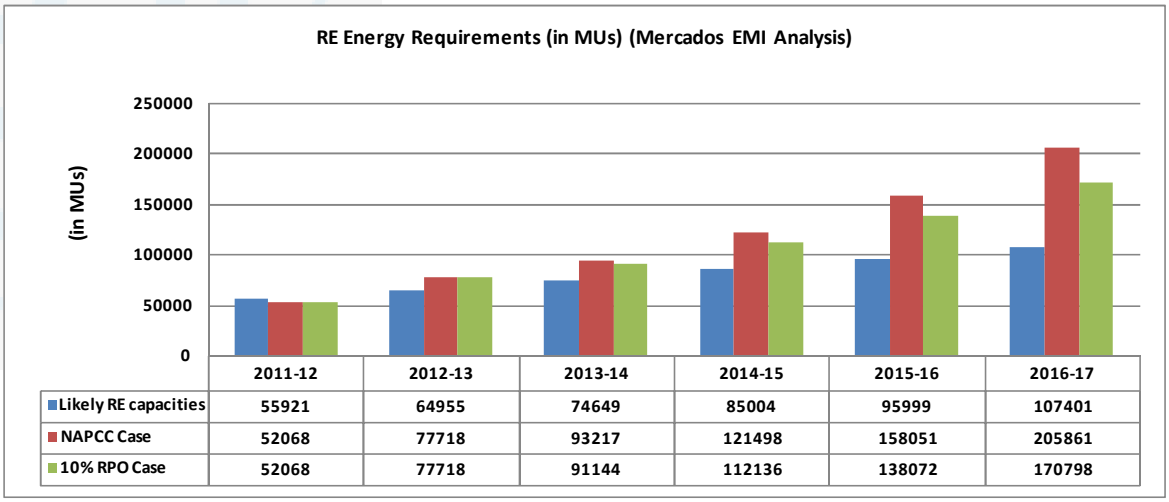
- **NAPCC case:** The NAPCC has fixed the national RPO target of 5% by 2009-10, which is to be increased by 1% every year till 2019-20.
- **Alternate case:** A conservative alternate case has been considered where RPO of 10% by 2016-17 (end of 12th Plan) has been considered.

The following graph illustrates the projected supply-demand gap (based on the methodology discussed above) for the MNRE-assessed potential.

[5] Logistic curve explained in Annexure 2

[6] The requirement of the study is till 2016-17

Figure 8: Comparison between RE supply and RPO requirement for the resource rich states (MNRE case)



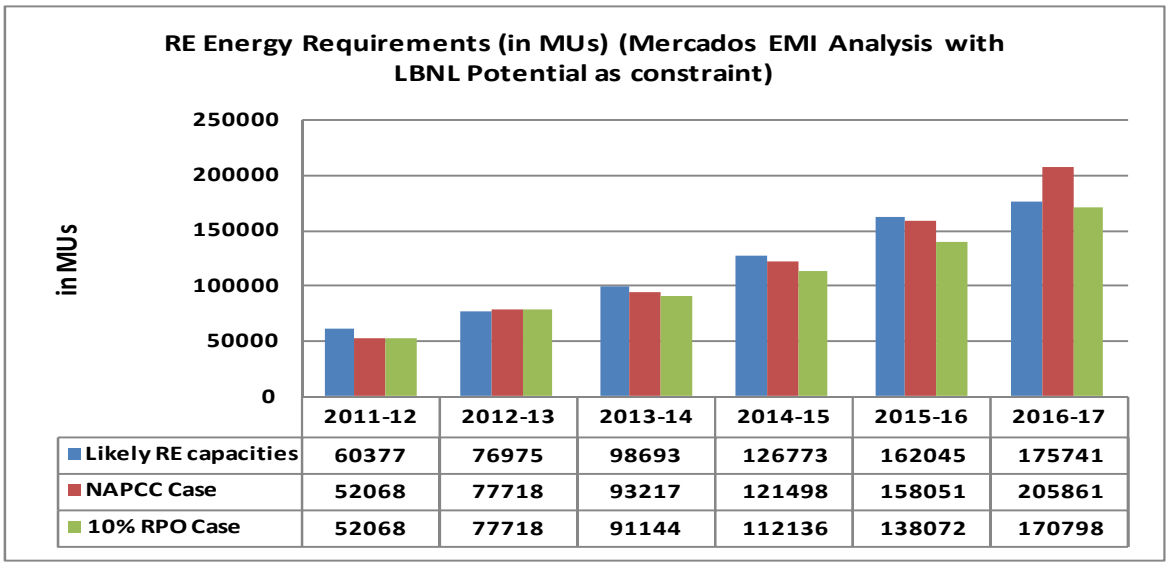
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Likely RE capacities	55921	64955	74649	85004	95999	107401
NAPCC Case	52068	77718	93217	121498	158051	205861
10% RPO Case	52068	77718	91144	112136	138072	170798

Source: AF-Mercados EMI analysis

It can be observed from the above chart that if the RE potential is limited to the MNRE-assessed potential, it will be difficult to meet RPO targets in coming years in either of the cases – NAPCC case or the alternate case, due to resource potential limitations.

The following graph illustrates the projected supply-demand gap (based on the methodology discussed above) for the LBNL assessed potential.

Figure 9: Comparison between RE supply and RPO requirement for resource rich states (LBNL case)



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Likely RE capacities	60377	76975	98693	126773	162045	175741
NAPCC Case	52068	77718	93217	121498	158051	205861
10% RPO Case	52068	77718	91144	112136	138072	170798

Source: AF-Mercados EMI analysis

It can be observed from above chart that if the RE potential is limited to LBNL's original estimates of wind[7] potential then, for the NAPCC case, the RPO targets can be met till the year 2015-16. However, in the alternate case, the supply of RE will be sufficient for states to meet their RPO by the end of 12th plan period.

As has been mentioned earlier in this report, since the alternate studies on wind indicate a very large potential (with similar high levels of potential forecast for solar), resource

[7] It needs to be noted that subsequent studies by LBNL and other agencies have indicated an even higher potential than the original estimates. This reinforces the fact that the resource availability is not a constraint if these estimates of potential are considered.

availability is unlikely to pose a constraint for the achievement of targets under the NAPCC case or the alternate case. Hence the limitations would be more in terms of infrastructure or commercial issues, and on account of resource potential.

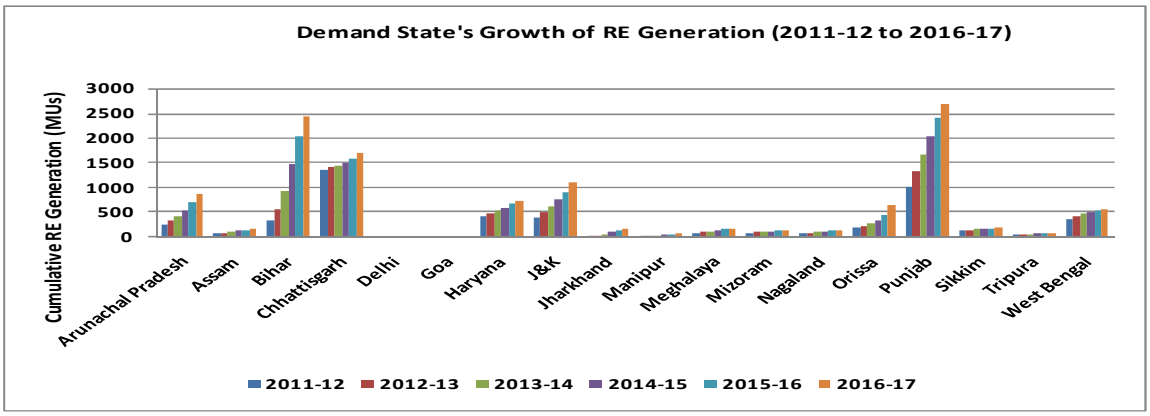
3.3.2. RESOURCE DEFICIENT STATES

For resource-deficient states, RE supply has been arrived at based on MNRE-assessed potential using the methodology explained earlier in the section.

The resource-deficient states comprise a mix of states which have some RE potential such as Bihar, Chhattisgarh, J&K, Orissa, and West Bengal and states with minimal RE potential such as Delhi, Goa, and the north eastern states.

The following graph illustrates the projected supply gap (based on methodology discussed above) for resource-deficient states based on MNRE-assessed RE potential.

Figure 10: RE capacity addition for resource-deficient states



Source: AF-Mercados EMI Analysis

It is evident from the above that resource-deficient states with small RE potential are expected to add an increasing amount of capacity although on a smaller scale. Also, the achievements can vary considerably between the states. On account of biomass potential, Punjab and Bihar have a higher achievement potential among the resource-deficient states as compared to others.

From the above analysis it can be inferred that RECs can enable states, especially resource-deficient states in fulfilling RPO targets.

Resource-rich states can fulfill their RPO targets mostly by buying physical electricity and the balance can be fulfilled through RECs, as the gap between supply and demand for RPO fulfilment is not significant. However, resource-deficient states can fulfill their RPO targets by buying RECs from exchange obviating the need to invest in establishment of transmission infrastructure.

RPOs have created a new market framework for RE. However, the new market faces several transition challenges emanating from the relatively higher cost of renewables, variability of generation requiring great operational flexibility in utilities, transmission availability and costs. Addressing these challenges by providing suitable incentives will therefore, be important.

