Strengthening Investment Climate for Renewable Energy in India

June, 2009

Prepared by

SASDE

The World Bank

[w1]

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ACRONYMS AND ABBREVIATIONS

AD	Accelerated Depreciation
APERC	Andhra Pradesh Electricity Regulatory Commission
BHEL	Bharat Heavy Electrical Limited
BOO	Build Own Operate
CAGR	Compound Annual Growth Rate
CDM	Clean Development Mechanism
CER	Certified Emissions Reductions
CERC	Central Electricity Regulatory Commission
CHP	Combined Heat and Power
CREB	Clean Renewable Energy Bonds
CUF	Capacity Utilization Factor
C-WET	Center for Wind Energy Technology
DDG	Decentralized Distributed Generation
DG	Diesel Generation
DoE	Department of Energy
DPR	Detailed Project Report
EIA	Energy Information Administration, US
EIRR	Economic Rate of Return
EoI	Expression of Interest
EPACT	Energy Policy Act
ESMAP	Energy Sector Management Assistance Program
ETA	Energy Tax Act
EU	European Union
FCCB	Foreign Currency Convertible Bond
FERC	Federal Energy Regulatory Commission
FIT	Feed-in Tariffs
GBI	Generation Based Incentives
GDP	Gross Domestic Product
HPERC	Himachal Pradesh Electricity Regulatory Commission
IEP	Integrated Energy Policy
IPP	Independent Power Producers
IREDA	Indian Renewable Energy Development Agency
IRR	Internal Rate of Return
kWh	Kilowatt hour
MEDA	Maharashtra Energy Development Agency
METI	Ministry for Economy, Trade and Industry, Japan
MNRE	Ministry of New and Renewable Energy , India
MoF	Ministry of Finance
MoP	Ministry of Power
MoPNG	Ministry of Oil and Natural Gas
MOU	Memorandum of Understanding
MP	Madhya Pradesh
MPWL	Madhya Pradesh Windfarms Ltd.
MtOE	Million tons of oil equivalent
MWh	Megawatt hour
NEP	New Energy Policy
NOIDA	New Okhla Industrial Development Authority
Nox	Nitrogen Oxides
NTPC	National Thermal Power Corporation
O&M	Operation and Maintenance
PEDA	Punjab Electricity Development Agency
PLF	Peak Load Factor
PPA	Power Purchase Agreement
PTC	Production Tax Credits
PTI	Press Trust of India
PURPA	Public Utility Regulatory Policies Act
PV	Photovoltaic
R&M	Repair and Maintenance
RE	Renewable Energy
REC	Renewable Energy Credits
REF	Renewable Energy Framework
REPI	Renewable Energy Production Incentive
RET	Renewable Energy Technology
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojna
RPO	Renewable Purchase Obligation
RREC	Rajasthan Renewable Energy Corporation
SERC	State Electricity Regulatory Commissions
SEU	State Electricity Utility
SEZ	Special Economic Zone
SHP	Small Hydro Plant
SIPS	Special Incentives Package Scheme
SREDA	State Renewable Energy Development Agencies
STU	State Transmission Utility
T&D	Transmission and Distribution
TPCES	Total Primary Commercial Energy Supply
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WPD	Wind Power Density
WTE	Waste-to Energy

EXECUTIVE SUMMARY

CHAPTER-1: INTRODUCTION

Background

1.1 ***Need for Alternate Energy in India*** India recorded a 9 percent GDP growth rate for the fiscal year 2007-08, which made it one of the fastest growing emerging economies in the world that year. The Government of India (GOI) has identified the power sector as key to achieving its goals of high and sustainable economic growth and accelerated poverty alleviation. In order to support economic growth and meet the ever growing demand there is a need to increase primary energy supply by 3-4 times and electricity generation capacity 5-6 times of 2003-2004 levels[1]. However, it will be difficult to meet these additional requirements through conventional sources of power alone. Moreover, the sector is currently already characterized by power shortages and low level of electricity access (according to 2001 census, 44.2 percent of households lack access). In addition to the problems associated with acquiring large sources of conventional fuel, global warming provides a very compelling reason for weaning away the world's power production industry from conventional fuels to make use of alternative, renewable sources of energy.

1.2 ***Aggressive RE targets compared to installed capacity*** India has set itself very aggressive targets for RE capacity addition. The 11th Five Year Plan (FY 2007-12) envisages the capacity addition of 14,500 MW of additional RE capacity, which means adding additional capacity in 5 years than what India has added since independence. This significant scale up of RE investments over a relatively short period of time would require a supportive investment climate across all RE technologies (wind, small hydropower, biomass and solar), encompassing policy, regulatory, market and institutional dimensions.

1.3 ***Need for the study*** While several policy and regulatory initiatives have been implemented to encourage the uptake of RE in India, there is currently considerable inconsistency in policy and regulatory framework across states. This variation has led to investment not necessarily taking place in the most economically viable manner in terms of choose apposite technologies and and/or locations.

1.4 Although, considerable experience and information is available on the costs of RE technologies and barriers to its development in India, what is now required is a comprehensive enabling framework (encompassing policy, institutional, and regulatory aspects). This framework should integrate all costs & benefits of RE and draw attention to the key barriers impeding RE development in a consistent manner to create an enabling investment climate for RE.

1.5 The purpose of this policy note is to review the existing investment climate for RE in India and to provide recommendations for addressing current gaps and inconsistencies and encourage the most viable investments.

[1] Integrated Energy Policy (IEP), 2006

Key objectives of the assignment

1.6 The key objectives of the assignment are to:

- Study the RE investment climate in India by reviewing the status of national and state level regulatory and policy frameworks, project costs & risks, current status of investments & investor appetite and future market potential.
- Assess the gaps and key barriers constraining investments in the RE sector.
- Identify areas for further intervention and strengthening of policy, regulatory and market instruments to achieve the national RE targets.
- Develop a Comprehensive Renewable Energy Framework (REF) to integrate all costs and benefits of RE technologies.
- Based on the (REF) and RE sector review, develop a harmonized approach to RE implementation for an improved RE investment climate across states.

Structure of the Report

1.7 The report has been divided into 11 chapters, including this chapter. The second chapter focuses on the country and sector context. This highlights the development of the power sector and the demand supply gap. This is followed by a chapter on the assessment of cost for different energy sources and relative potential based on a 'Supply Curve' for RE in India.

1.8 This chapter is followed by an analysis of the overall investment climate for RE in India which looks at the broad policy and regulatory framework for RE in India as a part of chapter 4. Chapters 5 to 8 deal with individual RE sectors of (small hydro power (SHP), wind, biomass and solar). These chapters trace the development of the sectors and identify the main constraints in their development. These chapters also identify the main policy and regulatory gaps that need addressing and emerge with a set of recommendations for streamlining these sectors.

1.9 An economic framework identifying the key economic benefits associated with RE has been detailed in chapter 9. The approaches for valuation and the role of different institutions in integrating these economic benefits through promotional instruments have also been discussed.

1.10 Chapter 10 reviews the current institutional arrangement for promotion of RE in India. It also identifies institutional issues prevailing in the RE sector and address gaps in institution design, capacity, networking, positioning and execution. It provides a mapping of institutional interventions required for adopting the economic framework.

1.11 In conclusion, Chapter 11 provides a consolidated set of recommendations for the policy makers and regulators in RE sector (India).

CHAPTER-2: INDIA'S ENERGY SECTOR

Power Sector Context

2.1 ***Indian Power Scenario*** At 7%, India is currently one of the fastest growing economies of the world, even during the present financial crisis. Before the crisis, the Indian economy registered an impressive growth rate of 9% for 2007-08. To sustain and increase these levels of growth, availability of quality power is a crucial input. To aid the development and further enhancement of the power sector (which is already the fifth largest in the world), it has introduced a number of policy and in institutional measures both at the centre and the state levels. State policies and legislations have successfully emulated national laws and policy guidelines to encourage the growth and restructuring of the power sector to make them more efficient, reliable and responsive. In view of the increasing trends of GDP, the following graph shows the corresponding installed capacity projections required to achieve these levels of growth.

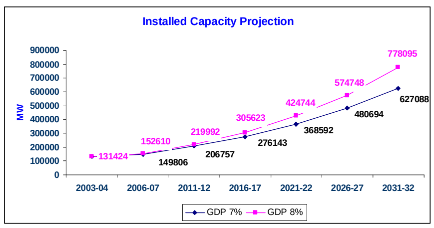


Figure 1 – Installed Power Generation Capacity – Projections till 2032
Source: Integrated Energy Policy, Planning Commission, India, 2006

2.2 ***Widening Demand Supply Gap:*** The electricity shortages continue to impose significant constraint to India's economic development and growth. In 2009, the electricity deficit was 11% and 12.2% peak deficit[2]. Demand supply gap is likely to increase in the future, unless adequate measures are taken to bring new generation capacity, improve operational efficiency and management of the power utilities. IEP forecasts a need for 306 GW of installed capacity by 2017 to meet India's electricity requirements. This means doubling of installed capacity in the next 10 years from 150 GWs in March 2008. Longer term projections up to 2032 estimate installed capacity requirement of 778 GW. As per IEP, of this, nearly three-fourth of the installed capacity is projected to be thermal (coal and gas) based, and RE including large hydro power accounting for one-fourth the share.

[2] Executive Summary Report, Power Sector Highlights 2008-09, Ministry of Power

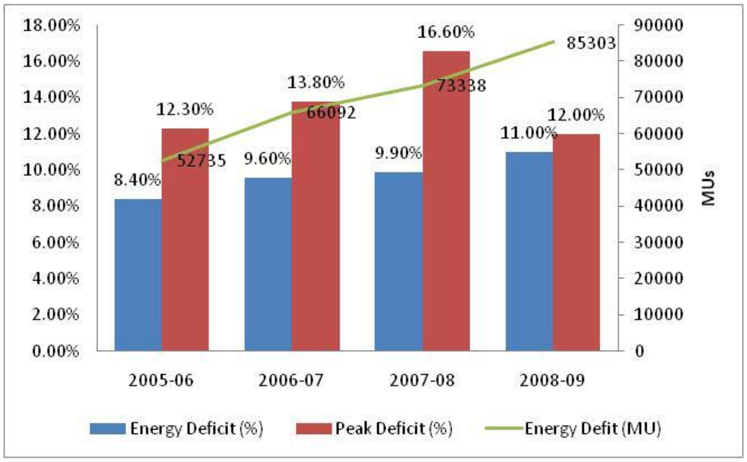
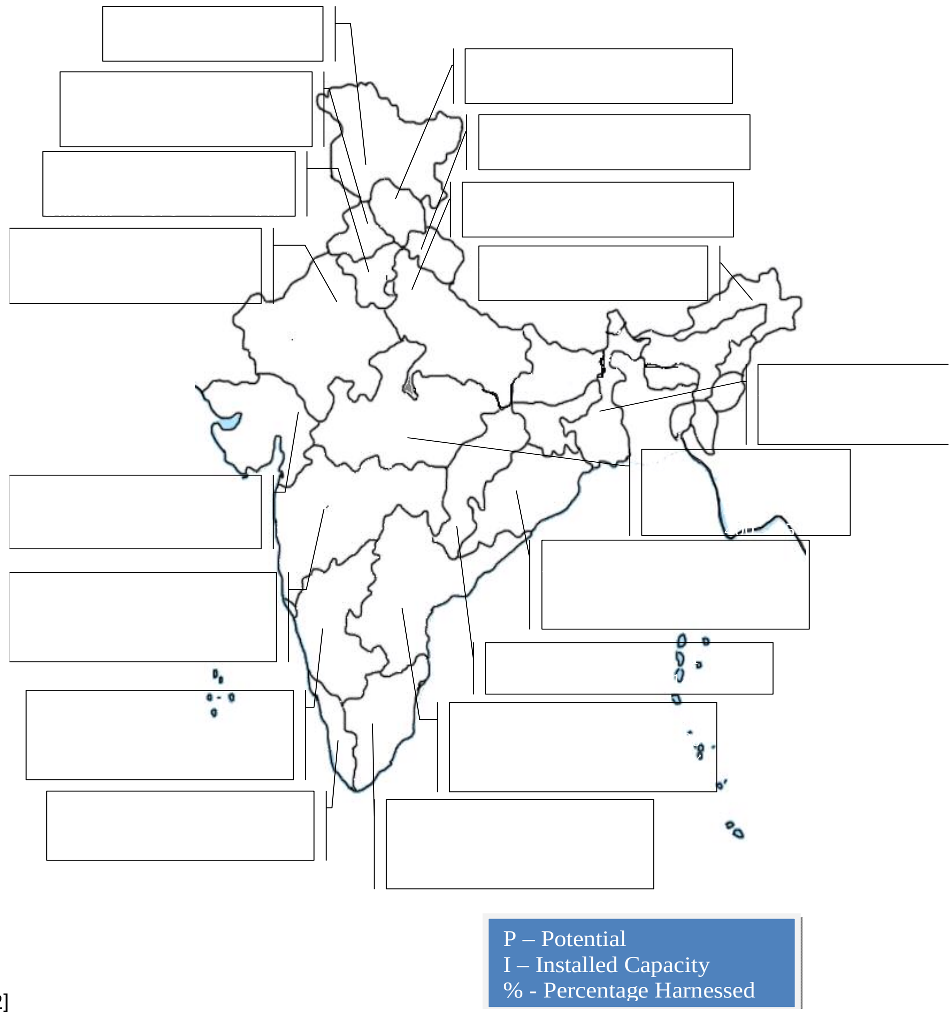


Figure 2: Power deficit across regions in India in 2008-09
Source: Ministry of Power Website (CEA Report)

2.3 ***Coal will remain the mainstay, but the resources are fast diminishing:*** One of the key constraints in India's endeavour to supply adequate energy for the country's development is its inadequate access to primary energy resources. According to IEP estimates in 2005-06, India's coal reserves are likely to run out in next 45 years, assuming a 5% per annum growth in demand. India's coal reserves are characterized by low calorific value and high ash content thereby posing significant environmental challenges. Exclusively for power sector application, reliance on imported coal is estimated to increase from present 10% to 16% by FY 2012. With the increase in demand for coal in Asia, which is one of the largest consumer segments, the global coal prices are expected to rise, thus exerting greater pressure on India's power sector.

2.4 ***Focus on Indigenous Clean Energy Production for Future Energy Security*** Higher costs of power generation from nuclear energy and to import higher cost coal and gas is now prompting policy makers in India to focus more on the indigenization of energy generation. One mechanism for countering this potential energy availability and energy security issue is to reduce reliance on imported fuels by focusing on indigenous clean energy technologies. Renewable energy technologies (RETs) can help address the demand supply gap through the addition of new capacity and with time substitute conventional fuels.

2.5 ***Renewable energy potential in India***: The country has a huge potential of 138 GW of RE sources of which only 7.7% (13.5 GW) has been harnessed as on January 2009. A very significant part of the total RE potential still remains to be utilized. The following figure illustrates the current status of RE utilization and available potential in different states across India.



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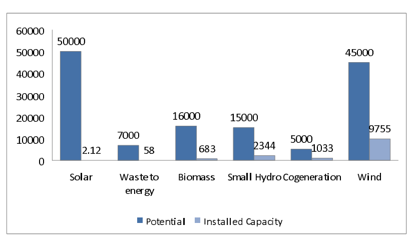


Figure 4: Renewable Energy Potential & Installed Capacity (MW)
Source: MNRE Website (As on 31.01.2009)

Development of Renewable Energy in India

2.6 ***India ranks fifth in the world in total renewable based installed capacity:*** Indian RE capacity with 13,450 MWs is fifth in the world. RE has registered a significant growth in the last decade, registering 27% CAGR. It has grown at a CAGR of 49.2% from 2002-03 to 2006-07 (with wind growing at 64%, small hydro at 22% and biomass at

16.5% between these years) to reach an aggregate capacity of 13.5 GW, as of January 2009.

2.7 ***Renewable Energy Sector outperformed its target during Xth Plan Period:*** Although the renewable energy sector's performance before the Xth plan can be termed as lacklustre, during the Xth Plan the sector was not only able to achieve its targets but also exceeded the target by almost 20%. A review of the physical achievements in grid-interactive renewable power during the X Plan indicates that the RE industry added capacity in excess of 6795.44 MW as against a target of 3075 MW for the Xth Plan period. Of this, 5426.4 MW came from wind power, 536.83 MW came from small hydro, 785 MW from bio-energy and 46.58 MW from waste to energy.

2.8 ***Wind dominates India's Renewable Energy mix:*** The installed capacity of RE sources in India is dominated by wind, constituting around 70 percentage of the total installed RE installed capacity. Small hydro and cogeneration are the other RE sources contributing more than 1000 MW in the overall installed capacity of RE sources in India. However, a lot of RE potential is still available and needs to be harnessed.

2.9 ***Government of India has set a target to reach 54,000 MWs renewable energy by end of 13th Plan:*** MNRE is targeting a huge capacity of RE in India and aims to add almost four times the present capacity by 2022. *Table 1* below summarizes the achievements and projections for RE development in India. The plan shows that wind will continue to dominate the future capacity addition from RE in India. By 2022, India would have harnessed around 88% of its available potential of wind and 43% of small hydro potential. However, the potential for each of the RETs is expected to change (increase) in future with more resource assessments and technological advancements.

	Up to 9th plan	10th plan (2007-12)	11th plan (2012-17)	12& 13th plan (Projected)	Total by 2022(MW)
Wind	1667	5333	10500	22500	40000
SHP	1438	522	1400	3140	6500
Bio Power	368	669	2100	4363	7500
Solar	2	1	-	-	3
Total	3475	6525	14000	30003	54003

Table 1: Renewable Energy - Past Capacity Addition and Projected Targets
Source: 11th Plan proposal MNRE, Govt. of India

2.10 ***Some key initiatives have facilitated development of the Indian RE Industry:*** One of the main factors contributing to the rapid rise of RE sector in India is the establishment of a specialized ministry (Ministry of New and Renewable Energy) and several facilitating agencies at central and state levels – e.g. Indian Renewable Energy Development Agency, Solar Energy Centre, Centre for Wind Energy Technology (C-WET), State Renewable Energy Development Agencies etc. A summary of the key policy and regulatory initiatives that have facilitated the development of renewable energy sector in India, along with their impact is provided in the table below.

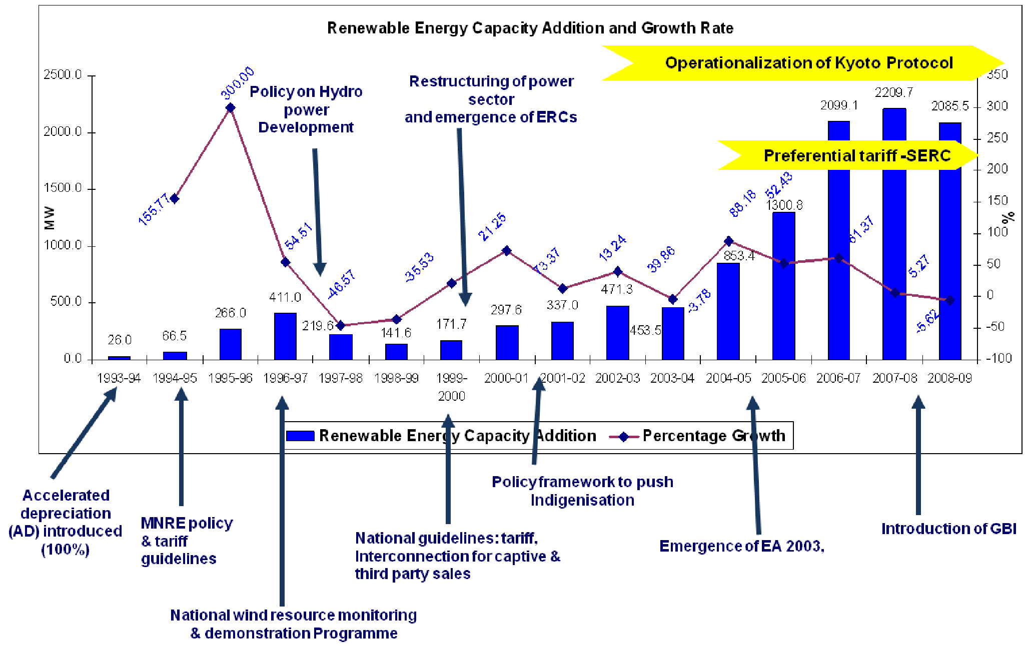


Figure 5 – Renewable Energy Capacity Addition in India
Source: MNRE Website and Publications

Year	*Instrument/Initiative*	*Key Features and Impact on RE Development*
1982	Creation of Department of Non-conventional Energy Sources	An independent department for development, demonstration and application of RE. RE sources were recognized as potential alternative energy sources and received special consideration.
1992	Creation of MNRE	The Department of Non Conventional energy Sources was upgraded into a full-fledged ministry.
1993	MNRE Policy and Tariff Guidelines	Introduction of RE tariff guidelines by MNRE - states to purchase RE power at Rs 2.25/kWh with 5% annual escalation on 1993 as base year. Introduction of Tariff guidelines offered relatively higher price for RE than what was prevailing, and thus triggered development of RE sector, especially wind.
1993-94	Introduction of Accelerated Depreciation	Introduction of Accelerated Depreciation (100% AD) for promotion of wind projects (altered to 80% AD in 1999). This program led to the successful commercial development by involving the private sector in wind equipment manufacturing as well as its application.
1995-96	National Wind Resource Monitoring and Demonstration Program	This programme was intended to develop a GIS platform for presenting spatial data to prepare a meso-scale modelling and a comprehensive wind power density map of potential sites. This program helped in mapping the potential wind energy sites

Year	Instrument/Initiative	Key Features and Impact on RE Development
		across India which in turn induced private sector participation for commercial applications.
1999	Establishment of Center for Wind Energy Technology	The Center provided much needed technical support for wind resource assessment, testing, monitoring, certification and R&D. It also helped the Indian wind industry to develop large scale commercial wind farms.
2002-03	Electricity Act 2003	Recognises the role of RETs for supplying power to the utility grid as well as in stand alone systems. Provides an overall framework for preferential tariff and quotas for RE.
2004 onwards	Preferential Tariffs for RE from SERCs	Following the enactment of the EA-2003, states adopted preferential tariff mechanisms to promote RE. Since it provides differential tariffs for the development of different RETs, it brought in a balanced approach to RE development across states.
2005-06	National Tariff Policy	Directed SERCs to fix a minimum percentage of purchase of energy consumption from RE sources (RPO). This created a demand side stimulus for RE development.
2005-06	Integrated Energy Policy Report 2006	Suggested a path to meet energy needs in an integrated manner. Recommended special focus on RE development and set specific targets for capacity addition through RE sources.
2008-09	Introduction of Generation Based Incentives (GBI) for solar and wind energy	This scheme offers fiscal incentives along with tariff on power generation from solar and wind. It shifted investment interest from installation to generation.

Source: MNRE Website & Publications

CHAPTER-3: COST ECONOMICS OF POWER FROM RENEWABLE ENERGY SOURCES

Introduction

3.1 In general, it is perceived that the financial cost of electricity generation through RE resources is more than conventional sources of energy. Although the initial capital costs of RE projects are typically higher than the capital costs of conventional energy projects, but when externalities such as environmental hazard and fuel price risk for conventional sources are included, RE sources become more competitive. Appropriate advocacy at institutional level is required to realize the correct value of RE sources incorporating the effect of externalities. Across the world, several policy instruments have been introduced to increase the financial viability of RE projects in the short-term so that the long-term benefits can be realized.

3.2 ***Levelised cost of generation for most RE technologies is lower than short term marginal cost from conventional sources*** A comparison of the levelized cost of generation of key conventional sources and RE sources reveals that even with higher initial costs, most RE technologies, with the exception of solar PV, are more cost effective than diesel generation. These levelised financial costs have been calculated without including financial incentives such as accelerated depreciation for wind and solar, capital subsidy for biomass and SHP and CER benefits for all RE technologies. Also, the applicable taxes have been excluded to reflect the economic value of generation from these sources. Given the current power supply shortages in India and the short term coping strategies, a number of state governments and consumers have to bear additional cost burden due to UI charges, high cost of spot market trading and diesel based captive generation. In such scenario, adoption of RE technologies becomes a competitive alternative source to meet short term energy needs.