4. INCENTIVES FOR RPO COMPLIANCE

Incentives for RPO compliance can be provided for the supply side or the demand side or a combination of the two. Incentives can also be provided for associated issues like infrastructure and/or balancing power provisions. This section discusses the possible incentive options.

4.1. POSSIBLE INCENTIVE OPTIONS

Because of the infirm nature of renewable energy and evolving technology (especially in the case of solar energy), the following incentive options are possible.

i. Financial incentives for cost reduction for energy supply

Even though the cost of wind energy supply has come down to approximately Rs 6 crore/MW and of solar supplies to approximately Rs 10 crore/MW, it is still considered to be a costly source for power procurement. Hence, financial incentives in the form of subsidies on equipment, concessional loans, excise duty reduction/exemption, and so on can be given to bring down the cost of generation of power from renewable sources.

ii. Financial incentive for meeting target RPO levels

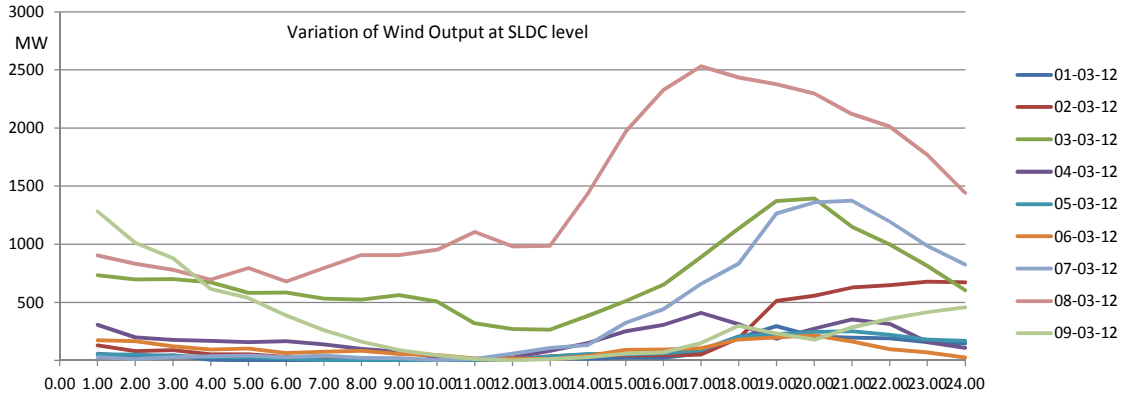
Schemes such as accelerated depreciation, GBI, subsidy on equipment, and section 80IA of Income Tax Act, for RE growth have been subsidy driven and have provided supply push.

However, for market creation of RE in India, a demand pull is also needed. This can be achieved through RPO and REC mechanisms. Need for RPO compliance results in additional burden on states due to cost of power procurement, buying REC, balancing power, and cost associated with transmission infrastructure development. Hence, to facilitate RPO compliance, states need to be incentivised to fulfil their own RPO obligations and help deficit states in fulfilling their obligations.

iii. Incentive for reducing the variability risks and bringing efficiency in operations:

Renewable energy is inherently variable in nature as indicated in the graph below. This is based on T amil Nadu SLDC data.

Figure 11: Wind generation variation in Tamil Nadu



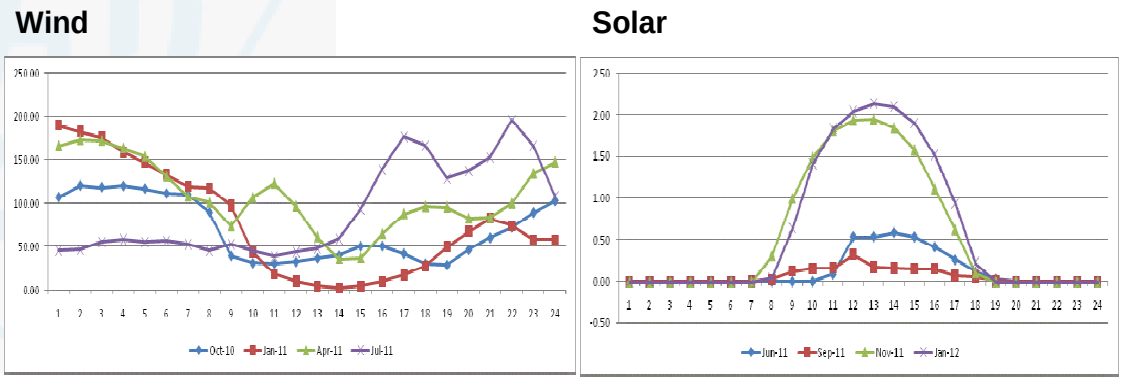
Source: SLDC data

As it is seen, on 8th March 2012, between 13:00 Hrs and 14:00 Hrs, wind generation ramped up by 45%, while between 13:00 Hrs and 16:00 Hrs it was ramped up by 135%.

Such variability results in additional cost to the system as well as creates technical issues related to frequency, voltage and reactive power in handling the grid.

Such variability can be handled by providing monetary incentives, increasing balancing area, creation of ancillary services mechanism / markets and creating faster electricity markets in the form of intra-day forecasting for scheduling. Also, spatial distribution of various renewable sources such as wind and solar can help in handling the variability as shown in the following graph.

Figure 12: Wind and solar generation pattern in Tamil Nadu



As illustrated, electricity generation from wind and solar are complementary in several months and help to smoothen variability.

Out of the above mentioned options, the report, based on the scope of the work, analyses the option for providing financial incentive to states for meeting target RPO levels.

4.2. IDENTIFICATION OF INCENTIVE NEEDS

Since renewable energy is intermittent in nature and perceived to be a costly source of energy, both resource rich and resource deficient states are generally unwilling to buy power from renewable sources to meet their RPO targets and/or procure beyond their current RPO targets to help resource deficient states in meeting their RPO targets.

Unwillingness of states to buy power from renewable sources to meet their RPO targets can be attributed to the following factors:

- Cost to be incurred by the host state utility for procuring balancing power to manage the variation in renewable energy generation.
- Expenditure to be incurred in establishing transmission infrastructure for evacuating renewable capacity and for procuring balancing capacity
- Relatively higher cost of procuring renewable energy

To assess the level of incentivisation to states, it is **important to differentiate between incentive requirements of resource rich and resource poor states.** The incentives would vary between resource deficient and resource surplus states because the cost incidence will be different for resource rich and resource poor states as discussed subsequently in this section. Also, level of incentive depends upon procurement route taken for RPO compliance.

Resource rich states need to be incentivised for the following:

- Incentive for fulfilling their own RPO target
- Incentive to increase their own RPO target beyond the existing target
- Help resource poor states to fulfill their RPO target

Resource deficient states need to be incentivised to fulfill their own RPO targets.

To incentivise states for above mentioned categories, it is important to identify the cost elements associated with each of the procurement routes for both resource rich and resource deficient states.

The following table identifies the applicable cost elements for resource rich and resource deficient states under two routes.

Table 8: Cost break-up for resource rich state

	FiT Route	APPC Route
Energy Cost (FiT)	Yes	-
APPC cost	-	Yes
REC Cost	-	Yes
Transmission cost	Yes	Yes
Transmission losses	Yes	Yes
Balancing power cost	Yes	Yes

Table 9: Cost break-up for resource deficient state

	FiT Route*	IPPC Route
Energy Cost (FiT)	Yes	-
APPC cost	-	-
REC Cost	-	Yes
IPPC	-	Yes
Transmission cost	Yes	Yes (Resource deficient state)
Transmission losses	Yes	Yes (Resource deficient state)
Balancing power cost	Yes	-

*This will involve inter-state transfer of power

The balance of incentives would depend upon the situation foreseen.

- **If buyer is in deficit:** The buyer will buy power through FiT route or APPC route whichever is economically beneficial.
- **If buyer is in surplus:** Under such situation, the buyer does not need energy immediately. Hence, the buyer may buy only REC or may buy power as well as REC and subsequently sell back the power which it does not need.

Hence, exact mechanism will depend upon cost economics of particular situational details. In this context the REC framework needs mention. The REC market, while providing a novel platform for propagating RE projects faces its own challenges in terms of economics of procurement of the RECs by the obligated entities. Clearly, the nascent market needs some transition support (such as in the form of incentives) to address the implementation issues that a new market inevitably faces. Incentives for generation are now less emphasized by GoI policy, and large scale market creation through RPO/SPO is encouraged. Regulation has created a pan-India market for renewables through the Renewable Energy Certificate (REC) trading mechanism to bridge the gulf between renewable resource deficient and resource rich states. The mechanisms relating to REC and incentivisation for the same have been studied to assess relative advantages and disadvantages of various options. The following sub-sections provide analysis of the same.

4.3. COST COMPARISON BETWEEN FIT ROUTE AND REC ROUTE BY RESOURCE RICH STATES & RESOURCE DEFICIENT STATES

One of the major roadblocks in RPO compliance through REC route is that it is considered a costlier route for RPO compliance. This section analyses both the routes – Feed-in-Tariff route and REC route - and compares the cost associated with each of these routes for both resource rich and resource deficient states.

Methodology: The methodology for comparing the cost economics for both routes is briefly described below:

i. Total cost involved under each route for both resource rich and resource deficient states is compared with cost of power procurement from alternative source of power (thermal power plants). Cost involved under each procurement route is discussed later in this section.

ii. The amount of incentive is arrived at by taking the difference of total cost incidence under RPO compliance route and cost of procuring power from alternative source.

RESOURCE RICH STATES:

Based on the methodology described, the table below compares the difference between cost of procuring power by resource rich state, through FiT route and REC route. *The analysis presented below considers 10% base load station contribution to balancing power. Analysis at various levels of base-load station contribution to balancing power is provided in Annexure 3.*

The following cost components have been included to compare cost economics of the two routes.

REC route:

- Weighted average cost of power procurement from balancing capacity & APPC (including transmission loss)
- Transmission infrastructure cost for evacuating variable renewable capacity and procuring balancing capacity
- REC cost

FiT Route:

- Weighted average cost of power procurement from balancing capacity & FiT (including transmission loss)
- Transmission infrastructure cost for evacuating variable renewable capacity and procuring balancing capacity

Table 10: Cost comparison between APPC+REC route and FiT route for resource rich state

Rajasthan

	Wt average cost of power procurement from balancing capacity & APPC including Transmission Loss	Transmission infrastructure cost	Total cost of procurement under APPC route (I)	REC Price (II)	Cost of procurement under FiT route including transmission infrastructure & backup power cost[8] (III)	(I)+(II)-(III)
@ Floor Price	3.68	0.43	4.11	1.50	5.22	**0.38**
@ Av. Price	3.68	0.43	4.11	2.4	5.22	**1.28**
@ Forbearance Price	3.68	0.43	4.11	3.3	5.22	**2.18**

AF-Mercados EMI Analysis; All fig in Rs/Kwh

Karnataka

	Wt average cost of power procurement from balancing capacity & APPC including Transmission Loss	Transmission infrastructure cost	Total cost of procurement under APPC route (I)	REC Price (II)	Cost of procurement under FiT route including transmission infrastructure & backup power cost (III)[9]	(I)+(II)-(III)
@ Floor Price	3.46	0.50	3.97	1.50	4.59	**0.87**
@ Av. Price	3.46	0.50	3.97	2.40	4.59	**1.77**
@ Forbearance Price	3.46	0.50	3.97	3.30	4.59	**2.67**

AF-Mercados EMI Analysis; All fig in Rs/Kwh

[8] Break-up provided in Annexure 3

[9] Break-up provided in Annexure 4

Taking Rajasthan as an example from the above table, the cost of procuring power from REC route is compared with power procurement cost at Feed-in-Tariff.

Procurement through REC route will involve weighted average cost of procuring power from balancing capacity and at pooled cost of power purchase which is Rs3.68/kWh (including transmission loss). It will also include the cost associated with setting up transmission infrastructure for evacuating power from renewable energy source and procuring balancing power which is Rs 0.43/kWh. Further, it will include the cost of REC purchase, which for the purpose of above computations is taken at floor price, forbearance price and average of the above two prices. Hence, the total cost of procurement through REC route (at floor price) works out to Rs5.61/kWh.

This is compared with cost of procuring power from Feed-in-Tariff route. This involves weighted average cost of power procurement at Feed-in-Tariff and from balancing capacity which comes out to be Rs 4.80/kWh. In addition to this, it involves cost associated with setting up transmission infrastructure for evacuating power from renewable energy source and procuring balancing power which is Rs 0.43/Kwh. Hence, the total cost of procurement through REC route works out to Rs5.22/kWh.

The difference of the above two is used to compare the economics of two routes of RPO compliance.

It is evident from the above analysis that FiT route is more attractive for resource rich state at all the REC price points.

RESOURCE DEFICIENT STATES:

Based on the methodology described above, the table below illustrates the *difference between cost incidence* on demand states for two routes (FiT v/s IPPC+REC).

The following cost components have been included to compare cost economics of the two routes.

REC route:

- Incremental cost of buying electricity
- Transmission cost for procuring power locally & associated loss
- REC cost

FiT Route:

- Cost of buying power at interstate Feed-in-Tariff
- ISTS transmission cost for power procurement & associated loss
- Balancing power cost

A comparison of cost incidence under FiT and IPPC+REC route (at Floor price of REC) for resource deficient states of Punjab and Delhi is shown below.

Table 11: Cost comparison between IPPC+REC route and FiT route for resource deficient state

Punjab:

	IPPC+REC	Feed-in-Tariff
IPPC	3.34	-
REC	1.50	-
FiT	-	4.63
Transmission cost	0.14	0.24
Transmission loss	0.04	0.12
Sub-Total	**5.02**	**4.99**
Balancing Energy	-	0.29
TOTAL	**5.02**	**5.28**

AF-Mercados Analysis; All fig in Rs/Kwh

Delhi:

	IPPC+REC	Feed-in-Tariff
IPPC	3.34	-
REC	1.50	-
FiT	-	4.63
Transmission cost	0.10	0.23
Transmission loss	0.04	0.14
Sub-Total	**4.98**	**5.00**
Balancing Energy	-	0.33
TOTAL	**4.98**	**5.33**

AF-Mercados Analysis; All fig in Rs/Kwh

Following a similar approach, cost comparison at average and forbearance REC price is tabulated below for both Punjab and Delhi

Table 12: Cost comparison between IPPC+REC route and FiT route for resource deficient state at various REC prices

Punjab:

	2011-12
@ Floor Price	**(0.25)**
@ Av. Price	**0.65**
@ Forbearance Price	**1.55**

REC route attractive/FiT Route attractive

AF-Mercados Analysis; All fig in Rs/Kwh

Delhi:

	2011-12
@ Floor Price	**(0.35)**
@ Av. Price	**0.55**
@ Forbearance Price	**1.45**

REC route attractive/FiT Route attractive

AF-Mercados Analysis ; All fig in Rs/Kwh

Hence, REC route is attractive at floor price of REC while FiT route is attractive at average and forbearance price.

Therefore, states, most of the time, may prefer to fulfill their RPO target by procuring power through FiT route instead of REC route. This may adversely impact REC market. This also necessitates the need to re-look at the existing REC framework for ensuring that RECs are able to achieve their desired objective.

4.4. INCENTIVE FRAMEWORK STRUCTURE – RESOURCE RICH & RESOURCE DEFICIENT STATES

The RE industry already benefits from certain incentive frameworks. However these are changing progressively with the changes in market consequent to the EA 2003. The earlier supply side incentives in the form of AD are progressively being de-emphasized. Even the GBI framework is currently under review. Incentives are being provided instead primarily to utilities and states through (i) National Clean Energy Fund for specific infrastructure requirements (notably transmission), (ii) Regulatory Renewal Fund (currently being refined) and (iii) GoI funds as per recommendations of the Thirteenth Finance Commission.

However, the analysis in the preceding section suggests that the incentive framework in the transition period may need to go beyond the available incentives to encourage regulators and utilities to set reasonable targets of RPO and enabling utilities to fulfill their RPO obligations. In this section, incentive framework has been presented separately for both resource rich and resource deficient states.

RESOURCE RICH STATES:

(A) Methodology and Rationale:

To arrive at an indicative level of incentive requirement, the following methodology has been used for incentive calculation based on two routes of power procurement. The method considers all costs that the states require to incur to procure renewables, including the costs related to transmission and balancing[10].

Scenario 1 - FIT Route:

I. Weighted average cost of power procurement from peaking stations (open cycle gas station, and pumped hydro), existing coal based stations and FiT is arrived at.
II. Transmission cost and losses for evacuating variable RE and procuring balancing power is calculated.
III. Cost of alternate power from base load stations and transmission cost and losses for base load stations is calculated.
IV. Incentive is arrived at by calculating (I+ II) - III

Scenario 2 - APPC route

I. Weighted average cost of power procurement from peaking stations (open cycle gas station, and pumped hydro) & existing coal based stations and APPC is arrived at.
II. Transmission cost and losses for evacuating variable RE and procuring balancing power is calculated.
III. Cost of alternate power from base load stations and transmission cost and losses for base load stations is calculated.
IV. Incentive is arrived at by calculating (I+ II) - III

Resource rich states will be eligible for incentives "only for Feed-in-tariff purchases" for meeting their "own" RPO target.

Beyond "own" RPO targets, resource rich states will be incentivised for APPC only for helping resource deficient states fulfill RPO obligations.

(B) INCENTIVE FRAMEWORK:

The following framework has been used to arrive at the incentive structure for resource rich states.

The incentivisation for resource rich state is to help such states meet the additional costs of RPO compliance, including for,

1. OWN RPO COMPLIANCE

For resource rich state's own RPO compliance, incentive is needed for:

- Incurring additional expenditure for putting up transmission infrastructure,
- Procuring power from peaking plants within or from outside of state to address the issue of renewable energy variability.

The framework for incentivisation for resource rich state is explained below:

i. Any resource rich state with RPO target lesser than prevailing NAPCC target will not be eligible for incentive.

ii. The incentive (which is calculated based on steps outlined before) will start from NAPCC target level for the year and will increase linearly till the RPO target set by the state.

   a. For a given RPO level (greater than equal to NAPCC target but less than or equal to RPO target set by the state), the amount of incentive will be pro-rated to RPO compliance for that RPO level. To be eligible for incentive at a given RPO level, the

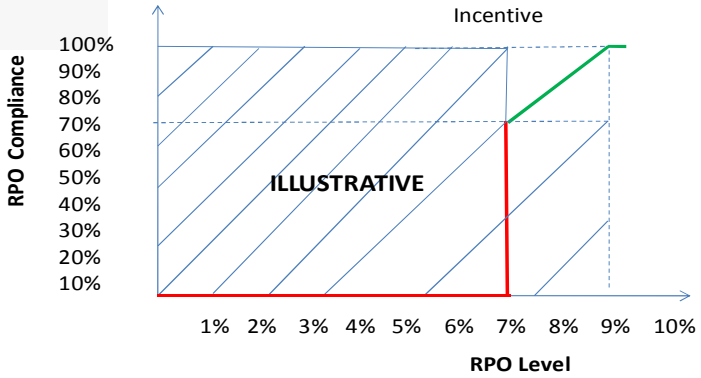
[10] The costs are indicative only and would vary from state to state and situation to situation. They have been used as a basis of incentive design and not to arrive at the incentive rates per-se.

minimum level of compliance needs to be 70% of NAPCC target applicable for the period.

iii. Once the state specified RPO target is reached, no incentive will be given.