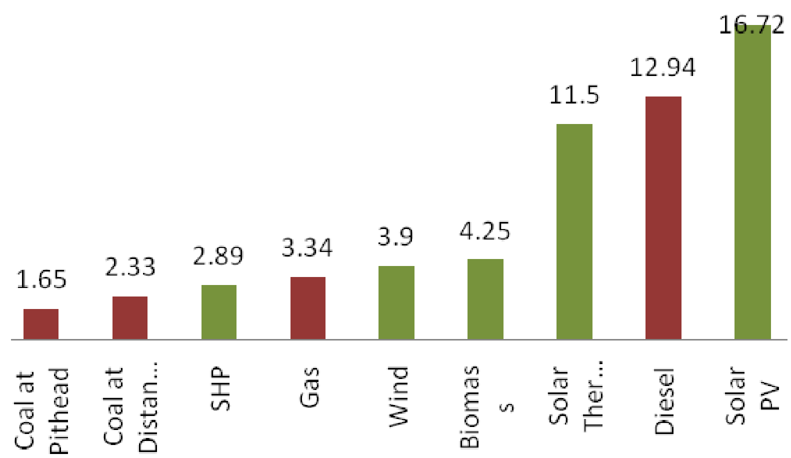


Figure 6 - Cost of generation comparison (Levelised cost - Rs per kWh)
Source: PwC Analysis

3.3 The above figure shows that:

a) SHP has the most competitive levelized cost of generation, amongst the RE technologies, and is even more competitive than gas based generation. This shows the financial viability of this RE source, even at current prices.

b) All RE technologies, with the exception of solar PV, are cheaper than diesel based electricity generation. This means that even without factoring-in the benefits from economic externalities, all renewable energy sources (except solar PV) should be preferable over diesel based generation. which currently accounts for nearly 9000 MW[3] of capacity in India.

c) Although the levelized cost of wind generation is higher than gas-based generation, if global environmental externalities of gas - conservatively valued between Rs 0.50 to Rs 0.75 per kWh in the CDM market - are considered, wind generation becomes more competitive than gas-based generation. Similarly, if cost externalities of transporting coal from distant sources (more than 500kms) are considered, then SHP becomes a cost competitive alternative to coal-based generation.

3.4 ***Increasing fuel costs for conventional energy in the future and stabilizing RE costs would shrink the cost gap for RE***: Fuel costs account for the largest proportion of total costs for coal, gas, biomass, and diesel-based power generation (see Figure 7 below). With rising demand and shrinking supply of sources like diesel and coal, the cost of power generation through these conventional sources is likely to increase. For wind, SHP and solar-based power generation, on the hand, the largest cost component is the high upfront capital costs of equipment. These equipment costs have been decreasing and are likely to continue to decline as technology advancements take place for these technologies. Hence, the conventional energy sources are exposed to high fuel risk than RE sources. These trends in the cost of conventional and RE power will continue to make RE sources more cost competitive than conventional sources.

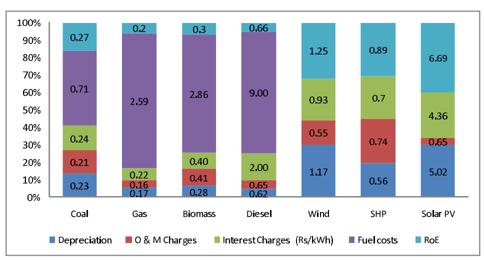


Figure 7 - Cost break-up for different technologies

Source: PwC Analysis

3.5 In the above analysis, financial cost for coal, gas and diesel do not include costs associated with externalities especially environmental hazard and energy security risks.

3.6 ***Increase in conventional fuel cost over the life of the plant implies that SHP becomes more attractive than coal based generation, and wind generation becomes more attractive than gas generation within a few years of plant life***. The largest component of cost of conventional generation is made up of operating expenses, whereas in contrast, the largest component of cost of RE is the upfront capital cost. Over the first few years of plant life, due to fuel price escalations the operating expenses

[3] CEA and Power Line Report

associated with conventional energy will increase while at the same time, capital cost expenses associated with RE equipment will decrease due to debt repayment. In addition, conventional generation continues to face high fuel price risks, while in contrast RE sources are free from such risks.

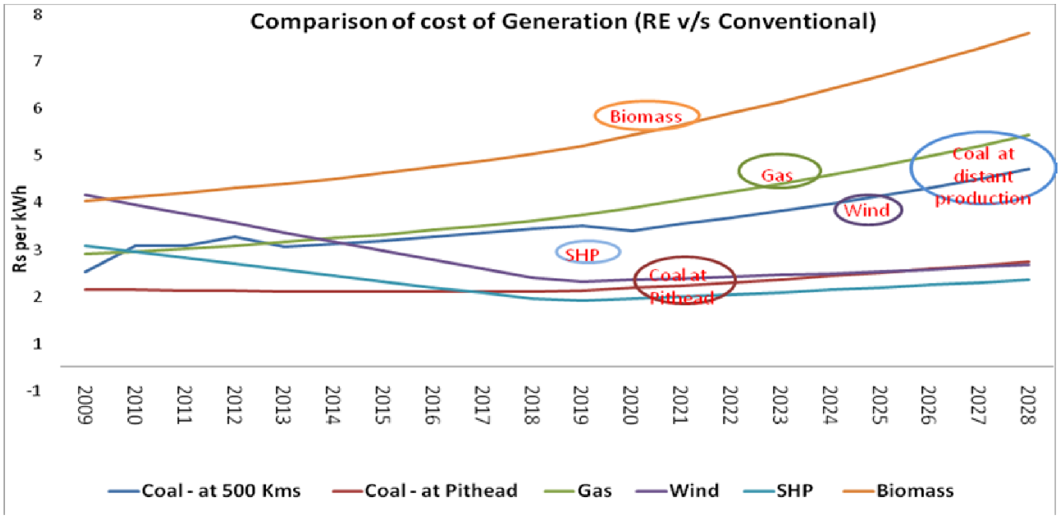


Figure 8: Comparison of Cost of Generation - RE versus Conventional sources
Source: PwC Analysis

Indicative Supply Curve for Renewable Energy

3.7 Based on an assessment of RE potential and costs for different renewable energy technologies (wind, biomass and SHP), an indicative supply curve has been prepared by arranging the cost of generation for RE technologies for different states in ascending order, and superimposing the potential available for harnessing. Due to the large number of data points, the supply curve has been displayed in 3 bands in ascending cost of generation.

3.8 ***Main Observations from the Supply Curve***:

a. ***Almost 11 GW of unharnessed RE potential is available at costs lower than gas based generation***: Most of the SHP and Biomass based generation potential n the country – aggregating to 11 GW – is comparable or more attractive than gas based generation, which has a levelised cost of Rs 3.34 per unit.

b. ***Significant untapped SHP potential at attractive rates of Rs. 2-3 per kWh***: The curve highlights the fact that around 8 GW of small hydro power capacity is available for exploitation in the range of Rs 2 to Rs 3 per unit. Most of the attractive sites in this cost range are located in northern (5 GW) and north-eastern states (2 GW), with only a few in southern states. At the above cost of generation, SHP is more competitive than gas based power which highlights the need to address barriers for SHP in these states, including integrated approaches to evacuation infrastructure development and clearances.

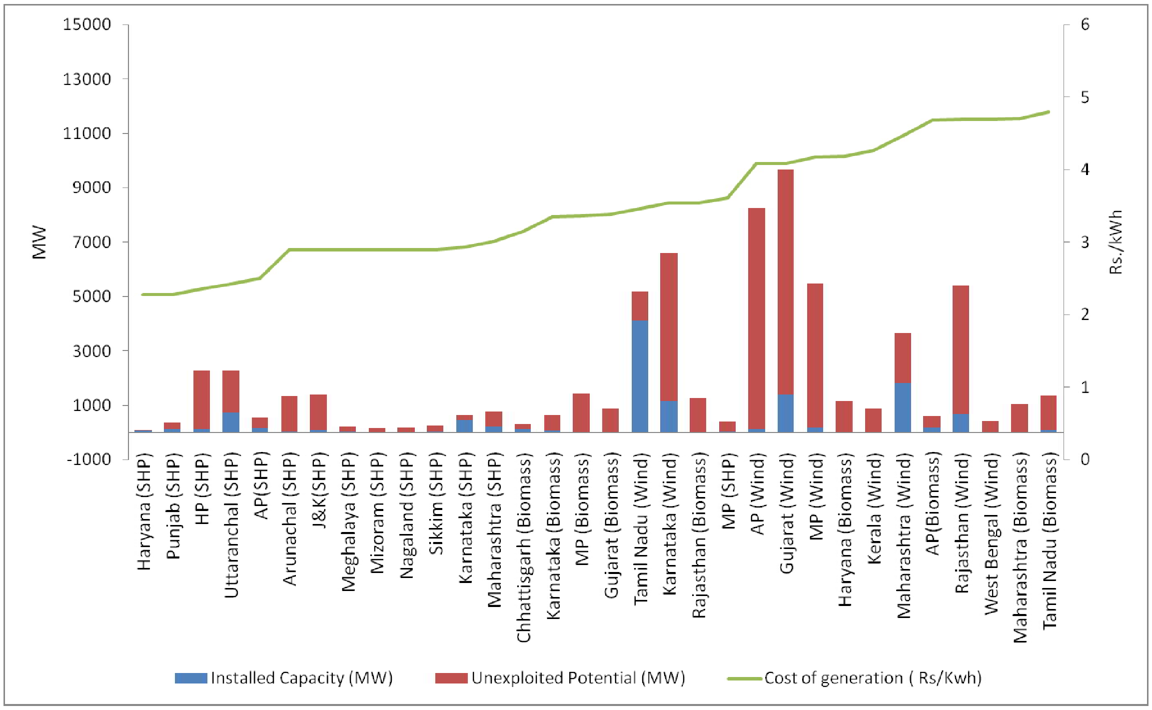


Figure 9 : Supply Curve for renewable energy sources

c. ***Significant potential to develop wind energy in select states***: A large proportion of wind capacity (around 27 GW) is available in the four states of Karnataka, Andhra Pradesh, Gujarat and Madhya Pradesh. Therefore there needs to be a more focused (central and state government) approach for the development of this potential in these select states.

d. ***Levelized cost of wind is more attractive than short-term trading prices of power***: At Rs. 3.5 – 4.8 per unit cost of wind based generation is below short term trading prices and also lower than industrial and commercial tariffs in most states.

e. ***Biomass Power is attractive in Karnataka, MP and Gujarat***: Biomass power offers a potential of 2.8 GW in these three states at a cost of about Rs 3.4 per unit.

CHAPTER-4: OVERVIEW OF POLICY AND REGULATORY INSTRUMENTS

Overview of Policy and Regulatory Instruments

4.1 ***Government interventions remain the key drivers of RE development***: A review of policies and regulatory framework across countries indicates that early commercialization of RE technologies remains dependent on support from the government. Such facilitating policy and regulatory instruments have made RE an economically and commercially viable source of alternative energy[4]. International experience with successful leveraging of these instruments includes several countries (or provinces), such as Germany (soft loans for residential solar photovoltaic systems, feed-in tariffs for wind and solar, technology specific renewable purchase obligations), Japan (net metering, grants for demonstration projects and subsidy for decentralised residential solar photovoltaic systems), California (accelerated depreciation for small scale projects, renewable portfolio standard for states, feed-in tariffs for all RE technologies), Texas (renewable purchase targets) and Spain (high feed-in tariffs for solar – photovoltaic as well as solar thermal)[5].

4.2 Over the years, the Government of India and various state governments have introduced a number of policy and regulatory instruments for promoting RE. Some of these initiatives have been illustrated in the table below. The table captures the key characteristics of the instruments, the impact of these instruments in the Indian context, a comparison with international experience and suggestive approaches for their implementation/further strengthening.

Policy Instrument	Key Characteristics	Indian Experience	Global Experience	Approaches for Implementation/ Strengthening
Feed in Tariffs/ Preferential Tariffs (FIT)	• Integrates the impact of all the cost and benefits of RE into a single instrument. • Ability to "jump start" the market for developed RE technologies by providing long term investment security and market stability. • Impact is crucially dependent on accurate determination of tariff commensurate with financial costs as well as economic benefits of RE. • Long term visibility of underlying principles for	• Most common instrument. Being used for all active RE technologies. Introduced by most states except J&K, Bihar, Jharkhand, Orissa and the North Eastern states. • RE development in states without FITs has typically lagged by far. States with inadequate FITs have experienced slow down in RE development. • Absence of consistent FIT determination methodology across states has affected optimal development of RE resources across the country. Further, FIT determination does	**Germany and Spain** • Most preferred promotion instrument in EU - Available for all RETs but a huge success in Wind and Solar. • Tariffs designed in 'Degression Mode' i.e. it reduces each year (annual digression rate 1-9% depending on the technology) to encourage further technology advancements. • No fiscal impact of Feed-in program - Local utilities pass on extra cost due to	• Develop consistent methodologies for FIT determination across states incorporating financial as well as economic costs and benefits of RE. • Develop a Renewable Energy Regulatory Information System at national and state levels to provide necessary data/ information for FIT determination. • Introduction of a technology up-gradation factor which can be used for calculation of Degression rate of tariffs.

4 Renewables 2007 - Global Status Report (REN 21) 2007

5 (1) Trends In Photovoltaic Applications – International Energy Agency; (2) Letting the Sun Shine on Solar Costs: An Empirical Investigation of Photovoltaic Cost Trends in California – NREL; (3) Renewable Energy Policies and Barriers - Fred Beck and Eric Martinot, San Diego - Smart Energy 2020 – Tech International, Santa Fe, New Mexico

Policy Instrument	Key Characteristics	Indian Experience	Global Experience	Approaches for Implementation/ Strengthening
	FIT determination is crucial for developers' confidence.	not incorporate economic costs and benefits of RE. • Preferred by developers because it enhances project bankability.	FIT, spread equally to all consumers.	• Typically FIT and RPOs should not co-exist as both price (under FIT) and quantity (under RPO) cannot be fixed.
Accelerated Depreciation (AD)	• Aimed at accelerating investment in emerging RE technologies by tapping private investors with large disposable income. • Allows broad basing of investments in a developing country where fund mobilization by RE industry alone might not be adequate. • Preferred instrument to offsets tax liability against investments that brings down realised cost of investment.	• Acknowledged as the key instrument for success of wind industry in India - Most wind installations in India have been developed under AD. • Focus of investment in wind sector remains on tax savings and not on energy generation. • Investment in wind sector in India dominated by non-IPPs. • Criticised for facilitating setting up of wind farms in low wind speed areas which have failed to deliver targeted power generation.	**USA: Modified Accelerated Cost-Recovery System (MACRS)** • Allows depreciation over 20 years with 50% in year 1 and 50% in remaining years. • Mostly attracts small scale developers with little investment (especially in solar rooftop) as an income tax saving tool. **USA: Business Energy Tax Credit (BETC)** • Enables developers to claim a 30% corporate tax waiver on expenditure for solar PV technology.	• AD for wind needs to be discontinued as the sector has attained scale & commercial viability on its own. • AD could be considered for other emerging RE technologies (such as Solar and Off-shore wind) along with adequate FIT. • AD needs to be linked with a minimum threshold generation output in a sustainable manner.
Production Subsidies / Generation Based Incentives (GBI)	• Handholds emerging RE technologies to establish an early market. • Encourages generation rather than only capacity installation • Encourages efficiency in project selection, design, procurement, implementation and operation. Allows professional players to emerge and participate.	• Recently introduced to shift investment focus from capacity addition to electivity generation – move from capital subsidies (AD) to generation based incentive. • Opened up new market prospect for wind IPPs – received application for above 300 MW • Pick up the pace of solar market significantly – received the excellent response from developers for over 1300 MW	**Spain: Premium Feed-in Tariffs for Wind and Solar** • Similar to the regular FIT, consists of two separate payment streams, one for the electricity sold to the state utility at regular market price, and second a fixed component paid to the investor as premium tariff to compensate for profitability shortfall.	• ***Wind***: Scale up GBI to ensure adequate market shift from non-IPPs to IPPs. Streamline GBI benefits with AD benefits to make the shift attractive. • ***Solar***: High GBI support needed for setting-up a market for solar. GBI also needed for small scale development (<1MW; rooftop PV).
Renewable Purchase Obligation (RPO)	• Stimulates demand side for take-up of cleaner sources of energy • Boosts investors' confidence by providing guaranteed market for sale of RE power	• RPOs are mandated by the Electricity Act 2003 and National Tariff Policy • RPOs adopted by 16 SERCs but targets met by 5 states only • Lack of clarity on principles and methodology for determining RPO standards • Lack of Penalty mechanisms in most of the states – only states (Rajasthan and Maharashtra) have penalty mechanism.	• Most of the EU and US states have technology specific RPOs; especially RPOs for emerging technologies to provide confidence to investor • In combination with Tradable Green Certificate (TGCs), RPOs have resulted in more broad based and economically efficient RE development	• Develop standard principles and methodology for determination of RPO standards by SERCs • With a suitable REC regime in place, RPOs need not be restricted to RE potential in the state. • Introduce RPO for all states based on paying capacity of Discoms • Separate RPOs for emerging RE technologies (especially Solar) could be considered

Policy Instrument	Key Characteristics	Indian Experience	Global Experience	Approaches for Implementation/ Strengthening
Renewable Energy Certificates (REC's)	• Addresses geographical constrains to RE development and allows most economic development of RE – consistent with the supply curve. • Offers a free market place for developer to realise the acceptable value of RE power. • Helps states with low RE potential in meeting RPO targets and facilitates RE rich states in developing this potential.	• Currently under discussion and design.	**EU and USA: Tradable Green Certificates (TGC)** • Driven by RE demand generated through RPOs, TGC is a highly successful instrument for RE development in EU and US • Has led to a broad based and economically efficient development of RE. • Higher value of TGC for emerging technologies that may be costlier, to support adoption of such technologies. • Enhances adoption of technologies with the lowest generation costs (economically efficient selection of projects)	• Introduce RPOs to all the states • Introducing technology specific RPO for solar as to boost investors confidence level • Bring in a penalty mechanism for RPOs to support REC At present, design of an REC regime for India is being undertaken by MNRE and CERC.
Capital Subsidy	• Meant to encourage development of capital intensive RE technologies involving first generation small scale entrepreneurs. • Gives developers instant cushion to realise lower capital investment so as to improve profitability. • Combined with production incentives, capital subsidy offers a balanced approach to enhance financial viability.	• Played pivotal role in rolling out and adoption of expensive RE sources for rural electrification (solar applications - lanterns, home lighting systems, water heating; all off-grid electrification projects) • Capital subsides brought in a target oriented approach amongst the implementing agencies – Absence of consistent monitoring and O&M resulted in project failure in terms of actual generation.	**Grants in EU States** • Grants were frequently applied in form of support for all RE technologies in EU states, US and Japan. • In Germany, it is observed that compared to other production support schemes, investment grants insufficiently motivate investors to invest in roof-top solar systems (2002 to 2005). • Focus shifting from investment grants to production based incentives • In US, the grants are restricted to only small scale solar PV developers for residential and commercial purposes.	• Capital subsidies are necessary for kick starting emerging RE technologies. May be considered for solar and waste-to-energy technologies. • As and when technologies mature, capital subsidies should be replaced by production based incentives. • Capital subsidies to be applied innovatively in order to link with generation to ensure long term sustainability of the investment. (For example, conversion of loans into grants upon meeting certain performance standards).
Carbon Trading	• Allows developed countries to meet their CO_2 reduction targets by facilitating developing countries to develop cleaner sources of power. • Enhances creditworthiness of projects having lower financial viability and additionality.	• India has largest number of registered and pipeline CDM projects in the world. • Helped to push the RE industry by making projects more financially attractive • Wind energy projects are finding it increasingly difficult to get projects registered due to the financial viability of wind projects and common practice clauses	-	• Need to set up a national agency to facilitate faster processing (registration, validation and issuance of CERs) • Develop a similar carbon trading mechanism at national level to encourage RE development.

Policy Instrument	Key Characteristics	Indian Experience	Global Experience	Approaches for Implementation/ Strengthening
RE Funds	• Provide low interest loans, fund high risk projects or provide mezzanine financing to new technologies or projects. • Low cost funds facilitate R&D projects and demonstration projects of high risk/ emerging RE technologies.	• Only Maharashtra and Rajasthan have Green funds (soft loans) to promote RE so impact is limited to 2 states. • Maharashtra is using funds to encourage co-generation projects and has set up Clean Energy Fund through which a 'Green Cess' (Rs 0.04 / unit) is levied on industrial & commercial consumers. • Penalties for shortfall in meeting RE obligations help to fund creation of transmission system infrastructure of RE plants.	**RE Funds in EU** • European R&D funding programs help to accelerate development of PV through R&D and demonstration projects **Dedicated soft loans in Germany** • Instrumental in attracting investments for PV as 100% of investment is subject to a low interest (2-3%) & high payback loan for private consumers	• Develop a national level framework for creation of RE funds in different states. • RE funds can be utilized effectively to develop transmission evacuation systems, pilot projects /technologies and other project development activities (studies)
Tax Incentives - Exemptions on Capital Investments and Generation	• The objective of any tax incentive or tax credit scheme is to allow tax savings on investments and electricity duties, which in turn brings down the net costs of RE projects.	• Tax exemption instruments such as exemptions or reductions on excise and customs duty have been introduced • The wind energy sector profited from this exemption in the 90's as a number of players imported components for turbines. • State governments allow exemption of duties on RE generated power (generally for the first 5 years of project life). • Although exemptions bring down the cost of RE equipment, they do not usually drive investments on their own	**Sales and property tax exemptions in US** • Exemption in property tax equivalent to installation costs of solar and wind energy systems • No sales tax (7%) levied for solar and wind energy systems (New Jersey and California). **Import Tax Exemption in EU** • Leveraging exemption of import taxes for new technologies (wind and solar) had two positive impacts in the EU: 1) Initially helped countries like Germany and Spain to procure equipment at more economical rates; 2) Subsequent removal of this exemption spurred development of domestic manufacturing industry.	• Focus needs to be on excise duty reduction as there is a move towards greater indigenisation of RE equipment manufacturing in India

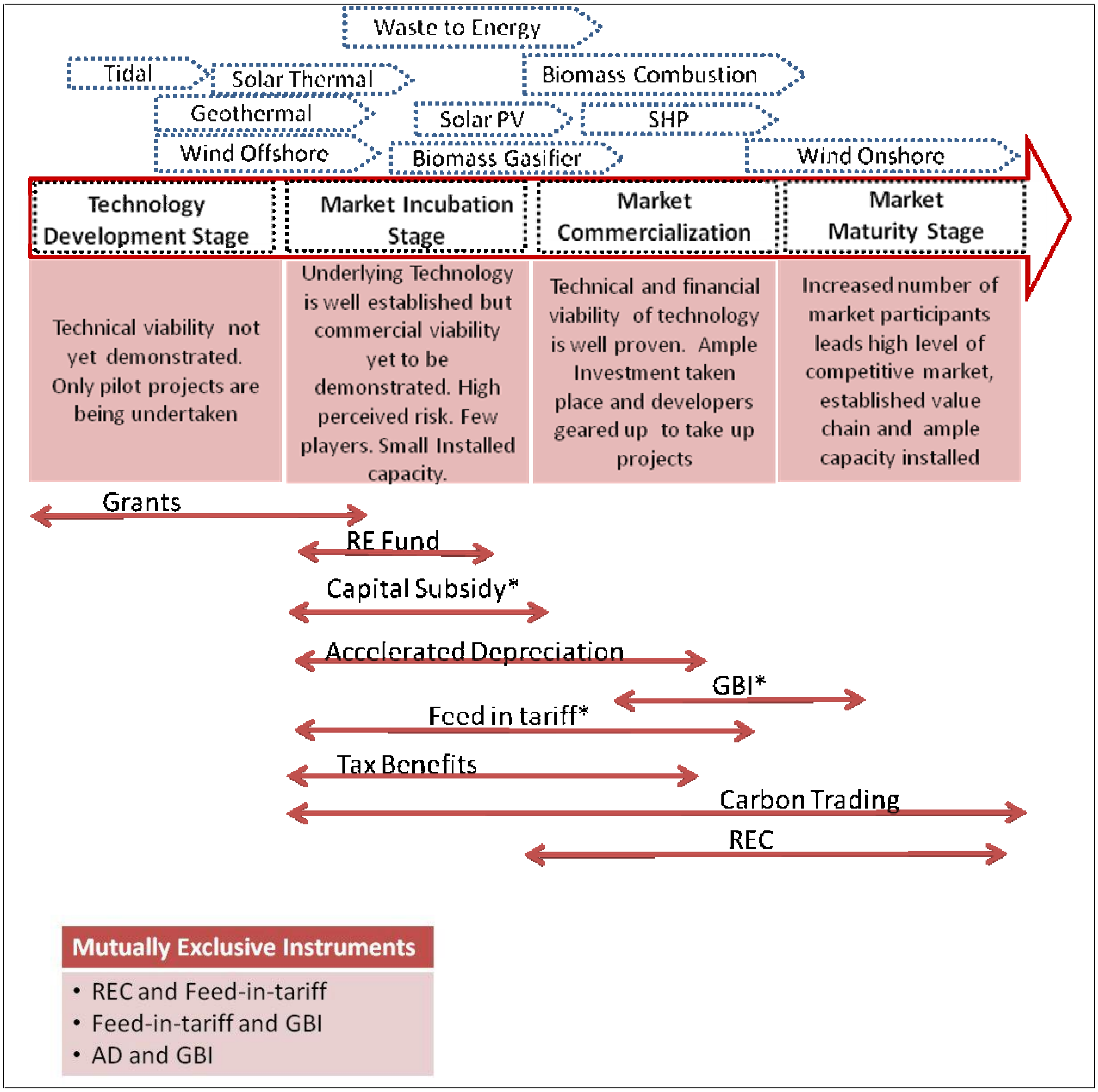
Demonstration Projects and R&D Grants	• R&D Grants/funding – necessary for any RE industry to stay competitive
	• R&D contributes to reducing cost of generation and improving efficiency of RE generation.
	• Demonstration projects provide evidence to investors and key stakeholders of the potential for future replication of new technologies.
		• The task of conducting R&D in RE lies with MNRE
		• There is more of focus on R&D in 11th Plan (MNRE has allocated Rs. 1500 crore for R&D) to encourage:
		  • Indigenization of technologies for through Public-Private partnership route.
		  • New & innovative projects and financing mechanisms (acquisition fund and Venture and Risk Capital funds)
			• The Voluntary Renewable Resource Research & Development Fund of Maine (U.S) helps establish cleaner, more efficient ways of producing electricity. The Fund supports research and development, as well as demonstration projects, for new ways to produce electricity using renewable energy sources.	• Although the SEC (Solar Energy Centre), C-WET, AHEC type institutions have been created, very little allocation was made for encouraging R&D in the private sector.

Policy Instrument	Key Characteristics	Indian Experience	Global Experience	Approaches for Implementation/ Strengthening
Green Power	• Green power – power from renewable energy sources • Green power is priced higher than normal retail power • Green Power aimed at consumers who are environmentally conscious	• Only Andhra Pradesh Electricity Regulatory Commission (APERC) has introduced a new concept of Green Power in retail tariff order for FY 2008-09. • This optional category allows consumers to purchase green power and thus support the development of RE. • Consumers buying green power also have the option of getting CDM benefits and Renewable Energy Certificates (REC's).	A number of communities, municipalities and utilities are turning to green power in the United States keeping in mind the environmental advantages of clean renewable energy. City Light in Seattle offers its customers the option of programmes such as The Green Up Programme.	• Green power without any tangible incentives or access to tradeable instruments like CER's or REC's has little chance of succeeding. • The Indian market does not seem to be ready for green power and no consumers in Andhra Pradesh has availed of the green power option
State RE Policies	• Introduced by state governments for the promotion of RE investments in the state • Measures include single window clearance systems, green energy funds, simplified procedures for allocation of RE project sites, relaxation in state taxes etc.	• Examples of state with policies for RE include Karnataka, Punjab, Madhya Pradesh, Gujarat, Himachal Pradesh, Uttarakhand etc • A number of states have designed single window systems but these have not been implemented with the spirit with which they were designed.	• Not Applicable	• A number of states have still not issued state RE policies and outlined thrust areas • There is a need for streamlining instruments like single window clearances and other statutory and techno-economic clearances

Use of Policy Instruments at Various Stages of RE Market Development

4.3 International experience indicates that appropriate introduction and utilization of these policy instruments at relevant stages of RE development are critical to their effective application. The following diagram maps the current positioning of various technologies, and the appropriate stage for deployment of various policy instruments. Different policy support instruments are positioned along different stages of market development. Their relative placement is determined by their ability to address specific needs of RE at different stages of development. Instruments providing direct assistance, such as grants and RE funds, provide crucial handholding in the inception phase of RE development when these technologies have no track record. As RE technologies gain a foothold and their technical basis is established, instruments like GBI, tax credits, FIT etc ease the transition from technical to commercially viability. Subsequently, as the market reaches a mature stage of development, instruments which allow competitive forces to operate, while assisting in decoupling the value of energy from the value of environmental and other benefits should be applied. Instruments serving global environmental benefits (such as Clean Development Mechanism) can be applied at al points of the market development cycle.

4.4 It may be pointed out that many of these instruments cater to identical support needs and are therefore mutually exclusive in nature. Such instruments should not be deployed together to avoid confusing signals in the market.


Waste to Energy
Tidal
Solar Thermal
Biomass Combustion
Geothermal
Solar PV
SHP
Wind Offshore
Biomass Gasifier
Wind Onshore
Technology Development Stage
Market Incubation Stage
Market Commercialization
Market Maturity Stage
Technical viability not yet demonstrated. Only pilot projects are being undertaken
Underlying Technology is well established but commercial viability yet to be demonstrated. High perceived risk. Few players. Small Installed capacity.
Technical and financial viability of technology is well proven. Ample Investment taken place and developers geared up to take up projects
Increased number of market participants leads high level of competitive market, established value chain and ample capacity installed
Grants
RE Fund
Capital Subsidy*
Accelerated Depreciation
GBI*
Feed in tariff*
Tax Benefits
Carbon Trading
REC
Mutually Exclusive Instruments
• REC and Feed-in-tariff
• Feed-in-tariff and GBI
• AD and GBI

CHAPTER 5: INVESTMENT CLIMATE FOR SMALL HYDROPOWER

Small Hydropower in India

5.1 Over the last decade, small hydropower (SHP) has seen significant growth, particularly in the grid connected form as against the stand-alone village electrification model pursued earlier. Small hydropower is amongst the cheapest forms of energy available, utilizes mature and largely indigenous technology, and its maximum power production coincides with the peak seasonal demand in India. Almost all small hydropower projects are being developed by the private sector, which has witnessed expansion of small single-project firms into multi-project entities (for example, Astha, Bhoruka, IndBharat), as well as entry of large companies (for example, KSK, GVK, GMR, Moser Baer).

Definition of the Small Hydro Sector in India

Hydropower projects in India are classified on the basis of their capacity. Small hydropower projects are defined as those with a capacity of 25 MW or less. These are further classified as Pico (less than 5 kW), Micro (5kW to 100kW), Mini (100 kW to 2 MW) and Small (2 MW to 25 MW) hydropower projects. All projects of capacity more than 25MW are classified as large hydropower plants. The mandate for development of Small Hydropower (25MW or less) is assigned to the Ministry of New and Renewable Energy (MNRE), whereas the mandate for Large Hydropower (more than 25MW) is with Ministry of Power (MoP).

With the development of SHP sector over the last one and a half decades, several players have emerged and expanded from single-project entities to multi-project entities. These developers have expanded in geography – now developing projects in several states, as well as in scale – now graduating to projects larger than 25MW. To support these emerging players as they transit from SHP to larger projects, it is suggested that a separate category of 'Medium Hydropower' for capacity between 25 MW to 100 MW be defined, and be provided appropriate hand-holding support from MNRE and MoP.

5.10

5.11 India has an estimated small hydropower potential of about 15000 MW, which is like to increase in the future as more sites are mapped and identified for development. Bulk of the identified potential is located in the Himalayan belt – in the northern states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and the north-eastern states of Sikkim, Arunachal Pradesh and Mizoram. As on December 2007, the northern states have a combined potential of about 5290 MW of which only 341 MW has been developed so far, whereas the north-eastern region as a whole has an SHP potential of 2181 MW, of which only about 183 MW has been developed.

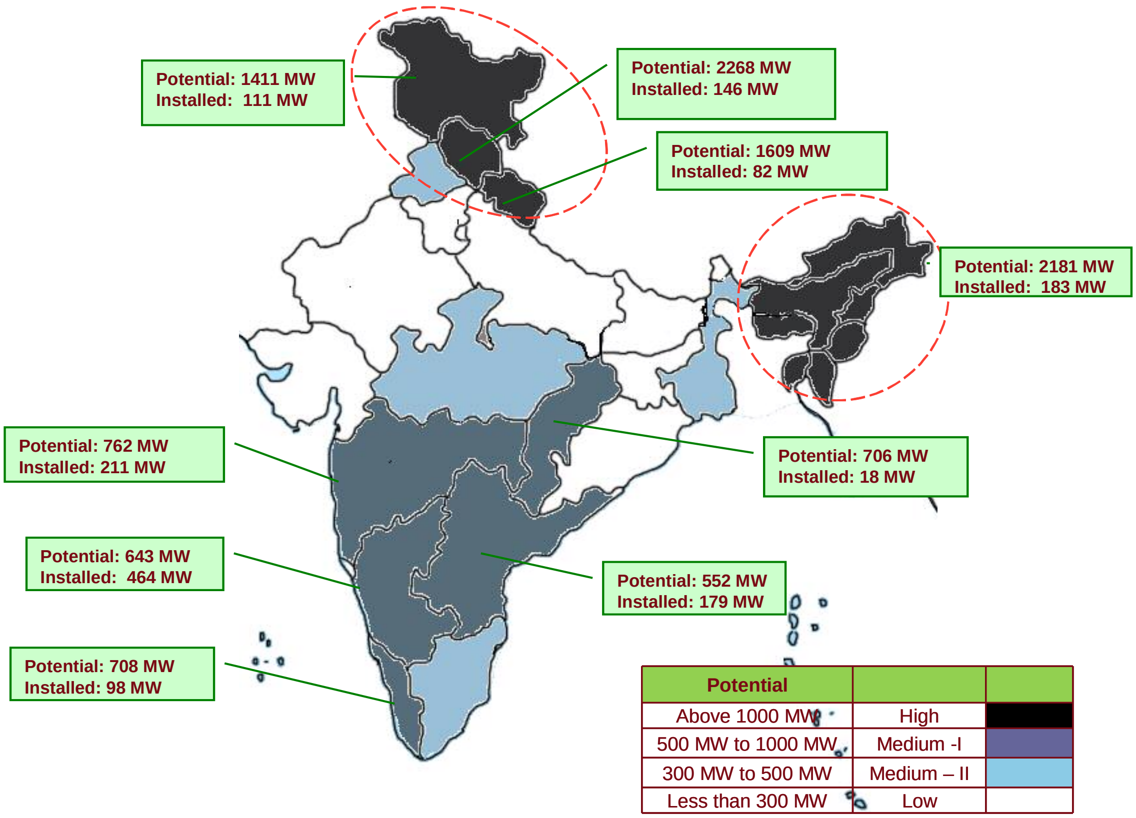
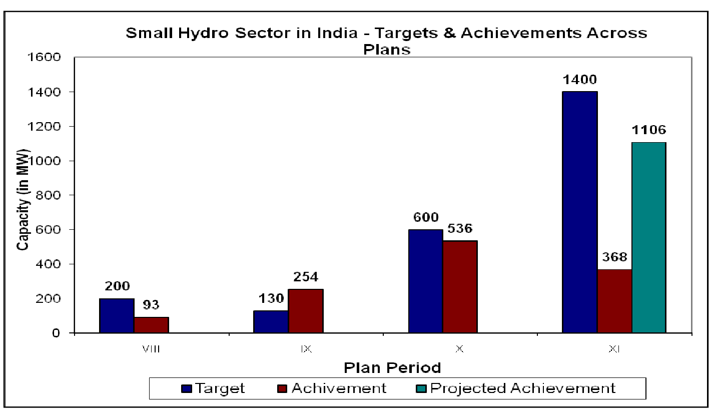


Figure 10: SHP Potential & Installed Capacity in India as on December 2007

SHP Development through the Years

5.12 The pace of capacity addition in small hydro remained slow till the VIII Plan Period. The main factors for slow capacity addition in the sector were inadequate State Plan allocation, lack of coordination among development agencies, low priority for SHP development by State Electricity Boards and lack of clear policy for private sector participation in the sector.

5.13 Small hydropower development received a significant boost during the IX Plan when state governments, in an effort to reduce project development time and increase capacity addition, allowed greater private participation in the sector. As a result small hydro was able to add 790 MW of capacity during the IXth and Xth Five Years Plans. The XIth Plan has set a target of 1400 MW for the SHP sector and so far only 294 MW has been added (as on January 2009).



Factors Facilitating the Development of the Small Hydro Potential in India

5.14 Figure 11 maps the development of India's SHP sector development from 1997 to 2008 and highlights some of the main events that helped bring the sector to its present shape.

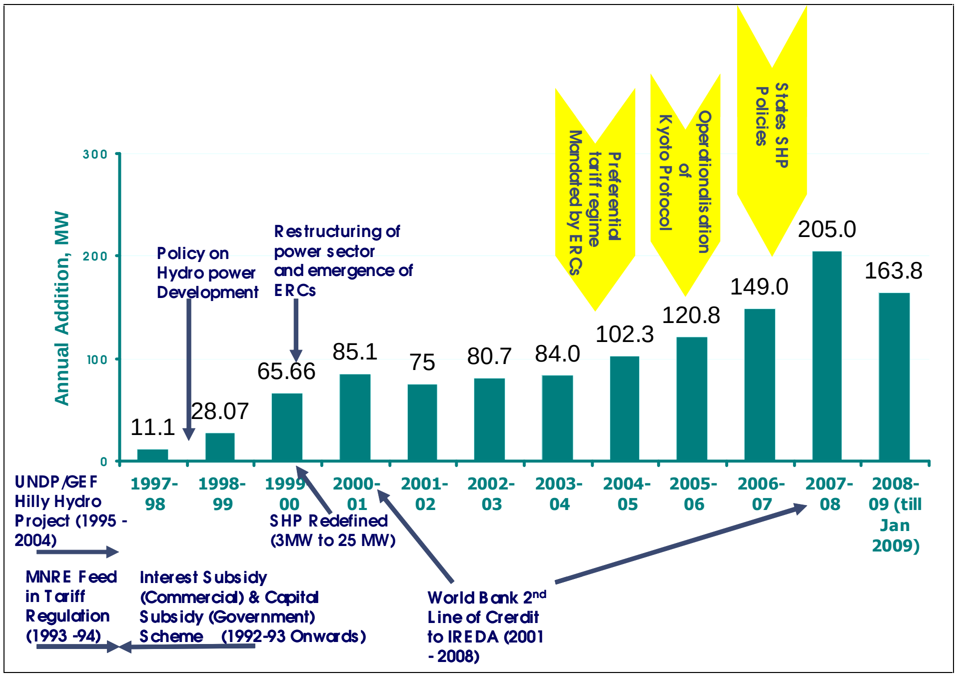


Figure 11: Development of SHP sector between 1997 and 2008

Source: MNRE and PwC Compilation

Key Initiatives	Characteristics and Impact
UNDP GEF Indian Hilly Hydro Project ***1994***	The project was aimed at developing a national strategy and master plan for utilization of small hydro in the Himalayan and sub Himalayan region. The project developed 20 pilot projects to demonstrate community participation and management of SHP for rural electrification. It lead to the development of a firm SHP programme for India.
MNRE Renewable Energy Tariff Guidelines ***1993-94 to 2003-04***	In 1993-94, MNRE introduced a RE tariff which offered to provide Rs. 2.25 per unit with a 5% annual escalation for first five years, and a tariff period of 20 years. This tariff allowed a number of private sector developers to set up small hydropower plants even in the absence of any large tax incentive program.
State Small Hydropower Policies	A number of states formulated their own small hydropower promotion policies which aim at encouraging private participation in the sector. As part of these policies, states introduced centralised procedures for land acquisition and other approvals/clearances for speedy implementation of hydroelectric projects. Till now 13 states (Himachal Pradesh, Uttarakhand, Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Karnataka, Kerala, Andhra Pradesh, Tamil Nadu, Orissa, West Bengal and Maharashtra) have announced SHP policies. The facilities covered under these policies include wheeling of power produced, banking, attractive buy-back rates, facility for third party sale, etc. In the states where policies have been announced, an encouraging response has been received from the private sector. Over 800 sites of about 2000 MW capacity have already been offered or allotted in these states by 2006-07. The state of

	Himachal Pradesh had offered over 400 sites aggregating almost 1000 MW followed by Uttar Pradesh offering 57 sites aggregating 161 MW. Sites have also been allotted in Karnataka, Andhra Pradesh, Punjab, and Kerala.
World Bank's 2nd Line of Credit (2001-2008)	The World Bank provided IREDA a Line of Credit (US $ 135 million) with the objective of providing an overall impetus to the SHP sector by mobilising private sector investments. The project was by and large successful in meeting its objectives. It supported 45 projects with a total capacity of 157.85 MW. A significant outcome of the project was the entry of a large number of players into the SHP sector (examples IndBharat, Astha, Polyplex). These players have since gone on to upscale and diversify into new geographical areas. The 2nd LoC was also responsible for developing the first two small hydro projects in the East when they supported two projects in the hill districts of West Bengal.
Feed-in-Tariffs (FIT) for Small Hydropower	Till now, 11 regulators (Himachal Pradesh, Uttarakhand, Uttar Pradesh, Karnataka, Andhra Pradesh, Maharashtra, West Bengal, Haryana, Punjab, Madhya Pradesh and Kerala) have issued FIT for small hydropower. FIT forms the most important variable for investors identifying a state for project development. SHP, unlike, wind or solar projects, have no access to other incentives (except CDM financing). It needs to be noted that the North Eastern states, which boast a sizeable potential have still not issued FIT.
Operationalization of the Kyoto Protocol (2005)	Ratification of the Kyoto Protocol allowed projects in developing countries with the carbon emission mitigation potential to earn revenues through carbon trading. The renewable energy sector including the small hydro sector in India has benefited immensely from this development. CER revenues have increased the returns from these projects, making them all the more attractive for the private sector.

Review of Project Allotment Process

5.15 For Small hydro, site identification and allocation is critical as it is a site specific technology. It is at this point in the small hydro sector that competition should be brought in to ensure efficiency and utilisation of economic value. There are basically two routes used for the allocation of sites in small hydro sites – the MoU (Memorandum of Understanding) route and the bidding route.

I. ***MoU Route***: Under the MoU route, the state nodal agency invites applications for allocation of sites. Although project allocation under the MoU route does go through a review of the technical and financial capabilities of the developer, this route suffers from a number of lacunae. These include lack of transparency in site allocation, low stake of developer which may delay project development and sub optimal realisation of economic value. Himachal Pradesh's experience with this model has not been very good.

II. ***Bidding Route****:* Under the bidding route, states invite bids for sites using one of the three parameters like Free Power, Upfront Premium, Tariff or State Equity. The project site is transferred to the bidder who quotes the maximum number above the base case for the identified parameters. Although all these three routes have certain inherent disadvantages, they score over the MoU model as they allow for better price discovery, penalise developers for inefficiency in project development and operation and bring in greater competition and capacity into the sector.

Table 2 - Advantages & disadvantages of different modes of project allocation

<table>
<tr><th></th><th>MoU</th><th colspan="3">Competitive Bidding Route</th></tr>
<tr><td rowspan="3">Advantages</td><td rowspan="3">• Simple bid evaluation process based on technical and financial qualifications
• Upfront preparation of Detailed Project Report (DPR) not essential
• Can be used to encourage local entrepreneurs</td><td colspan="3">• More rigorous upfront evaluation of the project by bidders (reduced project risks)
• Developers inclined towards timely implementation of project to achieve early revenue flows and optimal utilization of the lease period
• Competitive pressures encourage efficiencies in project design, implementation and operation
• Typically companies with more evolved project management competencies participate
• Under the SPV route, statutory and techno-economic clearances can be provided upfront – thus reducing the project delays/risks substantially.</td></tr>
<tr><th>Upfront Premium Based</th><th>Free Power Based</th><th>Tariff Based</th></tr>
<tr><td>• Short term revenues for state exchequer</td><td>• Lower risks and financial burden for developer vis a vis upfront premium model
• Long term revenues for state exchequer</td><td>• End users benefit most vis a vis other models
• High levels of price discovery vis a vis other models
• Site development not dependent on Feed in Tariffs</td></tr>
<tr><th></th><th>MoU</th><th colspan="3">Competitive Bidding Route</th></tr>
<tr><td rowspan="3">Disadvantages</td><td rowspan="3">• Lack of transparency in the project allocation
• Low stakes may delay project implementation
• Lack of competitive pressures in project allocation may result in sub optimal realization of economic value</td><td colspan="3">• Transaction costs high for low capacity projects due to extensive evaluation before bidding
• Inadequate information availability (poor PFR /DPR quality) increases risks (bid versus project cost and performance)</td></tr>
<tr><th>Upfront Premium Based</th><th>Free Power Based</th><th>Tariff Based</th></tr>
<tr><td>• Higher upfront burden on project
• Delays in project execution impact viability most among all four routes</td><td>• Benefits of free power may or may not be passed onto consumers (HP and Uttarakhand do not pass on benefits)</td><td>• High project performance related risk vis a vis free power</td></tr>
</table>

Source: PwC Compilation

Key Messages:

I. MoU route is desirable for smaller capacity projects as it has lower transaction costs, however it suffers from lack of transparency and the risk of sub optimal utilisation of the small hydro resource due to lack of competition.

II. Adoption of any of the three competitive bidding routes requires preparatory work from state nodal agencies in terms of pre bid preparation and bid evaluation. For the bidding to be successful there is a need for market development where competition can bring about greater efficiencies.

III. Tariff based bidding route allows maximum price discovery and provides maximum benefit to the state utility and consumers. However this route poses unacceptably high risks for developers (due to the uncertainties in cost and time for project development and generation). The Ministry of Power has therefore discouraged hydro power project allotment on tariff based bidding basis.

IV. States benefit the most from the free power route and the upfront premium route. Tariff based bidding benefits the states indirectly as their subsidy burden reduces.

Competitive Bidding Experience in Assam and Uttarakhand

Both the state governments of Assam and Uttarakhand have developed joint ventures with IL&FS for the development of small hydro projects through competitive bidding. In Assam, tariff based bidding is being used and the JV proposes to develop four SHP with a total capacity of 4.7 MW through a shell company. The shell company also house clearances for the 4 plants. In Uttarakhand, bidding is being undertaken on upfront premium, and the JV has created a Special Purpose Vehicles (SPV) for parking hydro sites along with the requisite clearances.

The Value Proposition: The Pre-feasibility Report cum commercial viability report, the Detailed Survey & Investigations work was undertaken by the JV's and major clearances obtained.

Key Observations: The SPV based allotment of projects (which have the DPR and clearances in place) increases the marketability of projects. This route if implemented well (that is the developers have complete confidence in the preparatory work done by the JV and do not go in for another DPR preparation) has the capacity to significantly scale down project development time and reduce risks associated with these projects.