The graph below illustrates the variation in incentives at various RPO levels as per the incentive framework described above.

Figure 13: Illustrative Incentive variation for Resource Rich states (Rs. /Kwh) for RPO compliance

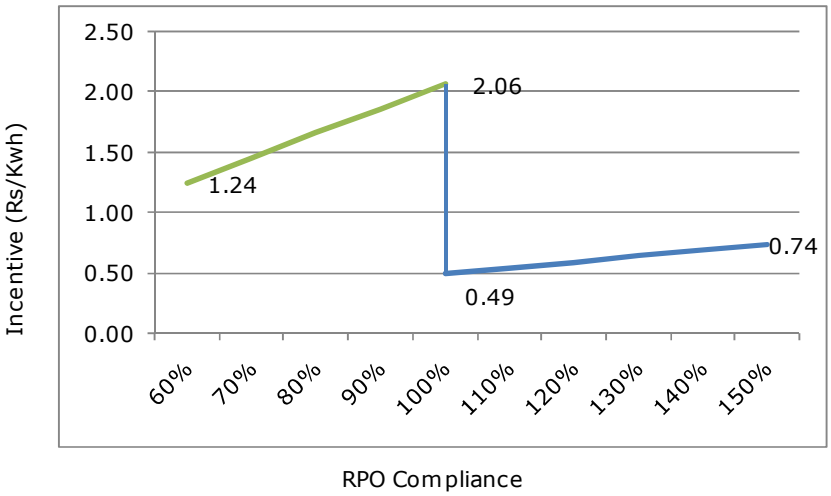


2. **HELPING OTHER OBLIGATED ENTITIES** comply with their respective RPO target

For higher levels of performance (over and above 100% compliance of RPO targets), these states will be incentivized for helping other obligated entities comply with their respective RPO target i.e. by purchasing the electricity from the renewable energy generators at the Average Pooled Power Cost (APPC). In this case, the host state will be eligible for incentives for:

a) Over-performing and aiding RPO compliance of other obligated entities. This has been illustrated in the graph below.

Figure 43: Illustrative Incentive variation for Resource Rich states (Rs. /Kwh) till RPO target and beyond RPO compliance



RESOURCE DEFICIENT STATES:

The following methodology has been used for the illustrative incentive calculation for resource deficient states based on two scenarios of power procurement:

(A) Methodology and Rationale

Scenario 1 – IPPC+ REC route:

I. Cost of power purchased from base load stations is considered as Incremental Power Purchase Cost (IPPC)
II. REC prices at different levels are considered.
III. Local transmission charges and local transmission loss are considered.
IV. Cost of alternate power including transmission cost & losses from base load stations is calculated
V. Incentive is arrived at by calculating (I+II+III) – (IV)

Scenario 2 - FiT Route

I. Cost of procuring power at CERC tariff for wind and inter- state transmission cost and losses are considered.
II. Cost of balancing power is considered.
III. Cost of alternate power including transmission cost & losses from base load stations is calculated
IV. Incentive is arrived at by calculating (I+II) - (III)

For the resource deficient states, incentives will be provided only for units bought through the IPPC + REC route.

(B) INCENTIVE FRAMEWORK

The illustrative framework for incentive calculation for resource deficient state is explained below:

i. Any resource deficient state with RPO target lesser than a minimum threshold target will not be eligible for RPO incentivisation irrespective of the level of compliance. For the purpose of illustrative calculations, a threshold RPO level of 4% has been considered.

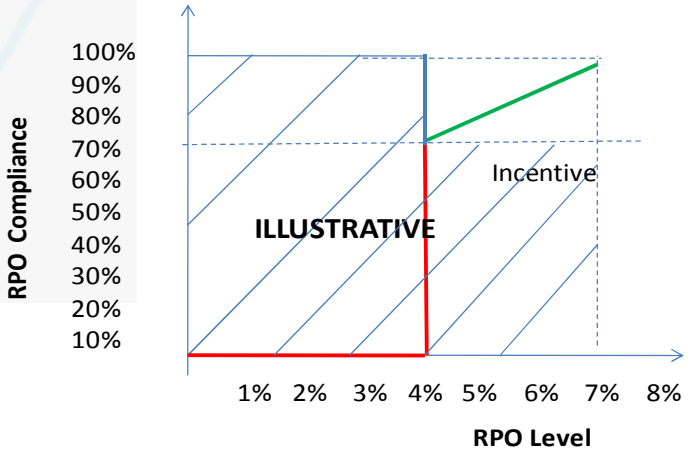
ii. The incentive (which is calculated based on steps outlined before) will start when the RPO target is equal to the threshold target and will increase linearly till NAPCC target level.

   a. For a given RPO level (greater than threshold target but less than or equal to NAPCC target), the amount of incentive will also depend upon RPO compliance for that RPO level. To be eligible for incentive at a given RPO level, the minimum level of compliance needs to be 70% of threshold target applicable for the present period.

iii. Once NAPCC target is reached, no further incentive will be given.

The following graph illustrates the variation in incentives at various RPO levels.

Figure 15: Incentive variation for resource deficient state



The graded incentive scheme suggested above is aimed at supporting obligated entities (licensees) to procure RE. This scheme may be more cost efficient than across the board GBI for RE resources since it would raise the RE penetration levels and support superior compliance. Even as the incentive rate (in Rs./Kwh) could be made attractive, since they would commence only after a threshold RPO level and indexed to compliance, they are targeted and leveraged better than traditional GBI schemes.

Guiding Principles of Assumptions for Illustrative Working:

For the purpose of arriving at rate of incentive, two sets of resource rich/resource deficient states (Rajasthan-Punjab and Karnataka-Delhi) are considered. Since incentive levels are very sensitive to assumptions, it is important to understand the guiding principles for these assumptions.

The following guiding principles have been used to carry out illustrative workings for the two set of states:

I. It is considered that 50% of the variable generation will be met through balancing mechanism – existing base-load stations, and peaking stations. Contribution from open cycle gas stations and pumped-hydro (as balancing capacity) is considered based on the availability and mix of such stations in the region.

II. All the tariff considered are on levelized basis.

III. Tariff for base load coal fired plants are considered based on recent Case 1 bids concluded.

IV. Tariff for storage hydro stations are considered based on approved tariff of hydro stations under the purview of CERC. Tariff for pumped hydro is considered based on Mercados internal database sourced from ARR filings. It is assumed that a combination of pumped hydro (70%) and storage hydro (30%) will be used as peaking stations for balancing power.

V. Gas based station tariff are considered based on its linkage to crude oil prices (JCC index). Open cycle based stations are considered to be used as balancing capacities.

VI. APPC is weighted average cost of short & long term power purchase.

VII. Transmission charges for resource deficient states are considered based on point of connection (PoC) mechanism

VIII. Transmission infrastructure costs for variable and new capacity are based on CERC Intervening Transmission Regulation.

4.4.1. ILLUSTRATION FOR INCENTIVE CALCULATION

For the purpose of illustrating the incentive requirement for resource rich and resource deficient states, two set of such states have been considered – Rajasthan(resource rich state)/Punjab(resource deficient state) and Karnataka(resource rich state)/Delhi(resource deficient state). The following section illustrates the incentive levels and their variations for such states under two routes for RPO compliance. The computations are all for non-solar RPO compliance.

A. Incentive levels for resource rich states [11]

Based on the methodology described previously, the table below presents the range of incentive requirement for resource rich states under two different scenarios. Range of incentives indicates incentive levels at different level of contribution to balancing power from existing base-load station. For example, if more of the balancing power is supplied by existing coal based base-load generating stations, then the incentives required would be towards the lower end of the range. Conversely if the balancing power comes more from new peaking power or ancillary services oriented projects, the incentivisation requirements would be higher.

Table 13: Incentive range for resource rich states (range depends on contribution of base load to balancing power)

	Rajasthan	Karnataka
FiT Route	Rs 1.52/Kwh to Rs 1.70/Kwh	Rs 0.92/Kwh to Rs 1.06/Kwh
APPC route (beyond RPO compliance)	Rs 0.40/Kwh to Rs 0.58/Kwh	Rs 0.30/Kwh to Rs 0.44/Kwh

AF-Mercados Analysis

The incentive levels may increase/decrease (based on incentive variation framework described in section 4.3) depending upon RPO levels achieved and the level of compliance.

Incentive variation:

For the purpose of arriving at incentive variation trajectory, the base level of incentive considered on achievement of NAPCC target is the average of incentive arrived at different levels of base-load contribution to balancing power.