Key Issues impacting SHP Development

5.16 The small hydro, sector suffers from a number of constraints that are impacting its development. One of the important constraints is the approach followed for site allocation, which has been discussed in sections 5.6 and 5.7. The other major constraints impacting the development of the SHP sector in India are:

a. Delays in clearances, approvals and land acquisition
b. Lack of adequate risk mitigation options for SHP developers
c. Access to financing
d. Evacuation & access infrastructure issues
e. Delay in delivery of electromechanical equipment
f. Lack of adequate manufacturing capacity

a. *Delays in Clearances and Approvals*: Most stakeholders consulted as a part of the study highlighted obtaining clearances and getting access to evacuation infrastructure as the biggest bottlenecks in SHP project implementation with over 60% of the concept to commissioning time being taken up by clearances. This is in contrast with the view of state agencies, which normally expect and keep a time period of just 6 months for obtaining all clearances.

   i. *Delays and Quality Concerns in Pre-feasibility Report:* In some states, the pre-feasibility report (PFR) is prepared by the state hydropower utility or the state renewable energy development agency. The utilities accord low priority to PFR development, thereby delaying project allotment. Utilities undertake development of PFR's using conventional norms and do not incorporate innovations from the perspective of cost reduction or capacity enhancement. Developers usually prepare their own PFR. For example, Polyplex Industries in Sikkim converted three project sites of 40, 80 & 90 MW to 100 MW each through better engineering, like shifting the position of the weir site upstream and power house site a little downstream.

ii. *Delays in Allotment of Projects:* Allotment of project sites does not follow strict timelines and delays are experienced due to policy ambiguities, change in government or change in management of the designated agencies. For example in HP, allotment is still pending for sites notified in 2008. There is a need for continuity of policy decisions at the state level and adhering to strict timelines, delays beyond which would lead to escalation to higher authorities.

iii. *Delays in Forest Land Allocation:* The process of forest land clearances tend to be cumbersome and causes substantial delays to projects. The process entails file movement from Forest Conservator right down to the Ranger and then back up again to the Conservator – thus requiring significant amount of time. For land allocation of more than five acres, the file has to go to Ministry of Environment and Forests (MoEF) at Delhi, which further adds to the cycle time. In case of some missing data or information, or if certain clarifications are required, the whole cycle has to be repeated and can result in a further delay of 6 months to a year. There is a need for review of the underlying processes, revision of formats for increased clarity on data and information requirements, as well as training of developers on how to fill out the required forms.

iv. *Difficulties in Acquisition of Private Land:* Land acquisition has become a constraint in SHP development due to the site specific nature of the project. Private land owners in states like HP and Uttarakhand have realized the importance of land in SHP project development. As a result, the premiums for sale of land have increased. Although states can acquire land under section 4 of the Land Acquisition Act, state administrations are reluctant to use this route due to political considerations and low priority awarded to SHP by these power surplus states.

v. *Lack of adequate capacity in Project Engineering and Construction:* The SHP sector in India lacks adequate Engineering, Procurement and Construction (EPC) contractors who can undertake complete project design and implementation activities. Usually contracts have to be split up between civil and EME (Electromechanical Equipment) contractors leading to increased coordination requirements, complex integration, and dilution of accountability in the project.

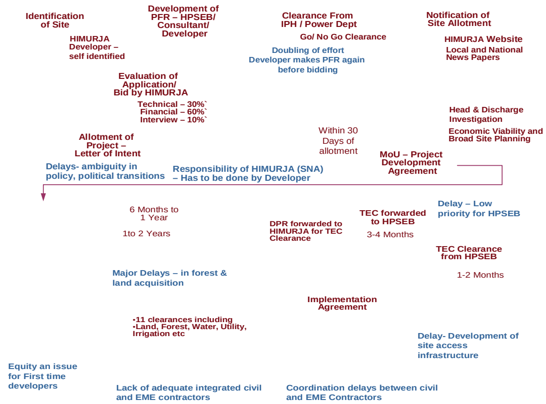


Figure 12: SHP Project Allocation and Development Cycle for the state of Himachal Pradesh

Source: PwC Compilation

b. *Lack of adequate risk mitigation options for SHP developers:* All RE projects including SHP are exposed to risks which have the potential of causing time over runs, cost escalations or loss of generation. Table *3* highlights the main risks associated with small hydro projects in India, qualitatively measures the probability of occurrence, potential impact and availability of risk mitigation instruments. The main inference from the risk analysis is that all risks have to be borne by the developers and for most of these risks, no risk mitigation tools are available in the Indian RE market. Even though the financial institutions themselves tend to get affected by these risks, no risk mitigation instruments are available at the national level due to lack of adequate data. Small start has been made in India. For example, Weather Risk Management along with ICICI Lombard has developed an insurance product for measuring and mitigating hydrological risks.

Table 3: Risks associated with SHP and the mitigating instruments

Macro Risks	Nature of Risk	Probability of Occurrence	Potential Impact	Risk Mitigation Instruments
Preparatory phase of the project	Resource Assessment Risk	Moderate	High	None
	Delay in getting government clearances and regulatory approvals	High	Moderate	None
Project Development Risk	Geological Surprises	Low	High	None
	Land Acquisition, Rehabilitation and Resettlement (R&R) and Environment Action Plan (EAP)	Medium	High	None
	Lack of project integration due to separate Civil and Electro-Mechanical EPC Contractors	Moderate	High	None (Cost capped Integrated EPC contracts available in power sector)
	Cost over runs due to faulty Survey and Investigation	Moderate	High	None

	Access to site	Moderate to high	Low to moderate	None
	Delays/interruptions in procurement of electromechanical equipment	Moderate to high	Moderate	Turnkey procurement - time & performance guarantees (happening in isolated cases)
Operation and Market Risks	Timely access to grid inter connect with the grid	High	High	Deemed generation state (HPERC and PSERC have passed orders to this effect)
	Increased siltation of rivers due to climate change	Moderate	Moderate	None
Performance risk	Equipment supplier fails to provide quality service in time – loss of production	Moderate	High	None (Can be through performance guarantees from manufacturer)
Climate Change related risks	Climate change may alter rainfall patterns, adversely affecting the financial viability and financial risks related to existing and potential hydro projects.	Moderate	High	Weather Risk Management has started offering insurance for this risk - Hydrology linked weather insurance

Source: PwC Primary Research

c. *Access to Financing:* One of the biggest bottlenecks constraining RE and SHP development in India is the cost and access to capital for project implementation. Some of the major issues under access to financing impacting the SHP sector development have been highlighted below:

   i. *Capital costs comprise a large part of life cycle costs:* RE developers in India are charged between 12.5 to 14.5% interest for RE projects including SHP by financers like IREDA. The interest rate is the same for large conventional plants like the Ultra Mega Power Projects. International experience on the other hand points to examples of China, Germany and other EU countries where RE projects are being financed at lower than market rates through soft loans and green funds.

   ii. *RE not a high priority focus area for most FI's in India:* Except for IREDA, most FI's lack the knowledge or bandwidth to undertake large scale RE financing and risk mitigation. These banks do not treat RE financing as one of their thrust areas and allow it to take a back seat in times of financial distress. For example, IREDA project sanctions have doubled after a number of Indian and multinational banks have temporarily stopped funding RE projects.

   iii. *Focus on balance sheet financing:* There is lack of adequate project financing in the SHP sector. Smaller first generation entrepreneurs face more problems as most financial institutions, except IREDA, prefer balance sheet financing. These players usually lack a strong balance sheet and credit history, making access to financing all the more difficult for them

iv. *Very few financial instruments for RE*: The Indian financial market has not been able to cater the need of RE sector completely. Low levels of awareness and lack of quality historical data are some of the bottlenecks for developing appropriate financial and insurance products. Other reasons why FIs are wary of lending to SHP developers include lack of data, adequate understanding of risks and lack of risk mitigation instruments.

> ***New trends in RE financing***: For the past few years, the arrival of a number of international FIs, venture capital funds, green funds etc has made access to finance easier for RE developers. However, the 2008 global financial meltdown has lead to a reduction in the quantum of financing available. A number of Indian FI's, especially public sector FI's in power and infrastructure financing have started taking a proactive approach to financing the RE sector. Firms like IREDA, IDFC, PFC etc are relying more and more on consortium financing, which minimizes risks and allows from better spread of funds. However with the present economic downturn and the need to significantly upscale RE capacity, there is a need for a more focused approach to RE financing, especially for established technologies like SHP is required.

d. *Evacuation & Access Infrastructure Issues:* Development of adequate power evacuation infrastructure especially for SHPs is one of the crucial issues/ barriers in scaling up any hydro plant. Critical factors that need addressing under evacuation are:

i. *Lack of adequate transmission capacity* – Lack of adequate transmission capacity is a generic constraint afflicting this sector. This issue is constraining the development of SHP across the Northern and North Eastern (NE) states (HP, Uttarakhand, Sikkim and rest of NE).

  i. In HP, areas like Kullu, Lahaul & Spiti, Kinnaur, Pangi and Chamba Valley are currently facing evacuation capacity constraints. A number of developers like Sai Engineering have either scaled down commissioning of projects or delayed commissioning.

  ii. In NE, SHP plants like Lodhama have been forced to construct their own evacuation lines lines due to capacity constraints.

  iii. Siliguri in Sikkim is turning out to be a choke point as most transmission lines have to pass through this narrow stretch of land.

  iv. In Uttarakhand, Polyplex is unable to sell power to TATA Power as PITCUL or PGCIL have been unable to guarantee availability of evacuation infrastructure.

ii. *Lack of adequate planning for future SHP potential:* Transmission planning is undertaken usually for large hydro projects and transmission requirements of SHP are largely ignored. For instance, till 2008, no state transmission plans existed for SHP. The focus of policy makers till now has been confined to large hydro projects. No state level plans for evacuation infrastructure were founded for the North East.

iii. *Lack of synergy between project site allocation and transmission infrastructure development:* No coordination or consultations take place between the State Transmission Utilities (STU) and the State Nodal Agency (SNA) for sites in process of development or allotment. This results in haphazard development of sites with the STU being forced to spread its resources.

iv. *Delay in Transmission Projects* – Delay in transmission plans due to factors such as lack of funds with the STU's also impact SHP development. For example, HP has developed an Rs 1100 crores state small hydro transmission plan, to be implemented over the next 5 years. However, the STU has not been able to initiate implementation of the plan due to lack of adequate funds. Several states also lack the capacity (technical and financial) to implement such large transmission projects, especially in the North East.

e. *Delays in equipment delivery:* India has in place a well established industry for the manufacture of electro-mechanical equipment for SHP. This industry has for decades been dominated by the Bharat Heavy Electricals Ltd (BHEL). However with a huge spurt in demand in the sector, private sector players like ABB, Alstom, Jyoti etc have entered the Indian hydropower sector.

f. *Lack of adequate manufacturing capacity*: Most small hydro equipment providers in India including BHEL are suffering from capacity constraints as the country's manufacturing capacity is unable to keep up with the growing demand in this sector. Players are reluctant to expand as they are unsure of the future demand. A number of these players have foreign collaborations and in times of high demand either outsource orders to these foreign collaborators or delay deliveries. Developer feedback pointed out that in a number of cases equipment providers promised delivery within a stipulated period but could not meet their commitments.

Competition from China in Supply of Small Hydropower Equipment

Lack of adequate manufacturing capacity in India has forced a number of developers to explore international markets like China for SHP equipment procurement. With time, Chinese equipment suppliers have also started entering into collaboration with Indian companies for the supply of turbines. Chinese manufacturers offer developers a lower commissioning time as they have an inventory of various turbines ready for shipping directly from China.

Recommendations

5.17 *Use of a basin level approach using pooling points for small and medium hydro development* – There is a need to follow a basin level approach to small and medium hydro project development. The Government of India has been following a basin based approach for large hydro projects. This approach becomes more critical in case of small and medium hydro projects. The main reasons for the same are limited capacity of developers to set up evacuation infrastructure and STU's reluctance to provide evacuation for small distributed projects. This approach needs to be followed by the state nodal agencies while allocating projects. Once these projects have been allocated the SNA along with the STU needs to identify pooling points for these projects and develop requisite infrastructure.

5.18 *Need for defining medium hydro power:* A number of projects are being developed by small hydro players that come under the large hydro capacity but are smaller than 100 MW. A number of other commonalities like problems with evacuation and access infrastructure exist between small hydro projects and large projects. Thus there is a need to define a new category called medium hydro which includes projects between 25 MW to 100 MW and design a hand holding mechanism involving MNRE and MoP.

Growth and Diversification in the Small Hydro Sector in India: Over the last few years, SHP in India has seen number of developers scaling-up and diversifying both geographically and into new market segments. Players who started out with one or two projects have over time grown, now developing multiple small and medium (25 to 100 MW) capacity projects across multiple states. One of the most prominent examples of this is the Polyplex Group, which has migrated from the small to medium hydro category and diversified to new states like Sikkim and Uttarakhand from a base in Punjab. Another example of scaling up has been the Bhoruka group, which now has projects with a cumulative installed capacity of 89 MW and another 140.5 MW under development. This group has now diversified from canal based projects to run of the river and from Karnataka to Haryana and Punjab. The Astha Group is another example. Astha has over the last decade initiated the development of over 150 MW of small hydro plants in HP and Karnataka.

5.19 *Bundling of*

Internal Approvals **–** Internal approvals from state departments like irrigation, water resources etc can be bundled together and provided to developers as a 'package of clearances' at the time of signing of the Implementation Agreement. There is a need for the state government to undertake a business process re-engineering (BPR) of the whole process. Another BPR exercise needs to be undertaken for shrinking project development cycle to 5 years from the present 8 to 9 years through execution of parallel activities. This BPR exercise would need to focus on:

a. Understanding the main bottlenecks impacting the project development cycle like clearances, data, capacity of institutions and institutional arrangements for SHP in the states of J&K, HP and Uttarakhand
b. Identifying data and information sources like site location, access issues, transmission status etc and facilitating access to these data points. Also undertaking a benchmarking of good practices for SHP project development across states
c. Providing an overall framework for other states to implement recommendations.

5.20 *Need for creating an agency at state level for ensuring good quality of project preparation:* One of the main reasons for long project development cycles and use of MoU routes for project allotment lies in lack of quality project preparation. DPRs tend use outdated norms and need to be developed again by project developers after allocation. Therefore, states need to create a new agency that would be responsible for undertaking good DPR preparation. This agency needs to be provided funds, expertise and power to ensure good quality DPRs backed up by a good competitive bidding based project allotment mechanism for small hydro projects. This agency should be empowered to invite and employ the best technical consultants to develop DPRs and then get these DPRs ratified. This will enhance the confidence of the project developers interested in these projects.

5.21 *Options for provision of evacuation infrastructure to SHPs at state level* - Utilities need to adopt a multi-pronged customized approach which may consist of any of the following interventions:

a. SHP plants need to be developed as clusters to allow STUs to optimise resources and reduce delay owing to lack of evacuation infrastructure
b. STUs need to develop a comprehensive transmission plan for RE at the state level every five years.
c. States need to create pooling points for SHP evacuation and develop sites around these points - Uttarakhand has launched an Integrated Transmission System to evacuate power through a system of designated pooling points within the state grid. This model of evacuation infrastructure development has been identified by the MoP as "The Model" for evacuation infrastructure development.
d. Allow STU to outsource development of evacuation infrastructure and allow utilities to provision this under Annual Revenue Requirement (ARR).
e. Make STU responsible for deemed generation if evacuation infrastructure is not in place by the time of commissioning
f. Create a dedicated national or regional level RE Transmission Development Corporation for RE projects across the country especially the North East.
g. Encourage STUs to form JVs with private firms at state level to develop infrastructure
h. Create an empowered committee at the state level to address evacuation issues related to development of evacuation infrastructure. The empowered committee should be provided powers to resolve disputes, issue orders to the STU and developers.

5.22 *Adoption of a SPV based approach with all clearances and DPRs in place:* There is a need to examine, study and adopt the approach being used by IL&FS in Assam and Uttarakhand to bring down the project development cycle time.

5.23 *Facilitate availability of low cost finance:* The central government needs to float tax saving 'Renewable Energy Bonds', like infrastructure bonds, to collect low-cost funds from the general public. This scheme could be managed by IREDA, a financial institution managing renewable portfolio in MNRE.

5.24 Need for the Central government to facilitate the development of capacity for SHP equipment manufacturing to attain self sufficiency and reduce overall costs.

5.25 *State initiatives need to focus on facilitating faster SHP project development:* State level policy initiatives play a critical role in streamlining project development and have not been very effective at attracting investments (that is still mainly based on FIT, potential etc), however, these policies do lay the basic foundation for the actual execution of RE projects. Hence, there is a need for these policies to encourage efficiency and facilitate project development. Some of the recommendations for facilitating development of SHP from the state government are:

a. *Single window clearance system* – Single window clearances which actually work is the need of the hour in this sector. A number of states have designed single window systems but these have not been implemented with the spirit with which they were designed. The highest policy body at the state level, i.e. the state cabinet or the state chief minister's office need to regularly monitor the performance of all of the projects and have a time bound plan for their development.

b. *Need for proactive support by state government on procurement and acquisition of land* – There is a need to facilitate transparent, fair and timely acquisition of land through a schedule at the state level. States also need to use 'Land Acquisition Act- section 4(1)' provisions more often in case the acquisition of land is delayed beyond a point.

5.26 *Need for risk mitigation instruments for small hydro:* There is a need for a collaborative effort in designing risk mitigation instruments for the SHP sector. Major institutions like MNRE, state nodal agencies, financial institutions and project developers need to work together to develop a data bank of resources, risks and other information related to risks. This data bank would serve as the basis for the development of risk mitigation instruments. A number of FI's and insurance agencies have the wherewithal to develop and market these instruments once the data banks have been developed. There is also a need for studying and adapting global practices like performance guarantees from equipment suppliers or fixed sum contracts from EPC contractors to Indian conditions and undertaking pilots on these instruments.

CHAPTER-6: INVESTMENT CLIMATE FOR WIND ENERGY

Wind Energy in India

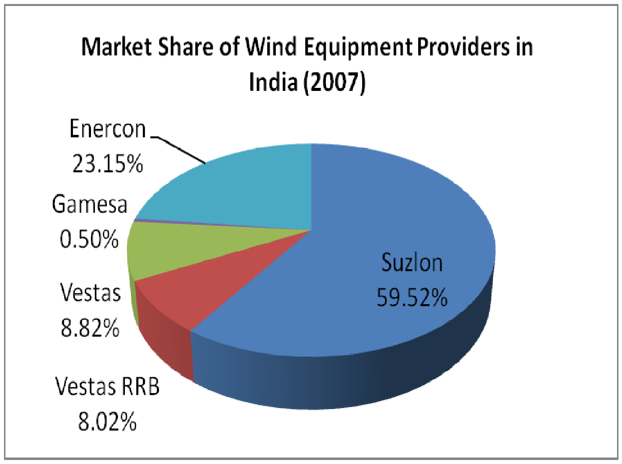
6.1 ***India's strong position in the global wind market:*** At the end of 2006, India had the fourth highest installed wind capacity globally. However India has slipped to the fifth position at the end of 2008 after China overtook it to become the fourth largest player globally. In 2008, China added 6300 MW[6] (2nd only to the United States which added 8,358 MW) which took its total installed capacity to 12,210 MW. India on the other hand has added only 1800 MW during 2008, which took its total installed capacity to 9,755 MW. According to the Global Wind Energy Council, over 27,000 MW of new capacity worldwide came online in 2008 with an estimated investment of about US $ 47.5 billion.

6.2 ***Wind dominates the Indian Renewable Energy Market:*** Wind Energy dominates India's RE industry, both in terms of installed generation capacity and investment in RE equipment manufacturing. As on March 2009, wind constitutes around 70 percent of the total installed renewable energy capacity. In the recent past, the maximum quantum and number of investments in the renewable sector have taken place in the

[6] The Global Wind Energy Council

wind energy sector, as evident from the transaction details in Chapter 3. The geographic spread of the investment for wind based grid connected power generation has been restricted mainly to Tamil Nadu, Maharashtra, Rajasthan, Gujarat and Karnataka, which together account for more than 90 per cent of the capacity. Going forward, India is targeting a capacity addition of 10,500 MW from wind based power plants during the 11th plan period (2007-12).

6.3 ***Wind energy investments are almost entirely from private sector:*** Over 99% of all investments in the wind energy sector have been from the private sector. However, this growth has been possible only through appropriate incentives and a positive policy outlook towards the wind energy sector from the Government of India. As a result of these policy initiatives, wind energy in India has been growing at a compound annual growth rate of 26% since 2001.



6.4 ***Sustained Policy and Regulatory Initiatives have facilitated the development of Wind Energy market:*** Wind energy has been receiving development incentives from both central as well as select state governments. These incentives have been largely targeted to improve the financial viability of the projects, and have been in the form of fiscal incentives, preferential tariffs, or special directives to encourage utilities to purchase renewable energy power. Most of these incentives have been in the form of accelerated depreciation, feed in tariffs and more recently generation based incentives (GBI). These incentives spur corporations and high net-worth individuals to set up wind energy projects, equipment companies to manufacture RE equipment or private and government entities to undertake R&D in wind energy. Till recently, wind energy investments were being driven primarily by tax savings and were considered feasible only with accelerated depreciation benefits. However with the maturing of the regulatory regime across states and announcement of the GBI scheme, a number of independent power producers (IPP's) have already entered the market and more are expected to enter in the near future.

6.5 ***Strong Domestic Equipment Manufacturing Industry:*** India has a strong domestic wind energy equipment manufacturing base, including local players like Suzlon and global companies such as GE and Vestas. These companies manufacture wind turbines with capacities ranging from 225 kW to 2,100 kW. In addition to catering to the domestic demand, these companies are also supplying equipment to other countries – especially to Europe. High growth potential of wind energy in India has encouraged some domestic equipment manufacturers to take-over companies abroad, thus also acquiring advanced technologies for manufacture of multi-megawatt class turbines, gearbox and off-shore wind energy equipment. Over the last 2 years a number of companies have announced plans of investing in wind energy equipment manufacturing, but most of these plans had to be shelved or put on hold due to the global economic slowdown.

6.6 ***Role of C-WET in assessment of wind energy resource:*** Indian wind climatology is strongly influenced by Monsoon circulations. In summer months (May to September) there is South West Monsoon and in the winter months (November – March) the direction is reversed and there are South East Monsoon winds. Therefore, the MNRE has launched the Wind Resource Assessment Programme (WRAP) to identify sites with wind energy potential. The WRAP has been one of the major factors for the success of the wind energy programme in India. This programme is being undertaken by the Centre for Wind Energy Technology (C-WET) and the state nodal agencies (SNAs). So far, the programme has covered 25 states and union territories and has established 1050 wind monitoring and wind mapping stations.

Wind Energy Potential in India

6.7 According to the MNRE, the potential for grid interactive wind based power generation in India has been estimated at around 48,500 MW. This estimation has been undertaken based on sites having wind power density greater than 250 watt per square metre at 50 metre hub-height and with 3 percent land availability.

6.8 ***Availability of good wind energy potential in some pockets***: A number of states in Peninsular India have good wind potential and attract investors by offering better returns on investment through higher capacity utilization factors. Figure 13 highlights the potential for wind energy generation across states and the capacity developed so far. The maximum capacity addition has taken place in states like Tamil Nadu, Karnataka, Maharashtra, Gujarat and Rajasthan. States like Orissa, Andhra Pradesh, Madhya Pradesh and West Bengal have potential but have not been able to leverage its development due to lack of adequate policy initiatives. For example, the state of Orissa has wind power potential of 1700 MW, but the current installed capacity is a mere 3.2 MW.

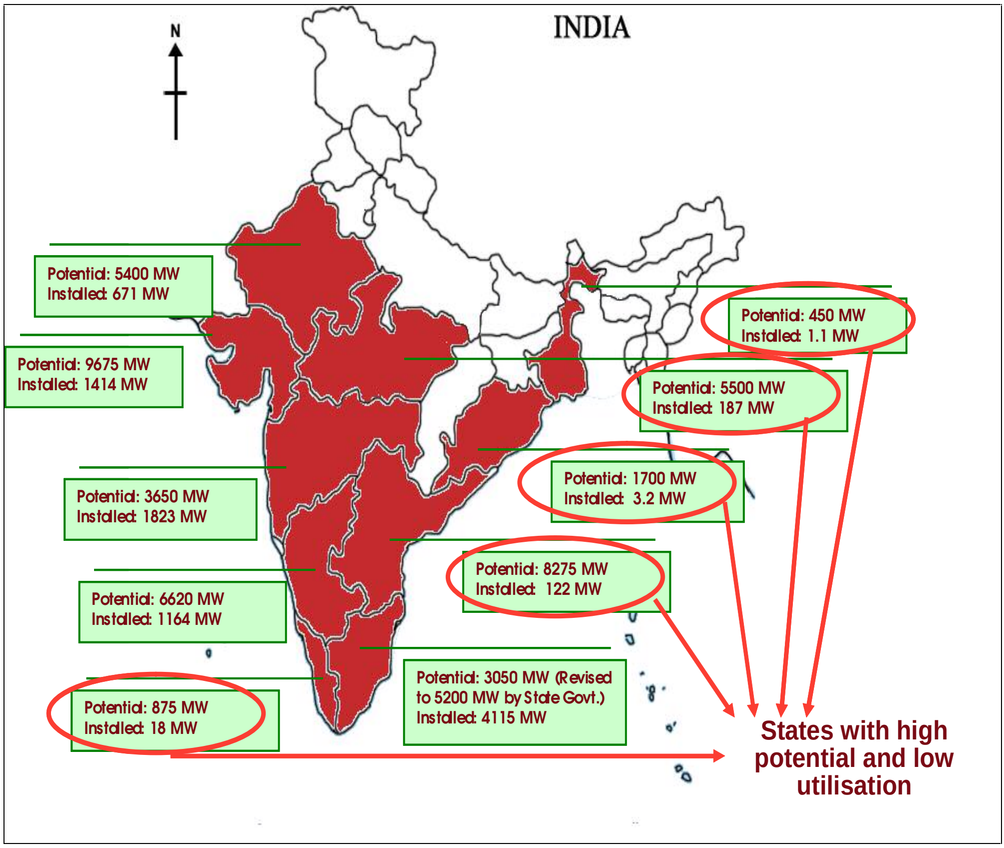


Figure 13: Wind Resource Assessment and Installed Capacity
Source: MNRE Website

6.9 ***Wind energy resource estimation is likely to increase with time***: With ongoing resource assessment efforts, grid extension, improvement in the wind turbine technology and sophisticated techniques for the wind farm designing, the gross as well as the technical potential is likely to increase in the future as is highlighted by the case study below.

[MB3]

Case Study: Increase in Wind Potential with Technological Advancement

Technological advancement in wind technology will definitely increase the available potential. With the increase in the size of wind turbine, the per MW requirement of land will also reduce. The table below shows the difference in land requirement due to differing wind turbine sizes in two locations in Maharashtra:

Location	MW installed	Average size of wind turbine	Land utilized (acres)	Acre Used per MW
Satara	300	250-350 kW	7200	24
Supa	60	1 MW	720	12

With increasing wind turbine size, more potential can be harnessed in a particular region. The table below shows how the technological advancements in wind will increase the exploitable potential in a particular region:

Location	Area available for wind farming	Technology based on Turbine size	
Maharashtra	87600 acres	250-300 kW	1 MW and above
Total Potential in MW		3650 MW	7300 MW

The above table shows that the potential increases by almost two times when 250-300kW turbines are replaced by wind turbines of size 1 MW and above. At present the potential assessed for wind is around 45,000 MW in India. This potential will definitely increase in future with technological advancement and repowering of the existing wind farms.

Data Source: Presentation on "Latest technology: Megawatt size wind turbines" by Senergy Global

Business Models in Indian Wind Energy Sector

6.10 The wind industry in India exhibits three distinct business models: (a) Turnkey Project Development & Sale, (b) Independent Power Producer, and (c) Pure Equipment Supplier. These business models constitute approaches for providing the entire gamut of wind energy related services from site identification, procurement/contracting, equipment supply, erection, plant operation, and repair and maintenance.

(a) ***Turn Key Project Development and Sale Model****:* Under this model, equipment manufacturers undertake identification of sites, land acquisition and statutory clearances. After the sites have been identified and the clearances obtained, the identified sites are offered to investors. Once the sale of these sites has been completed with the investors, these sites are developed. The turn key project developer is responsible for EPC, financing (if required), repair and maintenance (R&M) and evacuation. In effect the equipment manufacturer is responsible for all functions including clearances, evacuation and O&M. Till now, this has been the most successful model. Most of these projects are financed through recourse based financing in which the financial institutions use the balance sheet of the investor as adequate security. The investors profit from the feed in tariff and can claim accelerated depreciation. This model allowed equipment manufacturers, who took the maximum risks, to make wind fall profits. As the sector and industry was in a development mode, these profits were necessary for the sector to take off. However, with the sector attaining maturity, there is a need now to bring in greater competition and drive the manufacturers and investors to higher efficiencies.

(b) ***Independent Power Producer Model**:* A number of players are entering the Indian wind energy market as Independent Power Producers. These wind IPP's comprise of power generators like TATA Power, Roaring 40's, Green Infra, BP and equipment manufacturers like Suzlon, Enercon, Vestas etc. Under this model, the investor is also the project site developer. The developer is responsible for procuring equipment, identifying and obtaining land lease, EPC and O&M. Under this model, the main source of revenue is the sale of power to the grid. The IPP model has received an impetus after the announcement of the Generation Based Incentive Scheme.

(c) ***Equipment Supplier Model***: In this model, the equipment provider takes up the supply of equipment and EPC support. GE in India has adopted this model. However the model has not been very successful in India where the customers look for complete solutions. However market feedback reflects that till the time accelerated depreciation is available, the market would prefer turnkey project development business model.

Evolution of Policy and Markets in the Wind Energy Sector in India and Key Success Factors

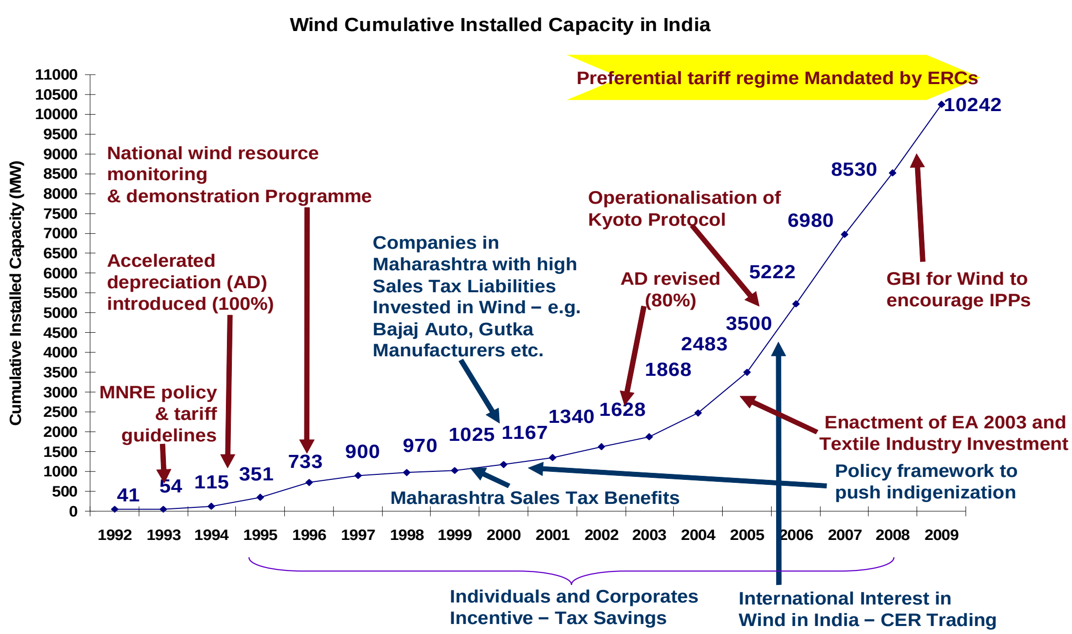


Figure 14: Evolution of Policy and Markets in the Wind Energy Sector in India
Source: PwC Compilation

6.11 *Figure 14* highlights the evolution of the wind energy sector in India from the 1990s to the present. As can be seen from the figure, wind energy investments have shot up considerably in the last 5 years, corresponding to the high economic growth of the Indian economy. This high economic growth has resulted in large disposable incomes and high tax liabilities with individuals and corporations. Many of these individuals and corporations have been the main drivers of demand in the wind energy sector in India.

6.12 ***Reasons for rapid expansion of Wind Energy investments in India***: Some of the key drivers for increased investment in wind power market in are:

(d) ***Accelerated Depreciation (AD):*** Till now, the major driver of the wind energy market in India was the accelerated depreciation benefits received through investments in wind based power generation. Accelerated depreciation was first introduced in 1994 and the depreciation rate was 100% which was changed in 2002 to 80%. Under this scheme, the Central Government allows for accelerated depreciation (at the rate of 80 % on a Written-Down Value basis) for renewable energy items (wind and solar) under section 32, Rule 5 of the Income Tax Act.

(e) ***Feed in Tariffs:*** Ten states have issued tariff orders for wind energy in India.[7] The impact of the tariff order across states can be seen in the capacity addition highlighted in Figure 15. The states of Maharashtra and Gujarat exhibited rapid increase during the period 2003-04 to 2007-08, which can be attributed partially to the implementation of attractive Feed-in Tariffs in 2003 and 2006 respectively. The FIT in Maharashtra was the most attractive tariff for wind in India. In Gujarat, a spurt of activity in wind energy was seen after a very attractive FIT was introduced in August 2006, along with the opening up of the high potential sites in Kutch.

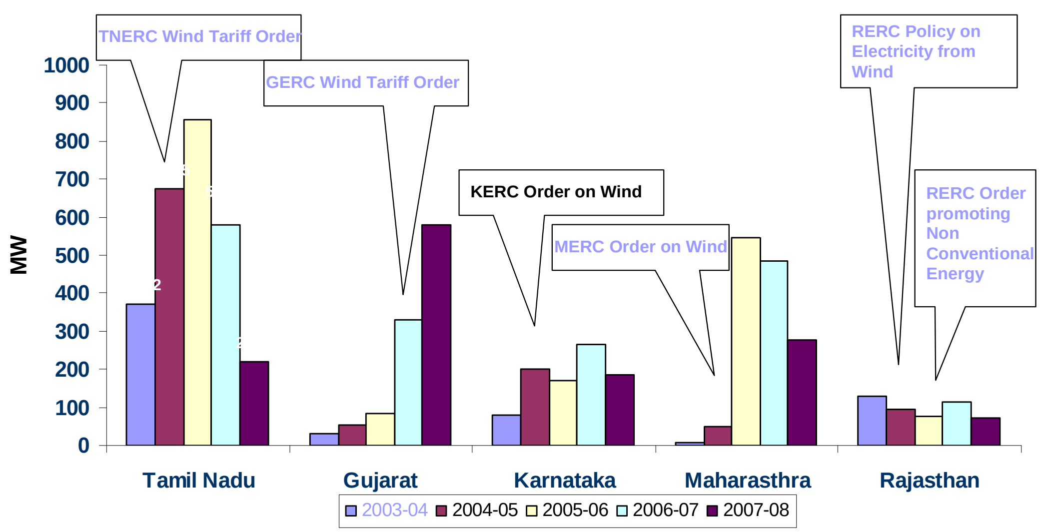


Figure 15: Impact of FIT on Wind Energy Development in Select States
Source: PwC Report

a) **High Electricity Tariffs for HT Consumers:** Historically, utilities have been cross-subsidizing the agriculture and residential customers with higher tariffs for the

[7] In India, most states with a sizeable wind potential have issued a tariff order, except for Orissa.

HT category. The provisions of captive power generation, wheeling, banking and third party sales have allowed a number of HT consumers to shift from higher HT based tariff to a lower cost PPA with a wind power producer or set up their own wind power plants. A number of industrial users in Maharashtra and Tamil Nadu have already moved over to wind based power. For example, Bajaj Auto now procures close to 90% of its annual power requirements for its plants in Pune from its captive wind turbines. A number of commercial and industrial consumers across states like Maharashtra and Tamil Nadu are also now moving to wind based generation to overcome higher power bills.

b) **Prevailing power shortage and open access under Electricity Act 2003:** The Electricity Act, 2003, came into force on 10 June 2003, and brought about wide-ranging changes to the structure and operation of the industry. The Act liberalised generation, introduced open access to transmission, and enabled provisions for power trading which has helped boost the feasibility of capacity addition from a wide variety of sources in the country including wind energy.

c) **MNRE Renewable Energy Tariff**: The MNRE offered a tariff of Rs 2.25 per unit in 1993-94 as a precursor to the Feed in Tariffs being offered by various State Electricity Regulatory Commissions (SERCs). This tariff had a 5% escalation factor for the first five years and was valid for period of 20 years. This tariff, along with tax incentives spurred a number of private sector developers to set up their own wind energy plants.

d) **Generation based incentives (GBI):** The Planning Commission, in its approach paper for the XIth Plan had highlighted the need to shift from a subsidy structure that provides relief and subsidies for capacity addition to a structure which provides relief for actual generation. The MNRE, based on the recommendations, came out with a scheme that provided direct incentives to actual generation. The GBI scheme has been formulated with this specific objective. The initial response of the industry has been encouraging, but the disbursement of incentive has not started. The GBI scheme is more attractive for new players who want to develop wind farms in the IPP mode. It does not require the investor to have adjustable income and offers foreign players wishing to invest in India's wind industry to invest without missing out on AD incentives. Analysis undertaken by PwC shows that a GBI of Rs 0.5 per unit would be marginally more beneficial to an investor than the AD.

e) **Advent of Independent Power Producers:** The last few years have seen a gradual change in the investment pattern in wind in India. There has been a small movement from accelerated depreciation, which meant using wind investments as a tax saving investments to Independent Power Producers entering the market Although the main driver of wind in India still remains accelerated depreciation, a number of investors are today opting for the Independent Power Producer model, owing to the development of an alternate policy structure (Generation Based Incentives), more reliable and predictable state policy and regulatory regime and improved service offerings. Some of the major players opting for the IPP route are TATA Power, Roaring 40's, BP, Green Infratech and NTPC.

Key issues affecting further development of wind energy in India

6.13 Although wind energy in India has progressed rapidly there are a number of issues constraining its pace of development. A number of issues are common to other RE Technologies. These issues and consequently the potential solutions and recommendations are cross cutting in nature.

a) ***Absence of competitive pressures to ensure cost efficiency in wind projects*:** [MB4] The Indian wind energy sector suffers from lack of adequate competition. Wind energy installations are provided a fixed Feed in Tariff which means they do not have to compete with other power producers under Case I and Case II bidding. Wind energy producers also do not face competition (like players in solar, small hydro or biomass) in the supply of equipment due to the nature of the wind industry in India. Most wind energy generators in India are owned by private firms (investors) who depend upon project developers who are equipment manufacturers for developing wind energy installations. These project developers use their own equipment. The impact in effect means that till AD is present in the market, developers with access to sites can keep developing installations without facing any competitive pressures.

b) ***Insufficient Renewable Energy Purchase Obligations in some states:*** Renewable Purchase Obligation (RPO) is a mechanism for ensuring that states or utilities procure a certain minimum percentage of their total power requirement from RE sources. At present, 16 SERCs have notified RPO targets for their respective states and of these only 8 states have been able to meet their targets as highlighted in *Table 4* below.

S.No.	State	Target (% of total consumption)	Achievement (% of total consumption)
1	Andhra Pradesh	5% (1% for wind)	5% (1% wind target not met)
2	Gujarat	2%	2%
3	Karnataka	7% to 10%	9.47%
4	Kerala	5%	1.22%
5	Madhya Pradesh	10%	0.11%
6	Maharashtra	4%	3.17%
7	Rajasthan	6.25% (Minimum)	7%
8	Tamil Nadu	10%	Not available

Table 4: Present status of RPO across select wind-rich states

Source: PwC compilation from various tariff orders

The table above highlights two states which have achieved their RPO target. In case of the state of Gujarat, the RPO target of 2% was very low (recently the commission has increased the target to 10%). Due to this reason, the Gujarat State Electricity Board stopped signing PPAs with the wind energy producers. In case of the state of Karnataka, although the RPO target is 10% (which is the highest by any state in the country), the state is well endowed with renewable energy potential, be it small hydro, wind or biomass. As the RPO target had been met, the state utilities were very reluctant to purchase either wind or small hydro power from the developers which became a bottleneck for renewable energy development. Therefore it is felt that once this target had been achieved, a higher RPO target should be set.

c) ***Inadequacies in Feed-in Tariffs:*** Feed in Tariffs (FIT) have become one of the most popular mechanisms for the promotion of RE at the state level since the enactment of the Electricity Act 2003. However, stakeholder consultations have revealed that there are inadequacies in the available Feed-in Tariff regimes across several states:

- ***Unattractive FIT for investors in Tamil Nadu***: In case of Tamil Nadu, the feed in tariff for wind energy generators for sale to utility was fixed at Rs 2.9 per kWh in 2006. This was an unattractive feed in tariff from the point of view of the industry and led to a decline in the pace of capacity addition. As a relief measure, the Tamil Nadu State Regulatory Commission recently, in its discussion paper dated 20 December 2008, announced a tariff of Rs 3.4per kWh duly recognizing the need for an upward revision.
- ***Utilities unwilling to procure wind energy at FIT in Andhra Pradesh***: Wind energy developers in Andhra Pradesh (AP) have been facing a peculiar situation since 2003. The APERC (Andhra Pradesh Electricity Regulatory Commission) declared a FIT capped at Rs 3.37 per kWh. The utilities used this FIT as a cap and were willing to procure wind at Rs 2.7 per kWh. This procurement price was considered very low by the wind energy developers and many developers abandoned their plans for wind installation development. As a result the state of AP was able to add only 29.3 MW between 2002 and the end of 2007, with only 1.3 MW being added in the last three years. The situation is likely to be resolved in the near future as the state is in the process of developing a new FIT and has released a new wind energy policy.
- ***Absence of FIT in Orissa***: A number of states have not adopted Feed in Tariffs (Jammu and Kashmir, Orissa, Bihar and Jharkhand and the North East states) till date. Orissa, which has a wind potential of 1700 MW[8] has been able to add just 3.2 MW in wind energy till now. Apart from the absence of FIT, the necessary provisions that permit wheeling for captive consumption or third party sale have also not been introduced in the state.
- ***Inadequate Duration of FIT in West Bengal***: In the case of West Bengal, the SERC has prescribed a FIT for five years which is clearly inadequate given the 20 year life of the generation plants. This is one of the main reasons why the state has seen a capacity addition of only 1.1 MW while it has a capacity of more than 450 MW. Similarly, the states of Karnataka and Maharashtra have specified the tariff for only 10 and 13

[8] PwC compilation from MNRE Sources

years respectively while Tamil Nadu and Gujarat have declared tariffs for 20 years.

- ***Lack of consistent approach for determination of FIT across states***: FITs and PPAs need to be consistent across states in terms of the basic conditions like tenure, control period and escalation. This lack of consistency in the duration of the FIT applicability or PPA duration lowers the confidence and increases uncertainty regarding the levels of returns for investors in a state and also impacts the ability of the project to obtain the necessary financing. *Table 5* below shows the inconsistency of approach among regulators while designing the FIT.

	Maharashtra	*Karnataka*	*Tamil Nadu*	*Gujarat*
Capital cost (Rs. Cr/MW)	4.00	4.25	5.00	4.65
Return on equity	16%	16%	16% (pre-tax)	14% (post-tax)
Derating	5% (after 10 yrs)	0%	1% (annually)	0%
Auxiliary consumption	0%	0.50%	0%	0%
O&M expenses (% of capital cost)	1.5% - for 3 yrs 2% - for 4th year	1.25%	1.10% (for 5 yrs)	1.50%
Escalation in O&M expenses	5% (from 4th year)	5% (annual)	5% (from 6th year)	5% (annually)
No. of years for which tariff is specified	13	10	20	20
FIT (Rs per kWh)	3.50-5.30	3.40	2.90	3.50

Table 5: Assumptions used by SERCs for determining wind energy tariffs
Source – PwC research

d) ***Inadequate Evacuation Infrastructure and Approach Connections:*** Availability of evacuation infrastructure and grid interconnection are amongst the biggest problems afflicting the harnessing of any renewable energy resource. Wind also faces issues similar to small hydro in the development of its potential when it comes to the availability of evacuation infrastructure. A number of examples are available where wind energy development has suffered due to non availability of evacuation infrastructure.

- ***Evacuation constraints in Tamil Nadu:*** Tamil Nadu has been unable to utilize all power generated from wind due to lack of adequate evacuation capacity. Wind resources in the state are located along the coast starting from the southern tip of Kanyakumari and moving north. The stretch of land on which these resources are located is very narrow and also houses considerable hydro resources. Both these renewable energy technologies share rural feeders (11 kV level) for the evacuation of power. During the monsoon season, 1,900 MW power is transmitted from the Tirunelveli region and 1,150 MW from Coimbatore, both of which lie in the South. During the peak season, the TNEB prefers to procure power from hydro resources as wind is more expensive. In 2007-08 only 800 MW was utilized which could go up to 2,000 MW during the peak season. To address this gap, TNEB has now sanctioned the development of a 400-kv transmission network from Pugalur, near Karur, to Sunguvar Chatram-Kalivaradhapattu in the north.

- ***Wind Power Evacuation in Andhra Pradesh:*** Till date, Andhra Pradesh has had very limited wind power capacity development. However, with the new Feed-in Tariff being introduced, wind energy development is likely to take off. Almost all wind power potential of the state lies in Rayalseema region and power generated in this region would have to be evacuated by the Central discom which is headquartered at Hyderabad[9]. This evacuation would have to be routed through Gutti, the main transmission point to Central discom. Based on consultation with wind energy developers, Gutti is likely to face a capacity constraint in the near future if the potential for wind in Rayalseema is tapped.
- ***Lack of focus on planning for evacuation of renewable energy:*** The basic genesis of the problem in case of evacuation is the lack of adequate planning especially for renewable energy sources as pointed out in Chapter 5. Most states in India do not take up system planning or the use planning standards for wind or most renewable energy evacuation. There is little evidence of planning for renewable energy in state transmission plans. Only the state plan of Maharashtra for 2008-09 discussed the creation of three sub-station facilities for wind developers, two of them for Suzlon and one for Vestas.
- ***Approach Roads Constraints in West Bengal Wind Energy Sites:*** Another issue impacting the development of wind energy potential is the lack of adequate approach roads and local infrastructure. For example, the development of sites at Digha, West Bengal is suffering due to a lack of a road network.

e) ***Land acquisition issues:*** States like Karnataka have witnessed a scurrying of their efforts at enhancing wind energy generation due to land acquisition problems[10]. Land or site acquisition is crucial for wind farm development. Wind energy developers need to acquire land before they can develop and sell the site. Most of the land is privately owned, especially agricultural land. Wind developers give the task of land acquisition to middle men who exploit farmers and acquire land at low prices. This subsequently causes a lot of social unrest in the area and impacts future land acquisition. In the case of Maharashtra, most high potential sites are now located either in forest areas or tribal areas. In case of forest areas, obtaining forest land clearances for establishing evacuation infrastructure and sites is not forthcoming and land acquisition in tribal areas is a very politically sensitive issue.

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[9] Source – Mr Vilas K Pathi, Advaita-capital and Enercon

[10] http://www.hindu.com/2008/09/06/stories

f) ***Inadequate wind resource assessment data:*** A cubic relationship exists between wind velocity and output energy and thus a very small percentage difference in average wind speed can lead to a substantial difference in available energy. Therefore, accurate monitoring becomes critical for the viability of any wind energy project. However a number of cases have come to light where a wind energy sites are not generating their projected annual production. This has been highlighted in Table 6 and showcases the following trends:

- The analysis points to the wind energy plants in the states of Tamil Nadu and Rajasthan, where these plants have been performing at a lower CUF compared to the projected generation of the tariff order.
- Based on comparisons of actual generation with the UNFCCC PDD projections, all states (Tamil Nadu, Maharashtra and Rajasthan) except Karnataka and Gujarat are performing at a lower CUF than what has been projected in the PDDs. It is pertinent to note that PDDs are developed using conservative estimates for generation and the actual figures are actually lower than these conservative numbers as well.