Rajasthan: *Non-solar RPO level for Rajasthan for 2011-12 was 4.5% which is lesser than 2011-12 NAPCC target of 7%. Hence, for the purpose of arriving at incentive trajectory at and beyond NAPCC target, a RPO target of 9% is assumed for Rajasthan.*

Karnataka: *Non-solar RPO level for Karnataka for 2011-12 was 9.8% which is higher than 2011-12 NAPCC target of 7%. Hence, for the purpose of arriving at incentive trajectory at and beyond NAPCC target, its current RPO of 9.8% is considered.*

Table 14: Incentive variation trajectory for resource rich states (depends on RPO compliance level)

	Rajasthan	Karnataka
FiT Route	Rs 1.24/Kwh to Rs 2.06/Kwh	Rs 0.71/Kwh to Rs 1.42/Kwh
APPC route	Rs 0.49/Kwh to Rs 0.74/Kwh	Rs 0.37/Kwh to Rs 0.55/Kwh

[11] The above levels of incentives are applicable at 100% compliance of NAPCC targets. Assumptions and detailed analysis provided in Annexure 3 and Annexure 4

AF-Mercados Analysis

Under FiT route (for own state compliance), the lower limit of above range indicates the incentive at 70% compliance while the upper limit indicates incentive at 100% compliance of RPO target set by the state.

Under APPC route (for helping resource deficient states comply with RPO target), the lower limit of above range indicates the incentive beyond 100% compliance while the upper limit indicates incentive at 150% compliance of RPO target set by the state.

B. Incentive levels for Resource deficient states[12]

Based on the methodology described previously, the table below presents the range of incentive requirement for resource deficient states under two different scenarios. The incentive ranges indicate incentive levels at different levels of contribution to balancing power from existing base-load station.

Table 15: Incentive range for resource deficient states

	Punjab	Delhi
IPPC+REC route	Rs 1.49/Kwh at floor price to Rs 2.39/Kwh at Forbearance Price	Rs 1.45/Kwh at floor price to Rs 3.25/Kwh at Forbearance Price

AF-Mercados Analysis

The base load contribution will not affect the incentive amount because the cost of balancing power under this route will be borne by the resource rich state, not by resource deficient state.

The above levels of incentives are applicable at 100% compliance of NAPCC targets. They can increase/decrease (based on incentive variation framework described in section 4.3) depending upon RPO levels achieved and the level of compliance.

Incentive variation:

For the purpose of illustrating incentive variation trajectory, the base level of incentive considered on achievement of NAPCC target is the incentive required while considering the floor price of REC.

Punjab: Non-solar RPO level for 2011-12 for Punjab was 2.37%. Since this target is lesser than considered threshold RPO target of 4% for incentive eligibility, RPO target of 5% is considered for illustration.

Delhi: RPO target of Delhi for illustrative calculation is considered as 5%. Delhi did have RPO target for 2011-12.

Table 16: Incentive variation trajectory for resource deficient states

	Punjab	Delhi
IPPC+REC route	Rs 0.75/Kwh to Rs 1.07/Kwh	Rs 0.73/Kwh to Rs 1.04/Kwh

AF-Mercados Analysis

Under this route, the lower limit of above range indicates the incentive at 70% compliance while the upper limit indicates incentive at 100% compliance of RPO target set by the state. The above incentive rage is computed at Floor price of REC.

[12] Assumptions and detailed analysis provided in Annexure 3 and Annexure 4

C. Incentive amount for Resource rich & Resource deficient states

The table below indicates the illustrative range of incentive amount based on per unit incentives arrived in above sections. Total illustrative incentive amount is arrived at by applying the above rates on the RPO targets considered for the states.

Table 17: Illustrative Incentive requirement for resource rich states

	Rajasthan		Karnataka	
Incentive range (Rs/Kwh)	1.24	2.06	0.71	1.42
FiT Route (Rs Cr)	573	953	375	751
Incentive range (Rs/Kwh)	0.49	0.74	0.37	0.55
APPC Route (Rs Cr)	227	342	196	291

AF-Mercados Analysis

- RPO target of Rajasthan is considered as 9% for illustration. Actual RPO target for 2011-12 set by state was 4.5%
- Actual RPO target of 9.75% for 2011-12 for Karnataka is considered
- Incentive variation is at Floor Price of REC

Table 18: Illustrative Incentive requirement for resource deficient states

	Punjab		Delhi	
Incentive range (Rs/Kwh)	0.75	1.07	0.73	1.04
IPPC+REC Route (Rs Cr)	183	262	99	141

AF-Mercados Analysis

- RPO target of Punjab is considered as 5% for illustration. Actual RPO target for 2011-12 set by state was 2.37%.
- RPO target of Delhi for above illustrative calculation is considered as 5%. Delhi did have RPO target for 2011-12.
- Incentive variation is at Floor Price of REC.

5. SUGGESTED INTERVENTIONS AND CONCLUSIONS

GoI and regulatory authorities have allocated significant funds for the development of clean energy in India. Following sources could be used to fund the state utilities in the form of incentives to enable them to increase RE deployment which will encourage them to go for higher RPO:

- **National Clean Energy Fund:** The Government of India has created a National Clean Energy Fund (NCEF) by imposing a clean energy cess of Rs. 50/T on all coal produced in India as well as on coal imports. *It is imperative that a substantial portion of the NCEF should be made available for development of renewable energy and incentivizing RPO compliance in an effective manner.*

- **Thirteenth Finance Commission Grant:** A grant of Rs 5,000 crore recommended for grid connected renewable energy based on the state's achievement in RE capacity addition from 1st April 2010 to 31st March 2014. Significant portion of the fund should be channelized for removing barriers to RE deployment and increase RPO levels and compliance. Guidance could be issued in this regard.

- **Renewable Energy Regulatory Fund:** In order to compensate the applicable unscheduled interchange (UI) penalty to state utility because of default of RE power schedules within the allowed limits, a renewable regulatory fund has been created to compensate the same.

- In addition to allocation of funds from above proposed sources, several **institutional and policy level interventions** are also needed to facilitate the implementation of the suggested framework.

However, availability of funds alone, whether through the NCEF, RRF or any other mechanism is unlikely to address the needs of RE development in the manner desired and envisaged. Apart from the mitigation of cost of compliance, the activities related to compliance need to be facilitated through a set of concrete institutional development measures. Some of the proposed **institutional interventions** to bring in more efficiency are listed below:

1. Under the Renewable Purchase Obligation (RPO) framework, the State Agency has to play an important role in monitoring and implementation of the RPO framework. In order to ensure the fulfillment of RPO targets set for different obligated entities, the State Commission needs to entrust the State Agency with the responsibility to devise suitable mechanism for RPO compliance monitoring and the enforcement[13]. The state Commission shall appoint a state agency to carry out monitoring and enforcement of RPO for all the obligated entities in the state.
   a. The State commission shall direct State Agency to prepare list of obligated entities and direct the State Agency to furnish the data of such obligated entities on a bi-annual basis (twice in a year).
   b. The State Commission shall mandate quarterly enforcement of RPO mechanism and direct State agency to act in consistency with the requirement of quarterly enforcement.
   c. Based on the quarterly compliance report provided by the State Agency, the State Commission shall direct the State Agency to collect the penalty amount as prescribed in the applicable RPO regulation from all the defaulting obligated entities and shall direct the State Agency to utilize such fund collected to purchase available solar and non-solar RECs from the market.

2. To bring down the cost of balancing power and reduce the variation variability, creation of larger balancing areas should be facilitated. For this, it is important that the visibility of system operators is increased.

[13] The roles and responsibilities of the State Agency and the Obligated Entity provided in Annex 6

3. Identification of balancing resources and providing sufficient incentives for them to be available for RE balancing should be encouraged.

4. Better scheduling and forecasting procedures should be adopted. Intra-day forecasting of resource will help reduce schedule deviations and bring down the cost to the system.

5. There should be suitable training for the system operators and a requirement of certification should be made mandatory.

As this report discusses in several instances, Variable Renewable Energy also imposes several costs for utilities for transmission and for system balancing. Apart from hydropower which is a flexible balancing resource, gas based open cycle generation is an alternative. However gas is scarce and expensive at this time. Hence the following **policy interventions** are suggested to aid RE development:

a. There can be subsidized allocation of gas for supply rich renewable energy states. This can be achieved by making suitable amendments in Gas Allocation Policy.

b. Since gas based stations are peaking stations and may operate at peak capacity only for a short duration during the day, some flexibility can be built around Take-or-Pay (ToP) structure of the Gas Supply Agreements. Also, development of storage technology will also make it imperative to introduce some suitable amendments.

c. Key issue faced by the gas industry is the availability and price volatility. Availability may be resolved with additional gas discovery; however, gas being such a critical commodity will always be subjected to price volatility. Hence, suitable amendments can be made in gas PPA for sharing of gas price risk between the seller and off-taker, on the lines of heat rate based Case II PPAs (though, in such case, fuel price risk is entirely on the off-taker in such PPAs).

There are number of sites in India with sub-MW WTGs which were installed during the initial days of development of wind energy in India. Consequently, there are a number of sites where wind resource is getting underutilized as the capacity of the installed WTGs is not enough to produce the required generation as per the site potential. With the development of WTGs of the order of 1.65MW and above, there arises a need to repower wind farms to be able to utilize the site potential efficiently. Hence, a re-powering incentive (on the lines of GBI) with suitable provisions in the PPAs should be introduced to cover additional project cost and handle other commercial issues incidental to it (such as land related, evacuation related and ownership related) for repowering of older wind farms.