CUF source	Weighted average CUF (C-WET)	Tariff order	UNFCCC (PDDs reviewed)	UNFCCC (Monitoring reports)
Tamil Nadu	28.15	27.15	25.93	20.20
Gujarat	25.05	23.00	23.17	24.23
Maharashtra	24.32	20.00	24.20	20.84
AP	25.63	-	18.86	-
Rajasthan	24.86	21 & 20	20.27	16.79
Karnataka	26.46	26.50	25.50	27.23
Kerala	26.24	22.00	-	-
MP	24.86	22.50	22.50	-
West Bengal	22.00	-	-	-

Table 6: Analysis of CUF across states

- In case of a comparison between the actual performance from UNFCCC's monitoring reports and PwC analysis based on C-WET resource data, all states except Karnataka are performing at lower than projected CUF levels.

Reasons for low Capacity Utilization Factor (CUF) of Wind Projects in India

Wind energy sites in India have not been generating at expected levels. A number of reasons might be contributing to this lower than expected performance.

- **Methodology for wind extrapolation results in higher than actual wind speed and wind distribution estimation:** Wind potential assessment at a site is undertaken using simple wind-speed distributions parameterized by the arithmetic mean of the wind speed. Wind speed readings are measured at 20, 25, 30 and 50 metres and these are then extrapolated to the hub height of the turbine, which is usually 70 metres. The accuracy of hub height wind velocity depends upon the accuracy of wind readings at other heights. However, wind speeds at lower altitudes are usually lower than measured due to the presence of obstacles. This error can result in a 15 to 20 % higher wind speed extrapolation if adequate is care not taken. These errors can be the reason for lower CUFs in older turbines.
- **Impact of Monsoon on CUF:** The wind speeds and wind speed regime in India is highly dependent on the monsoon except in Rajasthan (where the difference between night and day temperatures influences the wind speeds). Monsoon in India follows a 7 year cycle. If wind speed measurement is undertaken during the development or peak of the cycle, then the CUF experienced in subsequent years is likely to be lower which might explain variations in CUF. Thus any wind frequency measurement and speed extrapolation needs to be adjusted for the stage of development of the monsoon cycle.
- **Low number of met masts for wind farms:** Due to the high cost of wind met masts, developers usually deploy a lesser number than required. Gaps in wind monitoring might mean the inability to identify (for developers) areas of low wind velocity in a wind farm and result in lower CUF's. One way to compensate for this is to adopt norms for measuring potential, especially of large wind farms.
- **Showcased sites have higher potential and wind speed than the actual sites allotted for wind farm development:** In the absence of wind met masts, a number of wind energy developers set up farms based on the CUFs (as a proxy reading) of nearby wind energy sites. Developers tend to stretch wind farms to include larger areas where they might not have undertaken any assessment. There is a need developing and enforcing stringent norms for fixing distances between met masts as wind energy potential has the ability to change over very short distances.
- **Wind speed assessment has historically been undertaken over only 1 year:** The high costs of wind met masts; lack of stringent monitoring by investors, pressure to develop sites faster and the availability of accelerated depreciation have sites being are commissioned within one year or even two seasons in some cases. This can sometimes result in inadequate measurement of wind availability and lower CUF's.

Recommendations

- ***Recommendation 1: Benchmarking of Capital Costs*** - The capital costs of wind projects in India needs to be properly and scientifically benchmarked using indexation formulae. For this indexation to be successful, there is a need to create a Renewable Energy Database at national and state level. Apart from assisting in benchmarking of costs, such a database could also be useful in designing risk mitigation instruments and bringing about greater clarity and higher investor confidence.
- ***Recommendation 2: Need for new norms for Wind Resource Assessment*** – Due to the major gaps identified in wind resource development

and the need for guarding the interests of the investors, it is recommended that norms be introduced which make it mandatory for wind monitoring and wind data collection to be undertaken for at least 2 seasons. There is also a need for norms on the number of meteorological masts per unit area and the pattern of fixing these masts for identification of wind potential.

- ***Recommendation 3: Scaling up of GBI scheme from 49 MW –*** The 49 MW GBI scheme for wind received a tremendous response. There is a need to increase allocation under this scheme and streamline its time bound implementation as well as bring about greater clarity on allotment of the incentive.

- ***Recommendation 4: Need for a comprehensive five year transmission plan for RE at the state level –*** There is a need for better coordination among REDA, STU and the distribution companies for ensuring availability of evacuation infrastructure. Therefore, it is recommended that the state transmission utility develop a 5 year transmission plan for RE at the state level. It is also recommended that this plan have a detailed breakdown of the resources, monetary and infrastructure as well as a listing of priority areas that need immediate attention at the state level. The state transmission utilities need be encouraged to form JVs with private players for facilitating evacuation of RE power.

- ***Recommendation 5: Guidelines for SERC's on Renewable Energy Promotion –*** State Regulatory Commissions often lack adequate data and capacity to administer the RE sector. Therefore, there is a need to have centrally driven guidelines to help the state electricity regulatory commissions in bringing about a certain level of uniformity in:
  - Approach to Feed in Tariff design
  - RPO and Renewable Energy Certificates
  - Open Access
  - Sharing of CDM revenues

- ***Recommendation 6: Proactive support by state government on procumbent and acquisition of land –*** There is a need to facilitate transparent, fair and timely acquisition of land. It is recommended that a schedule at the state level needs to be developed for land acquisition and allotment by the state renewable energy development agency. There is also a need for the state to use section 4 provisions more often in case the acquisition of land is delayed beyond a point.

- ***Recommendation 7: Need to assess off shore wind potential and draw up a plan for harnessing this potential –*** India's long coast line (7500 kilometers) offers a huge scope for application of off shore wind installations. Off shore installations have higher CUF's due to higher wind speeds. Average wind speeds can be 20 percent higher than on land, and the resulting energy yield from wind farms as much as 70 percent higher. In addition to high wind resource available, ease of transporting large wind turbines also facilitates development as ships and barges can handle large loads more easily than trucks or trains. However these installations are more expensive on account of more complex technology and engineering, especially for citing turbines on the sea floor. Offshore wind farms also face higher risks, on account of cost and time overruns. Considering all of the above, it is recommended that MNRE undertakes a study of the techno-economic viability and potential for off shore turbines.

- ***Recommendation 8: Need to move to an RPO based competitive procurement route –*** Lack of competition is an area of concern in the Indian wind energy market. One of the ways for promoting competition in the sector is to move to a RPO based competitive bidding route. Sufficient scale, competition and capacity exists in the industry to go for RPO based competitive procurement.

- ***Scope for International Cooperation with Sri Lanka:*** The Northern coastal parts and Central Highlands of Sri Lanka offer very good wind potential, which the island country is unable to exploit on its own due to the small size of its electricity system and lack of expertise in wind energy development. After the end of the conflict with the LTTE, the significant wind potential in the country can be developed with assistance from the Indian government and evacuated to India. This holds significant potential for a mutually beneficial project.

OFFSHORE WIND ENERGY

Offshore locations exhibit much higher capacity utilization factors (CUFs) due to inherently stringer winds and lower variations in wind speeds. It is estimated that the average wind speeds can be 20 percent higher for offshore than on land, resulting in 70 percent higher energy yields from offshore wind farms as compared to onshore ones. Typical CUF for offshore wind farms ranges anywhere between 30% to 45% (*Source: Georgia Institute of Technology, 2006*).

Europe leads in off shore wind capacity development with an installed capacity of around 1000 MW (Source: Douglas- Westwood). The United Kingdom is in the process of installing world's biggest offshore wind farm of around 550 MW.

China's Off shore Plans: China's offshore wind energy potential is around 750 GW (Source: www.offshorechina.com accessed June 2009) and it has unveiled plans to make offshore wind farms a key part of its renewable energy strategy. Development of Shanghai East Ocean Offshore Wind farm began in May 2008 and is expected operational by May 2010. This farm has an installed capacity of 102 MW with 34 turbine units at an investment of US $ 343 million.

Exploring off-shore potential in India: India has about 7500 KM of coastline. This affords a vast offshore area which can be potentially used for harnessing wind energy. However, despite this natural advantage, there are no studies available for assessing the actual offshore wind energy potential and strategy to harness it.

CHAPTER-7: INVESTMENT CLIMATE FOR BIOMASS ENERGY

Biomass Potential & Current Status

8.1 India being an agrarian economy has abundant resources of bio-energy in the form of agricultural, forestry and agro-industrial residues. According to Government of India's estimates (MNRE), given the vast availability of nearly 700 million tonnes of biomass agri-residues (rice straw, wheat, cotton & mustard stalks, etc.), approximately 120-150 million tonnes of biomass can be attributed as surplus quantity after taking into consideration the alternative usages, which translates into a potential for about 16,700 MW11 of power generation. Further, MNRE has estimated additional around 34,000 MW potential of biomass based electricity generation from wood and energy plantations on wasteland as well. The following table gives an overview of biomass classification and respective potential in India.

	Key Category	Biomass Varity	Potential (MW)
Category I	Agriculture residues	Rice husk, wheat stock, Mustard stocks, Cotton stacks, leaf litter, weeds etc	16700
	Agri-industrial wastes:	Groundnut shell, rice husk, Coconut Shell & husk	
	Sustainable Wood plantation Private lands	Juliflora, casurina, eucalyptus	
Category II	Energy Plantation on Wasteland	Regional variety	33614
	Total Potential		**50323**

Table 7: Assessment of biomass potential in India
Source: PwC Analysis & MNRE

8.2 Of the estimated 16,700 MW potential, only 683 MW has been harnessed till December 2008. The existing biomass based installed capacity consists of largely biomass combustion technology; in particular for medium to large scale biomass plants (7-15 MW): while, Gasifier based technology is suitable for only small scale biomass projects (50 kW to 750 kW). Technical barriers, have also constrained scaling up of biomass gasifier projects. It is only recently that some developers have shown interest towards the development in MW scale (up to 2 MW) biomass gasifier plants.

[11] MNRE (Biomass Atlas of India; IISc)

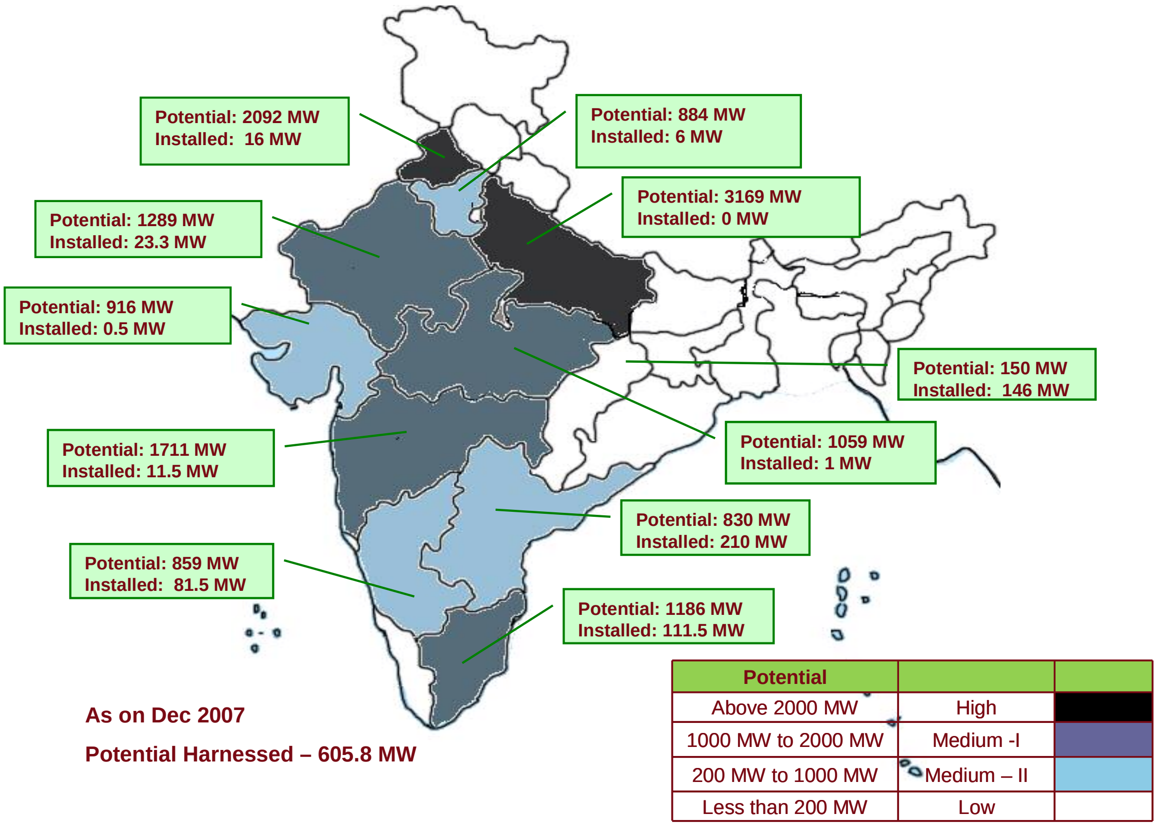


Figure 16: State-wise biomass potential and harnessed potential as on December 2007
Source: MNRE

Biomass Development in India

8.3 The figure below maps the development of India's biomass sector and highlights some of the main government initiatives that have helped the sector to evolve.

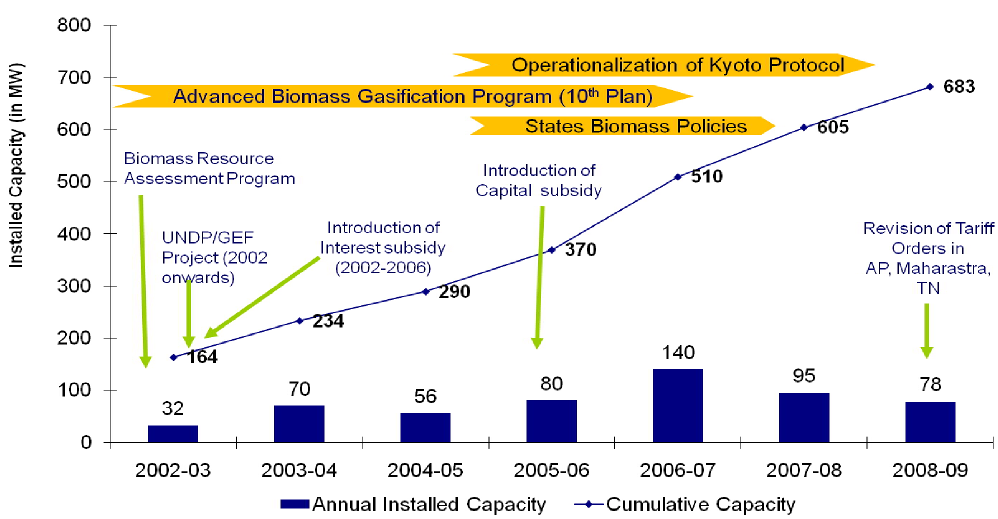


Figure 17: Development of biomass industry in India

Source: MNRE and PwC Analysis

Key Policy Initiatives

Programme	Key Feature	Key facilitating Instrument	Outcome of programme
National Program on Biomass Generation	• Launched by MNRE. • Aimed to kick off commercialization of biomass projects. • Equally applicable for all three technologies - Biomass combustion, gasifier and cogeneration for captive as well as IPPs	Interest Subsidy	• Commercialised the biomass combustion and cogeneration projects.
UNDP/GEF Program	• Providing technical assistance to remove technical, regulatory and institutional barriers • Providing investment support to demonstration projects, risk mitigation, designing management and ownership structures for these projects in select candidate states	Capital subsidy grants or soft loans for gasifier projects	• Reinforce adoption of gasifier as an option of rural electrification
Capital Subsidy from MNRE	• Designed to promote small scale biomass projects - structured in a manner that small sized projects get higher proportionate subsidy than the large sized projects. For instance, 1 MW combustion technology projects typically get capital subsidy of 4.4%, whereas the 10 MW project gets approximately 1.97% capital subsidy. .	Capital subsidy	• Only small scale projects are realizing benefits. • Insignificant support to mega scale (>10MW) development.

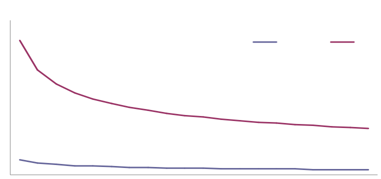
Table 8: Key Policy Initiatives for Biomass Development

Source: MNRE

8.4 **Biomass sector is given diminutive fiscal incentives that hinder sector's growth:** The incentives available for biomass based generation are much lower compared to that available for other renewable energy technologies.

- Capital subsidy is applicable only for Biomass and SHP projects. It is noticeable that SHP projects receive a relatively high percentage of capital subsidy incentive as a component of total cost compared to biomass projects.

- In case of wind and solar, accelerated depreciation and generation based incentives respectively bring in a significant fiscal support, which in monetary terms, is more than capital subsidy being offered to Biomass.



8.5 In addition to central government initiatives, several states have introduced policies to promote renewable in line with the National Electricity Policy, to promote private participation in biomass based electricity generation. The following table summarizes the policies prevalent in some select states.

State (Year of Introduction)	Tariff (Rs/Unit) Annual Escalation (2008)	Average Fuel Cost (Rs/MT) as per SERCs	Wheeling Charges (% of energy)	Cross Subsidy Surcharge[12] (%)	Other Incentives
AP (2005)	4.15	2000	5	Removed	
Chhattisgarh (2005)	3.05 (5% escalation)	995	3	50	Exemption in electricity duty
Maharashtra (2005)	4.28	2045	7	Removed	50% cost of evacuation borne by MSEB
MP (2008)	3.67 (3- 8 paisa)	1181	-	-	3rd party sale if licensee defaults for more than 3 months
Punjab (2008)	3.49 (5%)		2	-	
Karnataka (2005)	3.08 (2% escalation)	1000	5	-	
Haryana (2008)	4.4	1600	2	-	Exemption in electricity duty
TN (2005)	4.5	2000	5	50	
Gujarat (2008)	3.4	1000	4	Removed	

Table 9: States Biomass Tariff & Incentives
Source: PwC Compilation

Key Issues impacting biomass development

8.6 Even though India has one of largest agriculture base and thus an abundant source of feedstock for biomass industry, the development of biomass industry has been limited to only a few States and has at best been restricted in its capacity. The following figure illustrates the key issues faced by the biomass sector across its value chain:

[12] Cross subsidy surcharge is applicable for open access in addition to open access charges or wheeling charges. The reduction or removal of any of these charges acts as a driver to facilitate more open market, which is always appreciated by the electricity developers.

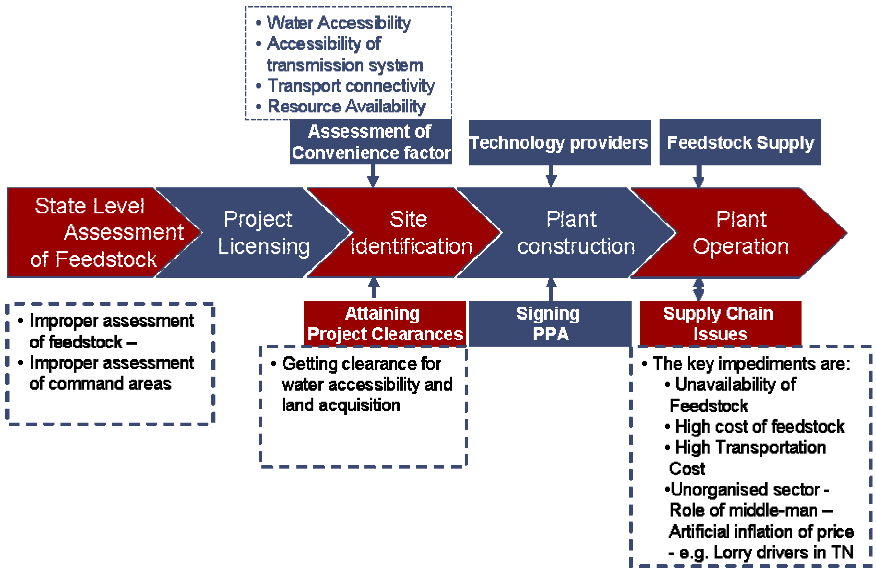


Figure 19: Highlights of issues in biomass sector in India

Source: PwC Analysis

Issues in Assessment of Feedstock

8.7 In the late 90s, Indian Institute of Science (IISc) commenced a study funded by MNRE for assessing biomass availability in India. Based on the data made available from different agencies and various scientific tools like remote sensing, GIS based interactive packages and other statistical tools, IISc prepared a country wide Biomass Atlas to assess taluka (Town) level production and type of biomass.

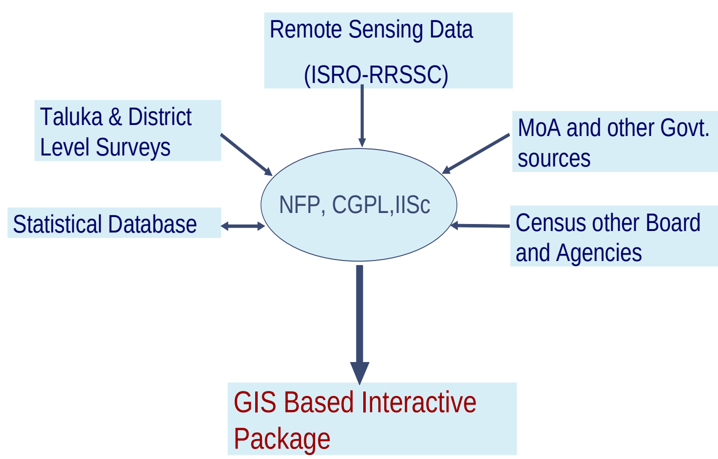


Figure 20: Method of biomass Assessment

Source: IISc

8.8 Although, the Biomass Atlas is a scientific tool to estimate the availability of biomass, alternate usage and the available surplus biomass has not been taken into account for assessing the potential of power generation in a given region. The Atlas could be outdated considering the development of the SME sector with recent high economic development.

8.9 Discussion with project developers and state nodal agencies revealed that the taluka and district level survey has not been done on realistic basis and is not correct. The assessment of biomass available for feedstock is extrapolated. The assessment of surplus biomass does not accurately estimate the viable potential. Therefore, the total potential of 16700 MW in India may not be the correct estimation.

As per the Biomass Atlas, the district of Bikaner has 98 kilo tonnes amount of surplus biomass available every year that in turn can be utilised to produce 12 MW of power. As a matter of fact, Bikaner has one of the largest geographical areas (approx 42000) in India and as a result, the density of biomass or availability of biomass per sq. Km is very low in the region. Due to this, the project becomes highly unviable because of very high extraction, collection and transportation costs. Also, in this region, a large amount of biomass is woodchips which is expensive resource due to its high collection cost.

8.10 The Biomass Atlas was developed in early 2000 hence the data set used is now somewhat outdated. Over the last one decade, the pattern of alternative usage has been altered significantly, which has impacted the estimation of biomass surplus and in turn the potential of biomass based power projects. Similarly, there are numerous locations in India where biomass is available but can not be utilised for financial viable electricity production for various reasons.

Escalation in Fuel Cost

8.11 Unlike other RE technologies, bio-energy technologies like biomass, WTE (waste of energy) and cogeneration require feedstock as fuel for the power plant which in turn entails an additional cost to the project developer. Thus apart from the above mentioned issues, one of the most important issues faced by the project developers is volatility of fuel cost. Unlike other conventional sources e.g. coal, gas or petroleum products, biomass feedstock is not traded in a regulated market therefore the pricing of feedstock is entirely a factor of the prevailing market demand & supply.

8.12 Over the last one decade, the supply of biomass sources has remained constant whereas the demand has been increasing significantly. The stakeholders' consultation mostly emphasises high and fluctuating cost of biomass as a major issue impeding the growth of this sector across India.