Most of the renewable energy projects are located in remote areas. Market suggests that large numbers of projects are getting delayed because of delay in getting forest clearance. Hence, the process of getting clearances should be streamlined for faster renewable energy capacity addition with greater emphasis on streamlining forest clearance process.

Forecasting of resource and generation and power system management in a RE heavy system are a key to establishment of reasonable RPO levels and effective compliance. Incentives need to be provided in this so as to send a clear signal to generators and utilities on the emphasis placed on these subjects. A separate fund can be established for creation of tools and techniques for accurate resource assessment and generation forecasting. A pre-requisite for creation of such tools is the availability of sufficient amount of historical generation data. Efforts are needed to establish tools to collect and manage such data so that improved generation forecasting can be done.

In summary, this study and other associated studies commissioned by FOR and CERC indicate a strong interest of developers for establishing RE projects based on RPO framework, but also practical implementation difficulties. In particular the transmission issues, infirm nature of the RE resources and costs need to be addressed for large scale deployment through suitable incentivisation. To permit the nascent RE market to develop through the RPO mechanism it is essential to provide some incentive support to the resource rich states to institute reasonable RPO levels and also exceed them. Similarly, incentives during the transition period would help resource deficit states to institute and

comply with reasonable RPO requirements. The graded incentive scheme aimed at supporting licensees to procure RE may be more cost efficient than across the board GBI for RE resources since it would raise the RE penetration levels and support superior compliance. Even as the incentive rate (in Rs./Kwh) could be made attractive, since they would commence only after a threshold RPO level and indexed to compliance, they targeted and leveraged better than traditional GBI schemes.

6. ANNEXURES

Annexure 1

Legal and Regulatory Framework

ELECTRICITY ACT 2003

The Electricity Act (EA 2003) was announced on 2nd June 2003 which consolidates the Indian Electricity Act, 1910, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998. The EA 2003 was the first comprehensive framework that spurred development of renewable power in the country by unfolding a regulatory structure favourable for promotion of Renewable Energy.

86 (e) – Pursuant to this section, "The State Commission shall discharge the following functions - promote co-generation and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, 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."

NATIONAL ELECTRICITY POLICY (NEP):

The National Electricity Policy (February 2005) aims at laying guidelines for accelerated development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders keeping in view availability of energy resources, technology available to exploit these resources, economics of generation using different resources, and energy security issues.

Some of the clauses pertaining to promotion of RE in the policy has been provided below:

5.12.1 - Non-conventional sources of energy being the most environment friendly, there is an urgent need to promote generation of electricity based on such sources of energy. For this purpose, efforts need to be made to reduce the capital cost of projects based on non-conventional and renewable sources of energy. Cost of energy can also be reduced by promoting competition within such projects. At the same time, adequate promotional measures would also have to be taken for development of technologies and a sustained growth of these sources.

5.12.2 - The Electricity Act 2003 provides that co-generation and generation of electricity from non-conventional sources would be promoted by the SERCs by providing suitable measures for connectivity with grid and sale of electricity to any person and also by specifying, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee. Progressively the share of electricity from non-conventional sources would need to be increased as prescribed by State Electricity Regulatory Commissions. Such purchase by distribution companies shall be through competitive bidding process. Considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the Commission may determine an appropriate differential in prices to promote these technologies.

NATIONAL TARIFF POLICY (NTP):

The NTP (January 2006) provides for procurement by distribution companies at preferential tariffs determined by the regulatory commission. Various changes/amendments have been made from time to time such as inclusion of solar PV and solar thermal tariff determination, indexation of tariff with steel and cement prices etc. which has encouraged investors for greater investments in the sector. Also, Feed in Tariffs have increased across all the states which has also helped RE capacity addition.

Some of the clauses pertaining to promotion of RE in the policy are below:

Pursuant to provisions of section 86(1)(e) of the Act, *the Appropriate Commission shall fix a minimum percentage for purchase of energy from RE 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 1, 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.*

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.

INDIAN ELECTRICITY GRID CODE (IEGC)

The Indian Electricity Grid Code (IEGC) lays down the rules, guidelines and standards to be followed by the various agencies and participants in the system to plan, develop, maintain and operate the power system, in the most efficient, reliable, economic and secure manner, while facilitating healthy competition in the generation and supply of electricity. All parties that connect with and/or utilize the ISTS are required to abide by the principles and procedures defined in the IEGC.

One of the objectives of the Grid Code is facilitation of the development of renewable energy sources by specifying the technical and commercial aspects for integration of these resources into the grid.

Some of the provisions pertaining to general conditions for connectivity of renewable energy are:

- *A generating station of renewable sources can be connected at the distribution level (below 33 kV) or transmission level (at or above 33 kV) of the State depending upon policies of the State Electricity Regulatory Commissions.*
- *All renewable energy power plants except for biomass power plants with installed capacity of 10 MW and above, and non-fossil fuel based cogeneration plants ,whose tariff is determined by the CERC shall be treated as 'MUST RUN' power plants and shall not be subjected to 'merit order despatch' principles*
- *It also specifies features mandated for connectivity of wind turbines at a connection point of 33 kV and above, if the collective capacity of the wind generator at the connection point exceeds 10 MW and where PPA has not yet been tied up*
- *Transmission requirement for evacuating power from renewable energy sources shall also be taken care of while doing transmission planning*.

This code also provides the methodology for rescheduling of wind and solar energy on three (3) hourly basis and the methodology of compensating the wind and solar energy rich State for dealing with the variable generation through a Renewable Regulatory charge

NATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Action Plan on Climate Change (NAPCC) aims to achieve a sustainable development path that simultaneously advances economic and environmental objectives leading to further mitigation of greenhouse gas emissions.

Paragraph 'Grid Connected Systems 4.2.2' suggests that 'The following enhancements in the regulatory/tariffs regime may be considered to help mainstream renewable based sources in the national power system:

A 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. It is suggested that starting 2009-10, the national renewable standard (excluding hydropower with storage capacity in excess of daily peaking capacity, or based on agriculture based renewable sources that are used for human food) may be set at 5% of total grids purchase, to increase by 1% each year for 10 years. SERCs may set higher percentages than this minimum at each point in time.'

Annexure 2

For supply projection, a *logistic curve* has been used. It is a common sigmoid curve, which can model the "S-shaped" curve (abbreviated S-curve) of growth. The initial stage of growth is approximately exponential; then, as saturation begins, the growth slows, and at maturity, growth stops.

A simple logistic function may be defined by the formula

$$P(t) = 1 / (1 + k e^{-c t})$$

Where,

P – denotes % potential to be exploited each year

t – denotes time/ year

k and c are constants

Based on above, cumulative installed capacity across states based on MNRE or LBNL constraint is computed.

Capacity utilization factors (CUF) as per CERC norms have been used (Wind: 21%, Biomass: 60%, Small Hydropower: 28%) to arrive at RE generation.

Annexure 3

ASSUMPTIONS FOR INCENTIVE CALCULATION

Resource Rich state (Rajasthan):

Following assumptions are used for incentive computations.

I. Representative Capacity charge and Energy charge for base-load and peaking stations is given below:

	Capacity Charge	Energy Charge	Total	Source
Existing coal fired @ 85% PLF	1.20	2.14	**3.34**	Based on recent case 1 bids
Gas (CCGT)	1.67	4.65	**6.32**	Energy Charge Based on linkage with JCC crude index and Fixed Cost based on CERC Task Force Report
Gas (OCGT)	1.00	5.25	**6.25**	Energy Charge Based on linkage with JCC crude index and Fixed Cost based on CERC Task Force Report
Hydro (Storage)	2.11 (Composite Tariff)		**2.11**	Based on hydro station tariff under CERC purview
Hydro (Pumped hydro)	1.50	2.28	**3.78**	Mercados Database based on ARR filings

All fig in Rs/Kwh

II.

	Assumption	Source
Transmission infrastructure cost	Rs.0.7 Cr/MW	As per CERC Intervening Transmission Regulation, for 66KV line, charges are Rs 682,244/MW/Year. Assuming 20% capital servicing cost, total cost of transmission infrastructure will be 70L
Capital servicing cost	20%	Includes depreciation, debt servicing cost (P+I) and O&M
PLF for gas based station	65%	Based on PLF in region for Gas
PLF for hydro station	55%	Based on PLF in region for Hydro
APPC for Rajasthan	Rs 2.60/Kwh	APPC for 2011-12 based on Floor/Forbearance price order 23/8/2011
FiT for Rajasthan	Rs 4.46/Kwh	Order dated 14/12/2011 (Rs 4.46/Kwh for Jaisalmer,Jodhpur,Barmer);Rs 4.69/Kwh for (Other districts)
Transmission Loss	1.1%	Point of Connection mechanism
Balancing capacity requirement	6 Hours/day	Task Force Report
NAPCC Target	7.0%	NAPCC

Resource Deficient State (Punjab):

	Assumption	Source
Transmission infrastructure cost	Rs.1.4 Cr/MW	CERC Intervening Transmission Regulation
Average UI rate	Rs 3.91/Kwh	Annual monitoring report on short term power markets (2010-2011) -July 2011
APPC for Punjab	Rs 2.71/Kwh	APPC for 2011-12 based on Floor/Forbearance price order 23/8/2011
CERC Tariff	Rs 4.63/Kwh	CERC tariff for 2011-12 for wind zone 2 (CUF 23%) without AD [Order dated 9/11/2010]
Transmission Loss (Raj/Inj)	1.1%	CERC notification for rates and other parameters for the purpose of bid evaluation and payment (7/10/2011)
Transmission Loss (Pun/W)	1.4%	CERC notification for rates and other parameters for the purpose of bid evaluation and payment (7/10/2011)
Transmission charges	0.14	PoC Regulation (Punjab W)
Transmission charges	0.10	PoC Regulation (Rajasthan Inj)
NAPCC Target	7.0%	NAPCC