8.13 The stakeholders' consultation reveals that in early 2000, at the biomass industry inception, the cost of biomass was very nominal (Rs 300-400 per tonne) in most States. Over the last one decade, the increasing demand of biomass for power generation as well as alternative uses has created a demand-supply gap in this sector, which in turn has inflated the price of biomass to very high levels of up to Rs. 2000 per tonne. The following figure illustrates the price trend of biomass in key states.

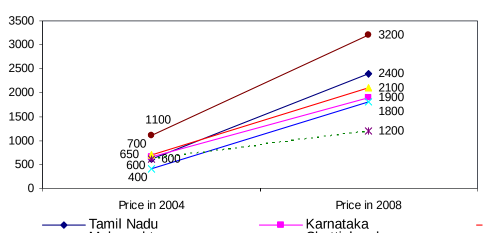


Figure 21: Illustration of variation in Biomass cost in different states
Source: PwC Analysis

8.14 While calculating the cost of power generation through biomass projects, most of the SERCs have considered the biomass cost in the range of 900-1000 Rs. with 5% escalation which was fairly acceptable, but in reality, the cost of biomass has almost doubled in the last five years due to its alternative uses. This increase in cost has created a huge gap between the estimated fuel price and the actual fuel price.

8.15 Although, different states have varied alternative uses for biomass, but by and large biomass is alternatively used by SME sector to replace the coal for heating (operating boilers), cattle fodder and household usage in rural areas. Moreover, the degree of price elasticity of alternative usage varies from State to State and across biomass types.

State Specific Issues

Tamil Nadu

8.16 Tamil Nadu is among the leading states in the development of biomass based electricity generation. Feed in tariff for biomass introduced in 2005 has propelled investments, with about 100 MW aggregate installed capacity (2007). More recently, though there has been a marked slowdown in new capacity addition because of highly fluctuating price of feedstock – during 2008 about 100 MWs of licensees were issued but no investment has materialized.

8.17 **Increasing/ fluctuating cost of feedstock is hampering the further investment**: TNERC considered the feedstock cost at Rs 1000 per tonne with 5% escalation, but the current cost of feedstock is approximately Rs 2400 per tonne which makes the generation financially unviable to deliver at the price agreed in PPA. Stakeholder consultations reveal two key reasons for cost escalation:

- **Increasing alternative usages of biomass result in price escalation**: Areas adjacent to Coimbatore (machinery cluster), Tirupur (textile cluster) where the SME industries have emerged in last 4-5 years there has a growing demand for biomass as an alternative fuel to coal. Due to the higher paying capacity of these industries, the biomass prices have reached as high as Rs 2500 per tonne. This is resulting in substantial losses to existing biomass based generators - it is learnt that a few units have been temporarily closed due to unavailability of feedstock or its high cost.

- **Unorganised and unregulated market leads artificial price inflation**: In most cases, the supply chain of feedstock (collection, transportation and storage) is arranged by third party/ lorry owners who exploit their monopoly position to escalate transportation costs and artificial price inflation.

Response of TNERC over fuel price escalation

In response to market price, TNERC in February 2009 has revised the FIT from Rs 3.47 per KWh (Rs 1.5 Variable Cost + Rs 1.97 fixed cost) to Rs 4.5 per KWh (Rs 2.5 Variable Cost + Rs 1.97 fixed cost). Variable cost has been revised from Rs 1158 per tonne (Estimated based on 5% escalation on price set in 2005) to Rs 2000 per tonne. However, the stakeholder consultations suggest that the feedstock price is much higher at Rs 2400 per tonne.

Further, to improve the project viability TNERC has also allowed open access (third party sale) starting 2009, for 6 months for biomass based projects, even for the existing PPAs with the State Utility.

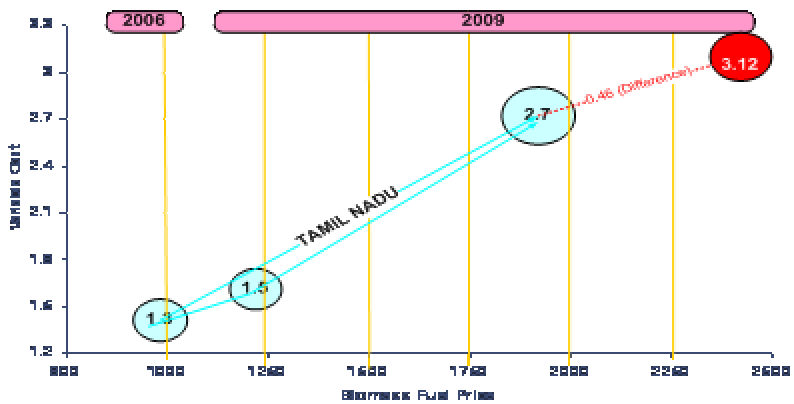


Figure 22: Price variation in Tamil Nadu

Source: Stakeholders' consultation and Tariff order

Chhattisgarh

8.18 The state has about 150 MWs of installed biomass based capacity. The State has been the most attractive destination for biomass based power plants because of large biomass resources and its low alternative usage due to availability of coal at cheaper price. Moreover, in 2007, SERC has reduced the wheeling charges from 6% to 3% (of energy) as a result; developers have started showing more interest in installing capacity.

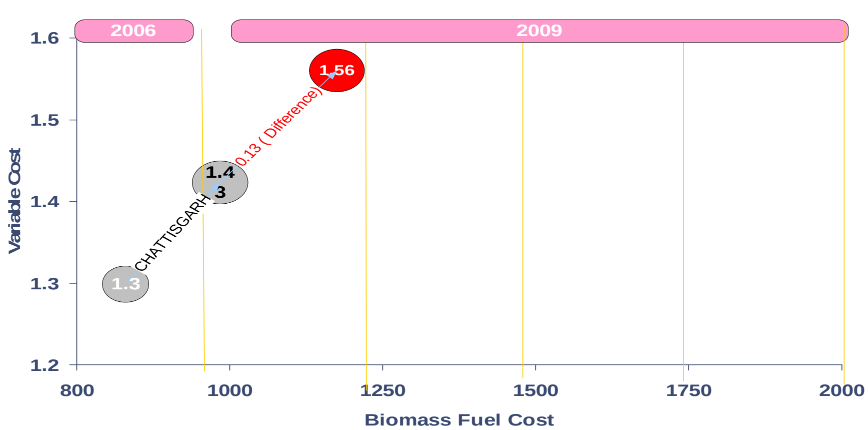


Figure 23: Price variation in Chhattisgarh

Source: Stakeholders' consultation and Tariff order

Maharashtra

8.19 **Limited supply due to financially unviable biomass feedstock has hampered the growth of biomass sector in state**: The potential of biomass in the state from agriculture is purely based on residues like cotton, soyabean, wheat and bajra stalks. The aggregate surplus biomass residue for power generation is reasonable in the state but the density (tonnes per sq kms) is considerably low. Low density of biomass and its alternative usage in the SME sector has resulted in supply demand gap which in turn has created price volatility.

In recent past the biomass fuel price has gone above the Rs 2000 per tonne mark threatening the financial viability of the biomass based power projects. Considering this the MERC in 2009 revised the variable component of tariff at Rs 2.58/Kwh @ fuel cost of Rs 2045 per tonne. Last tariff order in 2005 had considered the fuel price @ Rs 1000 per tonne. Fixed price remaining same the current tariff stands at Rs 4.28/Kwh.

Andhra Pradesh

8.20 **Dependence on single source of biomass imposes high risk of price escalation due to high price elasticity of alternative usage:** The coastal belt of Andhra Pradesh has ample availability of biomass (paddy husk and straws) from agri-residues. In the same region, rice husk is alternatively used by the SME sector, especially the fisheries industry for export packaging. The feedstock price has increased sharply from about Rs 500-600/tonne in early 2000 to as high as Rs2100-22000/tonne. In response to this, the SERC has in January 2009, revised the FIT to improve the financial viability of the biomass based generation projects..

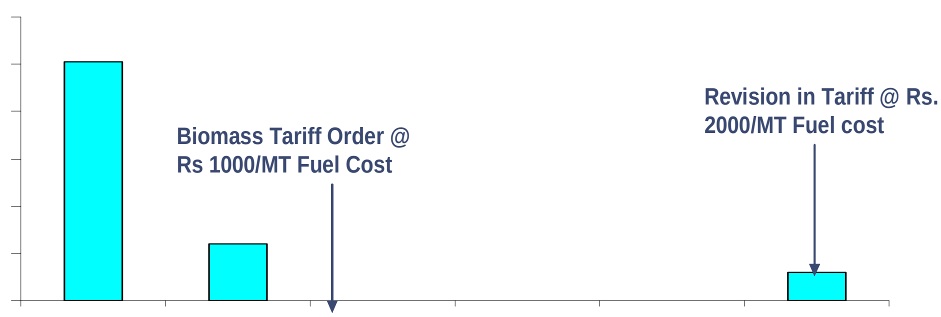


Figure 24: Development of biomass based projects in AP

Source: Stakeholders' Consultation & MNRE

Tariff order of 2005-06 on biomass considered the fuel price @ Rs 1000/MT which aggrieved the developers to the extent that there was not any capacity addition for three consecutive years (2005-06 to 2007-08). APERC thus has revised the FIT for biomass projects to Rs 2.54 per KWh (variable component) to be escalated at 5% every year starting in 2009. The recent revision in feed in tariff is primarily due to the adjustment in fuel cost, which has been amended from Rs 1276 per tonnes (estimated based on 5% escalation on price set in 2005) to Rs 2000 per tonnes (current Price). In result, the state has attracted considerable investment in biomass sector.

Punjab and Haryana

8.21 The biomass potential in these two states is based on agro-waste biomass. Although the potential in both states is significantly high, but at the same time, the demand from alternative uses of biomass is also high. For instance, almost the entire quantity of wheat stalks collected is used as cattle fodder in both the states.

8.22 Most rice mills in the states are located in the vicinity of Ludhiana, Amritsar, Yamunanagar, Panipat etc. where the concentration of the SME sector is high and hence most of the rice husk is used up by these SMEs for heating purposes. Other feedstock such as mustard stalks, rice stalks, and cotton stalks are used in rural brick manufacturing units. Due to their geographical location, most northern states including Punjab and Haryana, have a critical constraint of coal supply for small scale industry, therefore the demand and price elasticity of biomass is very high. In fact, recently the biomass price has reached up to Rs 3500 per ton. Considering the sizable potential in the states, about 300 MWs of biomass based projects have been awarded for development in Haryana, but so far have not progressed much. The stakeholders' consultation reveals that due to perceived high risk of fuel availability and price.

Gujarat

8.23 The government's decision to introduce Open Access/Third Party sale (2007-08) and competitive FIT has spurred the biomass developers and the state has registered around 150 MW worth of projects in the pipeline. As the demand for biomass for alternate use (in industries) is not considered to be high, the fuel risk may not be high. The attractiveness of the state with present regulatory scenario seems reasonable high.

Key Issues impacting Biomass Development

In conclusion, the following are the key observation drawn from the analysing the state experiences:

1. Analysis of state policy initiatives and respective potential reveals that the availability of biomass is not the only rationale for biomass sector development in any state. Development of biomass industry has boosted as a result of favourable policy framework; especially the synchronization between tariff setting and biomass pricing in the state.
2. In most of the states, the results of Biomass Atlas do not match with the actual availability of biomass: The Biomass Atlas has not been updated since early 2000 and could be outdated considering the development of the SME sector that uses the same biomass for their alternative fuel usage.
3. Moreover, based on statistical methods, the biomass atlas estimates absolute amount of biomass in the region, but does not comment on its density to estimate the commercially viable quantum of biomass.
4. Though command area restricts internal competition between biomass plants located in same vicinity, but in most of the states, allocation of command area is based on Biomass Atlas which leads to insufficient access to biomass in the region. The discussion with developers reveals that the size of the command area is not adequate to achieve the appropriate PLF especially in the states where the biomass density is relatively low.
5. Because of unregulated nature of biomass market, states with a strong industrial base faces strong competition as the price elasticity of biomass for small scale industry is higher than biomass sector which is regulated market.
6. In certain states, potential exploitation has been restricted due to regional issues such

Investment Analysis of Key States

8.24 Based on the stakeholders' consultation in different states, a qualitative analysis to assess the attractiveness of the states for investment in biomass power generation projects is highlighted in the following table. Qualitative issues covered are as follows-

- Biomass availability
- Alternative uses of the feedstock, if any, and the degree of the usage
- Alternative fuel availability for the alternative/SME industrial uses
- Allowed biomass fuel cost in the state

8.25 Gujarat and Madhya Pradesh are considered to have low risk linked to biomass fuel cost and therefore considered attractive states. The low fuel risk is due to the fact that these states have good availability of the gas/coal at competitive price, thereby reducing the demand for biomass. The recent regulatory decision to allow open access in these states would improve the financial viability of the projects and reduce risks.

8.26 The case is opposite for states where the availability of alternative fuels (coal, gas etc) for the SME or industrial sector is low and consequently the biomass price high, investment attractiveness for biomass projects is low. States like Punjab, Rajasthan and

Haryana fall under this category. It is pertinent to mention that even though Haryana has allowed higher biomass fuel cost that Punjab and Rajasthan, the installed biomass capacity in the state is the lowest. Major reason for this is the heavy industrial use of biomass fuel in the cities like Faridabad, Gurgaon, Panipat, Yamunanagar etc. Similarly in Punjab, industrial towns like Jalandhara and Ludhiana have heavy biomass fuel usage for heat/steam generation. Also the demand of specific biomass such as wheat stalks is quite high in Punjab, Haryana and adjacent states.

8.27 Tamil Nadu has considered a high biomass fuel cost in its latest tariff order but still has not been able to attract much investment in the sector due to significantly high degree of elasticity in the biomass fuel price. Chhattisgarh on the other hand has exhausted almost of the achievable potential and thus presents low attractiveness now.

State	Key Biomass Residue (Agro)	Alternative Uses	Degree of Alternative Use of Key Residues (Agro)	Alternative Fuel & Degree of availability for SME sector - Alternative uses	Current Biomass Fuel cost as allowed/Escalated in State TO Rs/MT	Degree of Elasticity in Biomass Cost	State Attractivene for Investme in Biomass
Gujarat	Cotton Husk, Stalk, Boll shell , Banana, ground nut shell and stalks, castor seed stalks	SME	Medium	Coal & Gas	1000	Medium	High
Madhya Pradesh	Arhar, Jawor, Maize, Soyabean Stalks and Cotton Husk, Stalk, Boll shell	SME	Low	Coal- Medium	1180	Low	High
Maharashtra	Cotton, Wheat, Bajra, Jawor and Soyabean Stalks	SME	Medium	Coal- Medium	2045	Medium	Medium
Andhra Pradesh	Paddy straw and husk, Coconut fronds, husk	SME	Medium	Coal- Medium	2000	Medium	Medium
Rajasthan	Wheat stalks and Pods, mustard, cotton and bajra stalks	Cattle fodder	Low	Nil	1215	Medium	Low
Punjab	Paddy straw, wheat stalks and Pods, Cotton Husk, Stalk, Bollshell	Cattle fodder /SME	Very High	Nil	1100-1200*	Very High	Low
Haryana	Paddy straw and husk, wheat stalks and Pods and mustard stalks	Cattle fodder /SME	Very High	Nil	1600	Very High	Low
Tamil Nadu	Banana, Coconut fronds, husk, shell, Groundnut and paddy husk and stalks	SME	Medium	Coal- Medium	2000	Medium	Low
Chattisgrah	Paddy Straw and Husk	SME	Low	Coal - Very High	995	Low	Low
Karnataka	Cotton Husk, Stalk, Bollshell , Paddy straw and Paddy Husk, Maize stalks and cobs, Coffee Pruning & wastes	SME	Medium	Coal- Low	1215	Medium	Low

Table 10: Mapping of various states for biomass assessment and assessment of investment potential

Source: Stakeholders' Consultation (* No declaration in Tariff order – assumed with respect to tariff)

Recommendations

- **Periodic Decentralized Biomass Resource Assessment –**The assessment done by MNRE through IISc hasn't gained wide acceptability from the biomass market. There is a need to have various decentralised assessments of the resources at state/district/taluka level with practical survey/consultations with the farmers and other players involved, in addition to theoretical GIS surveys.

  The assessment from forest & waste land should be considered as exploitable potential only after checking the financial viability, taking the cost economics of plantation, collection, extraction etc into consideration.

- The assessment must be done periodically to take into account the effect of changes in agriculture output and alternative uses of residues which depends upon agro climatic conditions and the prevailing economic scenario respectively.

- **Fuel cost adjustment methodology-** There is an urgent need for a methodology to pass the fuel cost adjustment through increases in tariff as and when required as is done in case of coal fired plants. For this, a monitoring agency at the state level mandated to regulate the fuel price (including the extraction, collection, transport, storage cost etc) and revise it at every quarter should be instituted.

- **Project Allocation Analysis in command/catchments area-** Plant allocation mechanisms must consider the total biomass potential available in a taluka, its area, availability of the water, fuel operation costs and alternate uses in the region to develop a viable plan consisting of optimum operation costs & functions by taking into account parameters like the number and location of plants, number and location of collection centres for feedstock etc.

- **Market for Biomass –** To overcome the problems posed by the existence of multiple middlemen (transporters, traders etc.) in the biomass feedstock value chain, and to streamline the interaction between feedstock sellers and buyers, an organized/ structured market for biomass should be developed. The market would reduce transaction costs and also allow for true and undistorted economic price discovery of feedstock based on available supply and demand.

CHAPTER 8: INVESTMENT CLIMATE FOR SOLAR POWER PROJECTS

8.1 India's Solar Potential - India receives abundant sunshine through most of the year. Many parts of the country get 250-300 sunny days a year. At 1900 kWh/sq M, India receives one of the highest levels of solar irradiance globally. On average, the power generation potential from solar PV in India is 20MW/sq Km. Certain sites with higher levels of insolation like Ladakh, Gujarat and Rajasthan have above average potential at 35, or even 40MW/sq Km. Located in the sub-tropical belt, India's favorable geographical position is highlighted below.

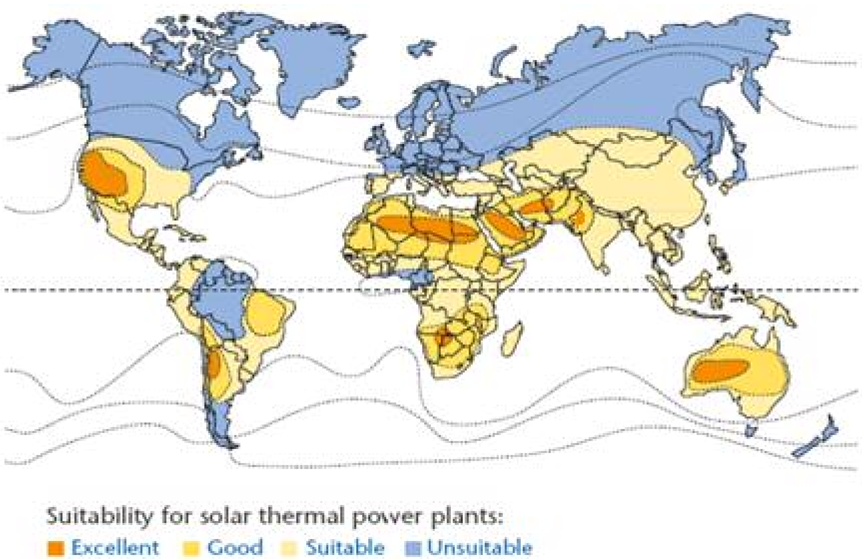


Figure 25: India's favorable location with regards to solar energy potential[13]

8.2 The Government of India has introduced policy and regulatory initiatives to encourage investments for harnessing the abundant potential of solar energy in India to address the country's growing energy demand concerns.

8.3 **Main solar technologies: In the solar photovoltaic (SPV) domain, there are two technologies that have been used on a commercial scale:** crystalline-silicon (c-Si) technology and thin-film technology. Solar thermal is a more nascent technology and although several configurations have been piloted on a global scale including parabolic trough systems, central receivers, dish stirling/dish-engine systems, and solar chimney power plants none of these technologies have been installed in India to date.

8.4 **Key Advantages of solar PV and solar thermal in Indian context:** Solar thermal and solar PV applications are both in the Indian market. Some of the key advantages of each are highlighted below:

[13] CSP Today - An Overview of CSP in Europe, North Africa and the Middle East-October, 2008, pg. 58

Solar thermal technologies	Solar PV technologies
• Cheaper relative to PV on a per kWh basis • Utilities are more familiar with turbine concepts and materials (concrete, steel) • Storage capability and hybrid compatibility with natural gas	• Modular in nature and thus quicker and easier to build • Less location sensitive • Distributed generation capability so extra transmission infrastructure is not necessary in all cases • Suitable for small, off grid applications so can meet rural

Policy Drivers for Solar Energy Development in India

8.5 The Government of India has put in place a structure of policy and regulatory initiatives to encourage investments for harnessing the abundant potential of solar energy in India to address the country's growing energy demand concerns.

8.6 **NAPCC identifies solar energy as key part of climate change solution:** India's National Action Plan on Climate Change (NAPCC), introduced in 2008, has identified the National Solar Mission (NSM) as one of eight key National Missions to address climate change.

8.7 **National solar mission outlines aggressive solar energy targets:** The solar mission is aimed at making solar energy cost competitive with fossil fuels and targets an aggressive increase in deployment of solar energy in the total energy mix. Specifically, the mission targets increasing production of solar photovoltaics (SPV) to 1000 MW/year; and of deploying at least 1000 MW of solar thermal power generation by 2017 (12th Plan Period).

8.8 **National solar mission provides directive for strengthening solar energy manufacturing industry:** In addition to setting targets for generation capacity the solar mission outlines specific goals for R&D development and commercialization of solar technologies this includes establishing solar research facilities to encourage the deployment of commercial and near commercial solar technologies and facilitating collaboration and technological transfer from international organizations.

8.9 Some of the important national incentives introduced by the GoI to encourage the development of solar include the following:

Name	Nature	Key features	
Special Incentive Package Scheme (2007)	Manufacturing	1) Encourage investments in PV manufacturing	
		2) Minimum Investment:	Rs. 2500 Cr. (fabrication plant)
			Rs. 1000 Cr. (ecosystem unit)
		3) Available till March 2010	
		4) Ceiling on units:	2-3 fabrication units
			10 ecosystem units
Special Economic Zone (2007)	Fiscal/Financial	1) Income tax exemption for 15 years:	Yr. 1-5: 100%
			Yr. 5-10: 50%
			Rest 50% of reinvested profit

			plowed back
		2) Allows 100% FDI investment in manufacturing	
Generation Based Incentive (2008)	Policy/Regulatory	1) 50 MW total capacity; Min: 1MW, Max: 10MW per state	
		2) Applicable during 2008-12	
		3) Overall tariff:	Rs. 15/kWh for PV
			Rs. 12/kWh for ST
		4) If no solar tariff, maximum of other RE tariff in that state is applicable	

Table 11: National Solar Energy Incentives

Evolution of State Level Policies

8.10 **Central GBI has spurred several state level policies -** Based on the central government GBI guidelines several states with high solar potential have declared specific solar policies. However, the tariffs set for solar projects are lower than tariffs for other renewable energy sources such as wind. This could in part be due to the clause in the GBI which states that the highest RE tariff applicable in the state should be applied to solar projects if no solar tariffs exist.

8.11 **GBI has prompted SERCs to declare tariffs for solar energy in their own states-** Gujarat has issued the Gujarat Solar Policy 2009 which offers a competitive alternative to the GBI by mandating the tariff for 25 years, instead of the 10 under the GBI scheme.

8.12 States like Rajasthan, West Bengal, Haryana, UP have introduced solar tariff orders that allow installation capacities in addition to and in excess of the 10 MW limit stipulated under the GBI scheme.