Incentive calculations

Resource Rich State (Rajasthan):

Resource Rich state Incentive at FiT Route

Base load contribution	Wt average cost of power procurement from balancing capacity & FiT (incl Transmission loss)	Transmission infrastructure cost (variable RE +balancing capacity)	Cost of procurement including transmission infrastructure & backup power cost (FiT route)	Alternative cost	Transmission infrastructure cost for alternative source	FiT- Alternative cost
	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh
10%	4.80	0.43	5.22	3.34	0.19	1.70
15%	4.75	0.42	5.18	3.34	0.19	1.65
20%	4.71	0.42	5.13	3.34	0.19	1.61
25%	4.67	0.42	5.09	3.34	0.19	1.56
30%	4.63	0.41	5.04	3.34	0.19	1.52

Resource Rich state Incentive at APPC route

Base load contribution	Wt average cost of power procurement from balancing capacity & APPC (incl Transmission loss)	Transmission infrastructure cost (variable RE +balancing capacity)	Cost of procurement including transmission infrast & back-up power cost incl. Tx loss (APPC route)	Alternative cost	Transmission infrastructure cost for alternative source	APPC- Alternative cost
	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh
10%	3.68	0.43	4.11	3.34	0.19	0.58
15%	3.64	0.42	4.06	3.34	0.19	0.54
20%	3.60	0.42	4.02	3.34	0.19	0.49
25%	3.56	0.42	3.97	3.34	0.19	0.45
30%	3.52	0.41	3.93	3.34	0.19	0.40

Resource Rich state Incentive variation (FiT Route)

					RPO TARGET		NAPCC		ALTERNATE RPO TARGET	
	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
10%	-	-	-	-	-	-	-	-	-	
20%	-	-	-	-	-	-	-	-	-	
30%	-	-	-	-	-	-	-	-	-	
40%	-	-	-	-	-	-	-	-	-	
50%	-	-	-	-	-	-	-	-	-	
60%	-	-	-	-	-	-	-	-	1.24	
70%	-	-	-	-	-	-	-	1.28	1.45	
80%	-	-	-	-	-	-	1.28	1.47	1.65	
90%	-	-	-	-	-	-	1.45	1.65	1.86	
100%	-	-	-	-	-	-	1.61	1.84	2.06	
110%	-	-	-	-	-	-	-	-	-	-
120%	-	-	-	-	-	-	-	-	-	-
130%	-	-	-	-	-	-	-	-	-	-
140%	-	-	-	-	-	-	-	-	-	-
150%	-	-	-	-	-	-	-	-	-	-

Resource Rich state Incentive variation (APPC Route)

					RPO TARGET		NAPCC		ALTERNATE RPO TARGET	
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
10%	-	-	-	-	-	-	-	-	-	
20%	-	-	-	-	-	-	-	-	-	
30%	-	-	-	-	-	-	-	-	-	
40%	-	-	-	-	-	-	-	-	-	
50%	-	-	-	-	-	-	-	-	-	
60%	-	-	-	-	-	-	-	-	-	
70%	-	-	-	-	-	-	-	-	-	
80%	-	-	-	-	-	-	-	-	-	
90%	-	-	-	-	-	-	-	-	-	
100%	-	-	-	-	-	-	-	-	0.49	
110%	-	-	-	-	-	-	-	-	0.54	
120%	-	-	-	-	-	-	-	-	0.59	
130%	-	-	-	-	-	-	-	-	0.64	
140%	-	-	-	-	-	-	-	-	0.69	
150%	-	-	-	-	-	-	-	-	0.74	

Resource Deficient State (Punjab):

Resource Deficient state Incentive at FiT Route

Base load contribution	CERC Tariff	Transmission loss (Host state)	Transmission loss (Demand state)	Add:Transmission cost (PoC)	Balancing power cost	Cost of alternte power	Incentive
10%	4.63	0.05	0.06	0.24	0.29	3.53	**1.75**
15%	4.63	0.05	0.06	0.24	0.25	3.53	**1.71**
20%	4.63	0.05	0.06	0.24	0.20	3.53	**1.67**
25%	4.63	0.05	0.06	0.24	0.16	3.53	**1.62**
30%	4.63	0.05	0.06	0.24	0.12	3.53	**1.58**

Resource Deficient state Incentive at IPPC + REC Route

Base load contribution	Floor Price	Average Price	Forebearance Price
10%	1.49	3.29	2.39
15%	1.49	3.29	2.39
20%	1.49	3.29	2.39
25%	1.49	3.29	2.39
30%	1.49	3.29	2.39

Resource Deficient state Variation in incentive (IPPC +REC Route)

				THRESHOLD	ALTERNATE RPO TARGET		NAPCC	
	1%	2%	3%	4%	5%	6%	7%	8%
10%	-	-	-	-	-	-	-	
20%	-	-	-	-	-	-	-	
30%	-	-	-	-	-	-	-	
40%	-	-	-	-	-	-	-	
50%	-	-	-	-	-	-	-	
60%	-	-	-	-	-	-	-	
70%	-	-	-	0.60	0.75	0.90	1.05	
80%	-	-	-	0.68	0.85	1.02	1.20	
90%	-	-	-	0.77	0.96	1.15	1.34	
100%	-	-	-	0.85	1.07	1.28	1.49	
110%	-	-	-	0.85	1.07	1.28	1.49	
120%	-	-	-	0.85	1.07	1.28	1.49	
130%	-	-	-	0.85	1.07	1.28	1.49	
140%	-	-	-	0.85	1.07	1.28	1.49	
150%	-	-	-	0.85	1.07	1.28	1.49	

Annexure 4

Resource Rich state (Karnataka):

Following assumptions are used for incentive computations.

I. Representative Capacity charge and Energy charge for base-load and peaking stations is given below:

	Capacity Charge	Energy Charge	Total	Source
Existing coal fired @ 85% PLF	1.20	2.14	**3.34**	Based on recent case 1 bids
Gas (CCGT)	1.67	4.65	**6.32**	Energy Charge Based on linkage with JCC crude index and Fixed Cost based on CERC Task Force Report
Gas (OCGT)	1.00	5.25	**6.25**	Energy Charge Based on linkage with JCC crude index and Fixed Cost based on CERC Task Force Report
Hydro (Storage)	2.11 (Composite Tariff)		**2.11**	Based on hydro station tariff under CERC purview
Hydro (Pumped hydro)	1.50	2.28	**3.78**	Mercados Database based on ARR filings

All fig in Rs/Kwh

II.

	Assumption	Source
Transmission infrastructure cost	Rs.0.7 Cr/MW	As per CERC Intervening Transmission Regulation, for 66KV line, charges are Rs 682,244/MW/Year. Assuming 20% capital servicing cost, total cost of transmission infrastructure will be 70L
Capital servicing cost	20%	Includes depreciation, debt servicing cost (P+I) and O&M
PLF for gas based station	63%	Based on PLF in region for Gas
PLF for hydro station	31%	Based on PLF in region for Hydro
APPC for Karnataka	Rs 2.66/Kwh	APPC for 2011-12 based on Floor/Forbearance price order 23/8/2011
FiT for Karnataka	Rs 3.70/Kwh	Order dated 14/12/2011 (Rs 4.46/Kwh for Jaisalmer, Jodhpur, Barmer);Rs 4.69/Kwh for (Other districts)
Transmission Loss	1.71%	Point of Connection mechanism
Balancing capacity requirement	6 Hours/day	Task Force Report
NAPCC Target	7.0%	NAPCC

Demand State (Delhi):

	Assumption	Source
Transmission infrastructure cost	Rs.1.4 Cr/MW	CERC Intervening Transmission Regulation
Average UI rate	Rs 3.91/Kwh	Annual monitoring report on short term power markets (2010-2011) -July 2011
APPC for Delhi	Rs 2.79/Kwh	APPC for 2011-12 based on Floor/Forbearance price order 23/8/2011
CERC Tariff	Rs 4.63/Kwh	CERC tariff for 2011-12 for wind zone 2 (CUF 23%) without AD [Order dated 9/11/2010]
Transmission Loss (Kar/Inj)	1.71%	CERC notification for rates and other parameters for the purpose of bid evaluation and payment (7/10/2011)
Transmission Loss (Del/W)	1.40%	CERC notification for rates and other parameters for the purpose of bid evaluation and payment (7/10/2011)
Transmission charges	0.10	PoC Regulation (Delhi W)
Transmission charges	0.13	PoC Regulation (Karnataka Inj)
NAPCC Target	7.0%	NAPCC

Resource Rich state (Karnataka):

Resource Rich state Incentive at FiT Route

Base load contribution	Wt average cost of power procurement from balancing capacity & FiT (incl Transmission loss)	Transmission infrastructure cost (variable RE +balancing capacity)	Cost of procurement including transmission infrastructure & backup power cost (FiT route)	Alternative cost	Transmission infrastructure cost for alternative source	FiT- Alternative cost
	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh
10%	4.09	0.50	4.59	3.34	0.19	1.06
15%	4.06	0.49	4.56	3.34	0.19	1.03
20%	4.04	0.48	4.52	3.34	0.19	0.99
25%	4.01	0.47	4.49	3.34	0.19	0.96
30%	3.99	0.46	4.45	3.34	0.19	0.92

Resource Rich state Incentive at APPC Route

Base load contribution	Wt average cost of power procurement from balancing capacity & APPC (incl Transmission loss)	Transmission infrastructure cost (variable RE +balancing capacity)	Cost of procurement including transmission infrast & back-up power cost incl. Tx loss (APPC route)	Alternative cost	Transmission infrastructure cost for alternative source	APPC- Alternative cost
	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh	Rs/Kwh
10%	3.46	0.50	3.97	3.34	0.19	0.44
15%	3.44	0.49	3.93	3.34	0.19	0.40
20%	3.41	0.48	3.89	3.34	0.19	0.37
25%	3.39	0.47	3.86	3.34	0.19	0.33
30%	3.36	0.46	3.82	3.34	0.19	0.30

Resource Rich state Incentive variation at FiT Route

							NAPCC			RPO TARGET	
	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%
10%	-	-	-	-	-	-	-	-	-	-	
20%	-	-	-	-	-	-	-	-	-	-	
30%	-	-	-	-	-	-	-	-	-	-	
40%	-	-	-	-	-	-	-	-	-	-	
50%	-	-	-	-	-	-	-	-	-	0.71	
60%	-	-	-	-	-	-	-	-	0.77	0.85	
70%	-	-	-	-	-	-	0.69	0.79	0.89	0.99	
80%	-	-	-	-	-	-	0.79	0.91	1.02	1.13	
90%	-	-	-	-	-	-	0.89	1.02	1.15	1.28	
100%	-	-	-	-	-	-	0.99	1.13	1.28	1.42	
110%	-	-	-	-	-	-	-	-	-	-	
120%	-	-	-	-	-	-	-	-	-	-	
130%	-	-	-	-	-	-	-	-	-	-	
140%	-	-	-	-	-	-	-	-	-	-	
150%	-	-	-	-	-	-	-	-	-	-	

Resource Rich state Incentive variation at APPC Route

							NAPCC			RPO TARGET	
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%
10%	-	-	-	-	-	-	-	-	-	-	
20%	-	-	-	-	-	-	-	-	-	-	
30%	-	-	-	-	-	-	-	-	-	-	
40%	-	-	-	-	-	-	-	-	-	-	
50%	-	-	-	-	-	-	-	-	-	-	
60%	-	-	-	-	-	-	-	-	-	-	
70%	-	-	-	-	-	-	-	-	-	-	
80%	-	-	-	-	-	-	-	-	-	-	
90%	-	-	-	-	-	-	-	-	-	-	
100%	-	-	-	-	-	-	-	-	-	0.37	
110%	-	-	-	-	-	-	-	-	-	0.40	
120%	-	-	-	-	-	-	-	-	-	0.44	
130%	-	-	-	-	-	-	-	-	-	0.48	
140%	-	-	-	-	-	-	-	-	-	0.51	
150%	-	-	-	-	-	-	-	-	-	0.55	

Demand state (Delhi):

Demand state Incentive at FiT Route

Base load contribution	CERC Tariff	Transmission loss (Host state)	Transmission loss (Demand state)	Transmission cost (ISTS/PoC)	Balancing power cost	Cost of alternte power	Incentive
10%	4.63	0.08	0.06	0.23	0.33	3.53	**1.80**
15%	4.63	0.08	0.06	0.23	0.30	3.53	**1.78**
20%	4.63	0.08	0.06	0.23	0.27	3.53	**1.75**
25%	4.63	0.08	0.06	0.23	0.25	3.53	**1.72**
30%	4.63	0.08	0.06	0.23	0.22	3.53	**1.70**

Demand state Incentive at IPPC + REC route

Base load contribution	Floor Price	Forebearance Price	Average Price
10%	1.45	3.25	2.35
15%	1.45	3.25	2.35
20%	1.45	3.25	2.35
25%	1.45	3.25	2.35
30%	1.45	3.25	2.35

Demand state Incentive variation at IPPC route

				THRESHOLD	ALTERNATE RPO TARGET		NAPCC
	1%	2%	3%	4%	5%	6%	7%
10%	-	-	-	-	-	-	-
20%	-	-	-	-	-	-	-
30%	-	-	-	-	-	-	-
40%	-	-	-	-	-	-	-
50%	-	-	-	-	-	-	-
60%	-	-	-	-	-	-	-
70%	-	-	-	0.58	0.73	0.87	1.02
80%	-	-	-	0.66	0.83	0.99	1.16
90%	-	-	-	0.75	0.93	1.12	1.31
100%	-	-	-	0.83	1.04	1.24	1.45
110%	-	-	-	0.83	1.04	1.24	1.45
120%	-	-	-	0.83	1.04	1.24	1.45
130%	-	-	-	0.83	1.04	1.24	1.45
140%	-	-	-	0.83	1.04	1.24	1.45
150%	-	-	-	0.83	1.04	1.24	1.45

Annexure 5

Thirteenth Finance Commission: Finance Commission had recommended a grant of Rs.5000 crores as incentive to the states for achieving addition of grid-connected renewable energy capacity from 1st April 2010 to 31st March 2014.

The amount of incentive to be paid to the state governments will be determined based on the capacity addition (in MW) achieved by the state, relative to the total increase in capacity of renewable energy achieved by all states from 1st April 2010 to 31st March 2014, assessed on the basis of a two-part formula, as under:

- 75 % of the grant of Rs.5, 000 crores, (i.e. Rs.3, 750 crores) will be available for addition of installed capacity (over 2010-14) relative to the aggregate addition in installed capacity across all states.
- 25 % of the grant of Rs.5, 000 crores, (i.e. Rs.1, 250 crores) will be available for addition of installed capacity addition (over 2010-14) relative to the unachieved potential of the particular state.

The incentive would be paid in the fiscal year 2014-15 and would be subject to overall caps, as under:

- Rs.1.25 crores per MW of installed capacity added, for general category states
- Rs.1.50 crores per MW of installed capacity added, for special category states

Renewable Regulatory Fund: The wind generators shall be responsible for forecasting their generation up to accuracy of 70%. Therefore, if the actual generation is beyond +/- 30% of the schedule, UI charges would be applicable to the wind generator. For actual generation within +/- 30% of the schedule, no UI would be payable/receivable by Generator.

The implication of these UI charges shall be shared among all the States/UTs of the country/DVC in the ratio of their peak demand met in the previous month based on the data published by CEA, in the form of a regulatory charge known as the Renewable Regulatory Charge operated through the RRF.

Annexure 6

Role of State Agency

State Agency shall be nodal agency for monitoring the RPO mechanism during the year.

i. State Agency shall identify the all the obligated entities in the State.
   a. For the obligated entities like: captive users and open access consumers, State Agency shall obtain information through the respective distribution license and from the office of the Electrical Inspectorate.

ii. The state agency shall prepare a list of all the obligated entities and shall furnish the same to the state commission on a bi-annual basis (twice a year).

iii. State Agency shall collect the data of yearly estimated RE requirement (solar and non-solar) from each obligated entity.

iv. State Agency shall collect the data of consumption by all the obligated entities.
   a. For open access users, SLDC to provide the information related to open access transactions from different sources (using renewable energy sources and fossil fuel) to State Agency on monthly basis.

v. State Agency shall collect the data of RPO compliance by the procurement of renewable energy of RECs (Solar and Non-solar) from the obligated entities along with the List of supporting documents.

vi. State Agency shall reconcile the information submitted on REC procurement from the Registry. (NLDC), renewable energy generation/consumption/procurement from the SLDC/distribution licensee.

vii. State Agency shall prepare the report on the compliance made by all the obligated entities and submit the same to the SERC by 30th April of each year.

viii. State Agency shall:
   a. Compile the information furnished by different Stakeholders to compute the RPO fulfilment by different obligated entities.
   b. Prepare a summary statement of RE procurement by different Obligated Entities and publish the same on quarterly basis on its website.
   c. Prepare and submit to the Commission, detailed statement of renewable energy requirement under RPO targets vis-à-vis actual procurement by the all the Obligated Entities, and shortfall/surplus thereof, and amount of Enforcement Charges to be levied on different entities, if any.

ix. The State Agency shall also collect the Compliance Charge amount as prescribed in the applicable regulation from all the defaulting obligated entities and shall make suitable arrangements to procure available solar and non-solar RECs from the market.

x. Further, the State Agency shall publish on its website list of all the defaulting obligated entities and the list of all the voluntary buyers on a quarterly basis.

Roles and Duties of Obligated Entity for RPO Compliance:

i. Every Obligated Entity, as per the meaning of SERC RPO/REC Regulations, shall submit the information, for reporting of the Yearly Estimated RE requirement (solar and non-solar) as per the form given under Annexure II.
   a. Such information shall be submitted to the State Agency on or before 15th March for the ensuing year with a copy to the SERC.

ii. Every Obligated Entity shall submit the report of Quarterly RPO Compliance to the State Agency.
   a. Such quarterly information shall be submitted to the State Agency within 15 days from end of each Quarter of the compliance year, with a copy to the SERC.

iii. Every Obligated Entity shall submit the report of Yearly RPO compliance to the State Agency duly certified by the auditors.

iv. Such yearly information shall be submitted to the State Agency on or before 25th April of each year, with a copy to the SERC.