8.13 The comparative details of GBI in states and other state policies are provided in the table below.

State	Type of Project		Tariff						Valid up to	Comments
			Solar Thermal			Solar PV				
Gujarat	Projects commissioned before Dec 2010		Rs 13 per unit for year 1 to 12 and Rs 3 for year 13-25			Rs 10 per unit for year 1 to 12 and Rs 3 for year 13-25			2034	50% of CDM benefits passed onto distribution licensee. AD permitted. No alternate fuel permitted
	Projects commissioned after Dec 2010 and before march 2014		Rs 12 per unit for year 1 to 12 and Rs 3 for year 13-25			Rs 9 per unit for year 1 to 12 and Rs 3 for year 13-25				
			MNRE	State	**Total**	MNRE	State	**Total**		
Rajasthan	Projects commissioned before Dec 2009	With GBI	12	1.78	**13.78**	12	3.78	**15.78**	2018	75% of CDM benefits pass onto distribution licensee. Without GBI, state has 50MW ceiling, 1 MW floor
		Without GBI		**13.6**			**15.6**			
	Projects commissioned after Dec 2009 but before 31 March 2010	With GBI	12	1.18	**13.18**	12	3.18	**15.18**		
		Without GBI		**13**			**15**			
West Bengal	With GBI		No tariff declared for solar thermal.			11	4	**15**	2018	Eligible for AD. Limit:1 MW to 5 MW
	Commissioned before 2010	Without GBI					**11**			
	Commissioned after 2010 and before 2012	Without GBI					**10**			
Haryana	Projects commissioned before Dec 2009	Without GBI	No tariff declared for solar thermal.				**15.96**		PPA for 20 years but tariff can be revised after 5 Years	Without GBI, 50MW ceiling capacity distributed over 8 developers for PV and 1 for thermal
	Projects commissioned after Dec 2009	Without GBI					**15.16**			
	With GBI					11.04	3.96	**15**		
Tamil Nadu	Projects Commissioned up to Dec 2009	With GBI	9.85	3.15	**13**	11.85	3.15	**15**	PPA for 10 Years	Limit up to 10 MW

Table 12: Solar Tariff Structures across Major States

Solar Development in India

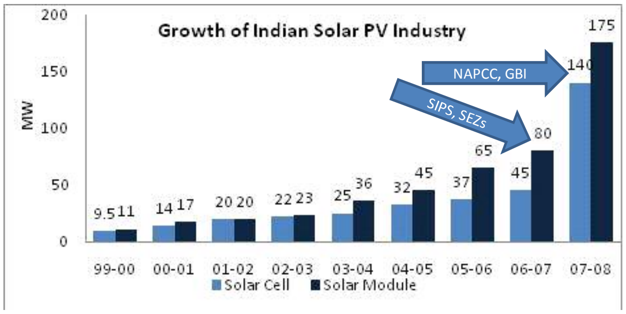
8.14 **Potential for solar energy applications in India** - There is huge potential for solar energy to be used for applications grid interactive solar power generation, solar thermal industrial applications, rural electrification and mobile towers in off-grid areas, and domestic solar water heating applications. As of now commercial applications of solar energy are confined to water heating and to a limited extent for decentralized, rural electrification. Presently, the country has initiated rural electrification program where solar based installations (like lanterns, PV modules etc.) provide basic electricity services through in remote areas where grid connectivity is financially unviable. However, largely the rural electrification program has not been able to transcend into commercial utilization.

8.15 **Low installed solar generation capacity**: At present, solar generation in India has been limited to solar PV applications. Till January, 2009 only 2.12 MW of grid-connected solar PV capacity had been installed. This includes seven grid-interactive plants totalling 750kWp have been set up by Bharat Heavy Electrical Limited (BHEL) in Lakshadweep on a pilot scale. Besides this, off-grid solar PV installation capacity is limited to 3MWp (excluding solar lanterns and pump-sets). This includes installations of PV plants of 25-200kWp on rooftops of government buildings and in rural locations in Rajasthan, West Bengal, Punjab and Gujarat for voltage management. In addition, stand-alone home lighting systems and lanterns are in use in the Andaman & Nicobar Islands, Lakshadweep Islands, Ladakh, Assam, Meghalaya, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. Currently approximately 77 million households are un-electrified but less than 1 million lanterns and solar home lighting systems are in use.

Indian Solar Manufacturing Sector

8.16 **Current solar incentives mainly target SPV manufacturing industry:** The introduction of SIPS and the SEZ Policy in 2007 the solar PV industry initiated a significant increase in SPV manufacturing capacity. The production of solar cells increased nearly four-fold from 2006-2007 to 2007-2008 and the solar module production levels more than doubled over that same timeframe. This favorable response indicates the presence of a strong supply side push from solar energy players. The figure below shows the growth of the Indian solar PV manufacturing industry for the past 9 years.

8.17 **Additional manufacturing capacity planned by private players**: India appears to be positioned well for a further increase in SPV manufacturing capacity. Moser Baer is commissioning a 200MW thin film module plant to produce the world's largest non-flexible thin film modules. Under the Semiconductor Policy of India, the company has also put in a proposal for a 282MW thin film plant. Other players like TATA BP Solar, Lanco Infratec, KSK Energy, BHEL and Signet Solar (US) are likely to join to the fray in the near future.



8.18 **Solar PV in India largely driven by global demand:** Despite the increase in manufacturing capacity in India, and competitive cost of manufacturing, the demand for solar PV applications has not increased significantly in India due to the high upfront costs of this technology. Even with an increase in Indian demand it can be expected that the solar PV market would still largely be driven by technological advancements and increasing global demand – particularly from Europe. Box 1 below provides an overview of global demand for solar PV and thermal.

Box 1: Overview of Global Demand for Solar PV and Solar Thermal

Global Solar PV Demand

The impressive international growth in the solar PV market is driven by a surprisingly small number of countries. Europe is the undisputed market leader in solar PV, with over 82% of the 5.95GW total sales. Along with European nations like Spain & Germany, USA and Japan share a very strong policy framework which includes instruments like FIT and investment grant/subsidy, net metering etc. which makes them not only large manufacturers, but also large demand centers.

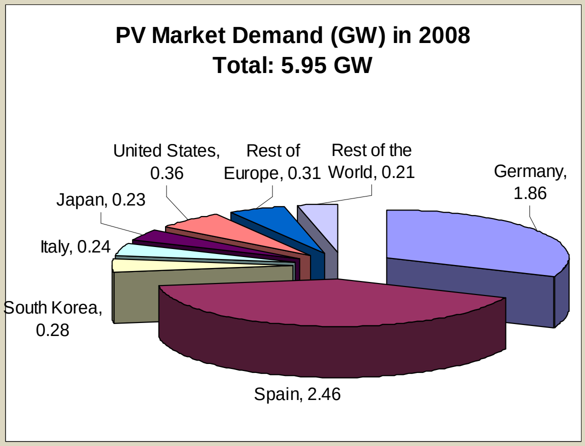


Figure 6: Global Solar PV Demand Centers

Global Solar Thermal Demand

The global solar thermal market is more nascent than the solar PV market and currently includes almost all capacity in non power applications like industrial, commercial and roof-top water heating. In 2007, the installed capacity of all these applications on a global scale was 19.8GW. China leads the industry with the largest solar thermal market for solar water heating applications and has added 15.4GW of capacity, which represents 77% of the total global market.

Indian Solar Project Development

8.19 **Current Players in Solar PV in India:** Some of the major solar PV players in India include Astonfield Solar, Moser Baer, Tata Power Company, Welspun Urja India Ltd., Acme Tele Power, Millennium Synergy Pvt. Ltd., Ruchi Soya Industries Ltd. All of these companies are targeting installations in a wide range extending from 50 MW to 2000

MW. Other players like TATA BP Solar, Lanco Infratec, KSK Energy, BHEL and Signet Solar (US) are likely to join to the fray in the near future.

8.20 **Interested Players in Solar Thermal:** Although no solar thermal power plants have been installed in India to date, there are a number of private players who have expressed an interest in entering the solar thermal market. India-based Acme Group has been in active discussions with state governments for setting up solar thermal power plants since 2008. Acme Group has made a USD 30 million investment in US-based eSolar in exchange for a 5% ownership stake and the right to use eSolar's 46MW modular solar thermal power plant technology over the next 10 years14.Suryachakra Power Venture Private Limited (SPVL) too has entered into a joint venture with a Germany-based CSP technology firm, MAN Solar Millennium GmbH (MSM), for joint development of solar thermal power projects in India. State governments have also been approached by local firms who want to sign MOUs for setting up solar thermal plants. A private firm, Power Cube Private Limited is in talks with the Uttar Pradesh Power Corporation Limited (UPPCL) to set up a 10MW solar thermal plant in the district of Unnao15. Similarly, the Gujarat-based firm Electrotherm (India) Ltd. plans to sign an MOU with the state government for setting up a 50MW solar thermal power plant in the Kutch region. The company plans to invest Rs. 400 crores (approx. USD 80 million) for this project and expects this to be completed within 18 months after government approvals are attained16.

Despite having sizable manufacturing base and investment interest, solar PV/thermal installations remain limited – As highlighted above, GBI combined with a strong manufacturing base provides a conducive environment for solar installations to flourish. Several states like Haryana, West Bengal, UP, Tamil Nadu have offered solar specific tariffs. A lot of investors have also expressed their interest for projects totalling over 3000 MW valued at over Rs. 55000 Cr. However, despite all of these favourable factors acting together, there has been no significant capacity addition in solar installations. The lack of an enabling policy environment that facilitates the interaction of these factors impedes the development of solar project installations.

Barriers and Risks for Large Scale Solar Projects

1. **Prohibitively high capital costs –** Solar projects require from high upfront capital costs due to the expensive input material and high cost of components required. The main components like solar cells for solar PV applications and specialized mirrors and absorber tubes for solar thermal can comprise more than 50% of total capital cost[17]. This problem is further accentuated by the commercial rate of lending at 12.5% for 7 years at 70:30 debt-equity ratio. In contrast, in Germany and Spain for example, interest rates vary in the range of 3-6%. Such a high rate of interest unduly increases the cost of debt increasing the risk component for the developer. Undertaking a few pilots will help in bringing down future capital costs. This will also stimulate the development of domestic manufacturing, further bringing down costs due to indigenization.

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[14] *Acme India Group invests 30 million dollar in E-Solar*. Source: www.solarindiaonline.com
[15] *Solar Thermal Plant in Unnao*. Source: www.solarindiaonline.com
[16] *More Companies Entering Gujarat Solar Policy.* Source: www.solarindiaonline.com

[17] Institute for Technical Thermodynamics, German Aerospace Center (DLR), 2008

2. **High perceived risks due to short term PPAs –** In India, all PPAs are valid for a maximum period of only 10 years at tariffs in the range of Rs. 15-16/kWh under the GBI scheme as well as under a few state tariffs. In comparison, European tariffs are valid for 20 years at rates equivalent to Rs. 25-30/kWh[18]. This small period of barely adequate tariff does not allow project developers to gauge the viability of their projects sufficiently ahead into the future and places an undue risk burden on them.

3. **Geographical Constraints for Large Scale Solar Projects –** In addition to adequate solar radiation levels for large scale solar generation requires the following minimum resources for technical feasibility:
    a. High levels of direct solar radiation
    b. Availability of transmission infrastructure to evacuate power from the project location.
    c. Large stretches of flat land, particularly for parabolic trough systems. A typical CSP plant requires about 5-10 acres of land per MW of installed capacity, depending on the plant's usage of heat storage[19]
    d. Continual water supply for steam generation and to cool turbines in case of solar thermal plants[20]
4. **Nascent Technology Issues** – A large cost component of solar projects comprises of capital inputs which comprise of high precision engineered components such as parabolic mirrors, silicon cells, receiver tubes etc. Due to limited field experience and data, process standardization and quality benchmarks are not uniform across projects, with each manufacturer imposing its own standard. The level of customization, depending upon project size, necessitates the equipment to be commissioned on a project to project basis. This custom ordering prevents the manufacturer from exercising the benefits of reduced cost due to economies of larger scale production.

    The problem is accentuated further by the lack of a learning curve and data gained from ground level experience for simulating capital and operating costs for potential projects. Most components have a proven track record but scale-up and their integration is still seen to be potentially risky. A few large pilot projects of 50MW – 100MW (perhaps 3-4 pilots) would be required to help drive the market by reducing the risk premium as design, construction, and O&M experience is gained.

Mathania ISCC Plant

Overview of the Project - Conceived in the 1980's, the Project was an Integrated Solar Combined Cycle Plant at Mathania, Rajasthan. It was a Greenfield Project to be set up on a Build-Own-Operate (5 years) basis.

Technical Description - The plant was to have a total capacity of 140 MW, of which the solar component was 35 MW. The solar component was a parabolic trough setup with a field area of 219, 000 sq. m. The solar thermal energy was to be supplemental to a natural gas-fired capacity of 105 MW. The plant would have comprised of gas and steam turbines generating 70 MW of power each.

Financial Description - Estimated to cost $245 million, the project's funding was supported by the KfW,

[18] Euro equivalent at 0.45-0.6 Eurocents
[19] An *Overview of CSP in Europe, North Africa and the Middle East*, October, 2008, CSP Today
[20] Water supply not required for dish sterling system configurations and Solar PV

which provided funding worth $150 million. An additional $49 million was to come from the GEF, and a $20 million contribution met equally by the Governments of Rajasthan and of India. The balance of $26 million was to be met by private Independent Power Producers.

Chronology of Events - The initial detailed project report (DPR) was submitted after lengthy technical evaluation in 1998, and CEA approval was obtained in 1999. The Engineering, Procurement and Construction contract with an Operation and Maintenance approach was decided on in the same year. The government sanctioned the project in 2000. However, there was a sharp increase in the price of Naphtha, the initial choice of fuel, in 2001. Thus it was decided to switch to Re-gasified LNG as fuel, and a revised pre-qualification process was initiated. The new RfP was finalized in 2002, but negotiations with potential bidders failed to yield fruitful bids in 2003. The World Bank requested a letter of commitment from the Government of India in 2004 to continue with the project but before further progress could be made, a large natural gas reserve was discovered 150-170 kms from Mathania. This find skewed the economic feasibility of the project, as gas supply prices and parameters would have had to be recalibrated. Another techno-economic feasibility study was ordered, and there has been no progress since.

Major barriers -

- **Gas supply issues –** Continuous delays in finalizing gas supply agreements. Rajasthan Renewable Energy Corporation Ltd. was unable to sign a Gas Supply Agreement with Gas Authority of India Ltd. for the required supply of 0.5 mmscmd gas. The project saw continuous changes in gas supply parameters: from Naphtha to RLNG in 2001, and with the 2005 gas find, efforts to gain gas supply from that site. These changes have meant significant changes in the techno-economic analyses involved, and modified bids had to be prepared each time. Confidence of GoI and bidders was low due to such fluctuations.
- **Technology Aspects – The** project, initially meant to be a stand alone solar thermal plant was refurbished to be based on Integrated Solar Combined Cycle System (ISCCS) technology. This project was affected by issues of gas availability (at a location suitable for solar project) and pricing.
- **Transaction Structuring:** Single EPC and O&M contract with revenue from PPA with state power utility put high project risks with the selected bidder/project developer. Technology specific procurement process was restrictive (parabolic trough with a combined cycle plant was specified)
- **Delays in implementation –** The World Bank's request for a letter of commitment from the GoI led to a cyclic delay. RSPCL also caused delays due to change in government.
- **Low bidding confidence –** The scope for profits was limited due to price control characteristic of state-owned plant projects. There was no appreciable reduction in risk to coincide with state ownership, and risk allocation remained vague throughout the project conceptualization. In addition, there was an absence of domestic players.

Due to overall delays in project, no further progress was made and it was closed.

Recommendations

Recommendation 1: Mobilize dedicated funds for R&D & demonstration projects

One of the biggest problems confronting the solar industry as a whole is the high upfront cost of installing a solar generating plant. One of the proven medium to long term solutions for capital cost reduction is investing in R&D and scaling up operations to utilize economies of scale. For India to maintain its status as a low cost manufacturer and to capitalize on its inherent advantages in the solar sector, it needs to consider revamping and upgrading its solar R&D and manufacturing capabilities. Pilot plants will help create technology trust, build a learning curve and address issues pertaining to grid-parity, and provide institutional learning thus reducing the hurdle for subsequent market entry.

Recommendation 2: Competitive interest rates for solar projects
Due to the high upfront capital cost investments required for large-scale solar power plants access to access to low cost and large gestation period financing would help to reduce the current cost burden to developers and may attract more players.

Recommendation 3: Augmenting GBI and structuring longer-term PPAs

- In its present form, the GBI scheme is only applicable to a total of 50MW of grid interactive solar power generation. It also limits each state to a total of 10MW and even within each state sets a ceiling of 5MW per developer and floors the capacity of each plant at 1MW. These artificial constraints on the size and (effectively) the number of developers and plants restricts the ability of developers to exploit the economies of scale associated with large units and limits the overall share of solar energy in the energy mix.

- In India, the PPAs are valid for a maximum period of only 10 years at tariffs in the range of Rs. 15-16/kWh. Providing longer-term arrangements with predictable pricing and financial incentives would help to increase the viability of projects and reduce the risk burden to developers.

Recommendation 4: Promote Indigenization through enabling policy environment
Policy and regulatory mechanisms should be designed to encourage indigenization of solar manufacturing capabilities to exploit the advantages of low cost domestic manufacturing while giving an impetus to the local industry. The benefits of low cost manufacturing will be further enhanced by savings in foreign exchange.

Recommendation 5: Dedicated RPO for Solar Energy
Due to the higher cost of solar generation, combined with the fact that a limited number of state tariff policies for solar energy have been issued till date, there is a need for instituting a dedicated solar RPO to encourage the solar based generation.

CHAPTER-9: ECONOMIC FRAMEWORK FOR RENEWABLE ENERGY DEVELOPMENT

Need for a Economic Framework for Renewable Energy Development

9.1 ***RETs are presently uncompetitive vis-à-vis conventional energy technologies***: Till now, India has been able to exploit less than 10% of its RE potential. One of the reasons for low development of the RE potential is the relatively higher cost of generation from RE vis a vis conventional energy technologies. This has been highlighted by the supply curve and comparison of the cost of generation across conventional and renewable energy technologies points (as highlighted in Chapter 3).

9.2 ***Case for a more comprehensive approach to RE development***: Globally, it is accepted that RE based generation is more desirable than conventional power generation. The only barrier to higher adoption of RE is its higher cost vis a vis conventional generation. Policymakers across the globe are trying to find ways to encourage RE without putting too much burden on the exchequer. One approach that can justify higher investments in RE even though the financial cost of RE generation is higher is the Economic Framework Approach to RE Investment. The main features of this approach are:

- **Financial returns as the criteria for investment do not take into account the economic benefit to society or nation from that particular investment**: Current conventional approaches does not appropriately capture in energy pricing the long term impacts on a variety of other stakeholders. One example of this lack of long term view of the present approach is the risk of future increase in fossil fuel prices and their subsequent impact on energy security for all stakeholders at the national level. Therefore evaluation of energy investments needs to look at both the short and the long term implications of any energy investment; be it a future fuel risk, the potential for developing a cheaper indigenous clean renewable substitutes or reducing long term environmental damage. All of these have to be built into the economic cost benefit analysis model for that investment.
- **Need to evolve new economic valuation methodologies for RE projects:** Current energy valuation methodologies do not consider social and environmental (except CDM) benefits when valuing energy generated by RETs. These benefits are merely acknowledged as positive externalities with no bearing on the actual market price for RE, which in turn results in lower pricing of RE power.
- **Present approaches to evaluating renewable energy projects also do not take into account other externalities** such as subsidies (access to cheap land and captive mines of coal, cheap funds, and state subsidies for setting up plants, subsidized fuel supply etc.) and sops that help bring down the costs of conventional power projects run on coal and gas. On the other hand RETs have to pay either the market price or a higher price than the market price for most inputs.

9.3 ***Comprehensive Framework for Renewable Energy Development –*** A comprehensive approach based on the Economic Benefit Framework for Renewable Energy is needed for undertaking evaluation of future energy investments. The intention of the Economic Benefit Framework for Renewable Energy Development is to address not only the realization of the direct tangible benefits accruing from RE projects in the short term, but also the potential for realizing larger longer term economic benefits (externalities). The Framework would also provide a platform for bringing on board a diverse set of decision makers and stakeholders on a single platform to discuss and debate the economic rationale behind RE investments and to look at RE development in the short, medium and long term horizon.

The Economic Benefit Framework for Renewable Energy Development in India

9.4 Investments in RE result in a set of direct as well as indirect benefits which may be economic, social, environmental or technical in nature. To design the Economic Framework of Renewable Energy Development, a set of quantifiable economic, environmental and social benefits associated with investments RETse were identified. These have been highlighted in the figure below:

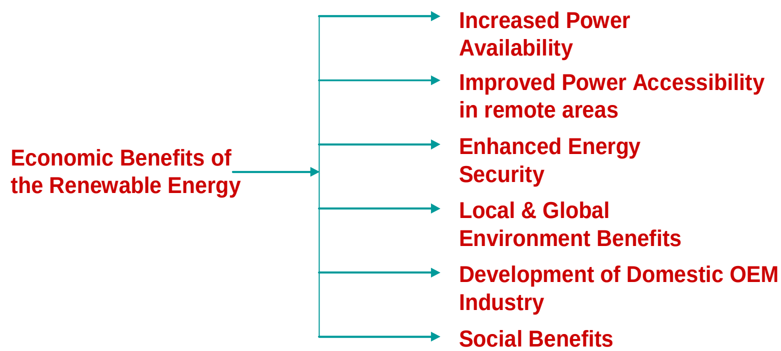

Figure 26: Economic benefits associated with Investments in RE

9.5 **Error! Reference source not found.** highlights the design of the Economic Framework for RE development in India. This framework is based on the analysis of the main economic benefits highlighted in the diagram above, the main stakeholders involved in their promotion and administration and the broad methodology for the measurement of all the economic benefits.

Approaches for Valuing the Economic Benefits of Renewable Energy Development

Economic Benefit 1 - Availability of Energy

9.6 Low endowment of fossil fuels like oil, gas or uranium, coupled with investment constraints and delays in project implementation have resulted in the India power sector facing a supply deficit. This gap presently stands at 10.4% average power deficit and 12.2% peak deficit (Chapter 2) and is likely to increase in the future with increasing economic activity, energy intensity and rate of rural electrification. Besides this gap, there exist a large number of potential consumers who have not yet been connected to the grid. As the economy develops and the 'unconnected consumers' are connected to the grid, the demand supply gap is likely to increase unless addition of large generation capacities takes place. Investment in RE is one of the ways of addressing this gap. RE sources can generate power in the same manner as conventional energy sources and have the advantage of having a "recurring" supply of fuel, i.e. a fuel source that is not "single use and finite" but recurs after a certain time period (mostly in daily or annual cycles).

9.7 ***RE can provide the requisite impetus*** **–**RE sources can play a crucial role in India for addressing the present and future power supply deficits by putting a significant amount of electrons in the wire. As mentioned earlier (Chapter 2), India can still exploit 125000 MW of small hydro potential, 350000 MW of wind potential, 47000 MW of biomass potential and more than 50000 MW of solar potential to meet its energy demand in the near future. Added to this incremental capacity available for development, RETs also offer the advantage of a relatively short gestation period as compared to conventional energy plants. This allows RE projects to be commissioned faster. For example, wind, biomass and solar energy plants have a commissioning period of less than a year once the clearances are through. In this manner, the RE sector is uniquely placed to have an immediate impact on the country's power situation if RE investments and development can be streamlined.

9.8 ***Approach for Measurement***: It is recommended that the CERC along with SERCs develop a detailed methodology for pricing RE generated power using the characteristics of power being made available These characteristics are defined by the following four parameters: type of contract, dispatchability, voltage level and distance of load from source. It is also recommended that RE power be priced using these four parameters and the viability gap (gap between this pricing and cost of generation) be met through the costing of other economic benefits associated with RE generation and investment. The estimate of the economic savings that RE based generation would deliver in the short to long term would be based on the value of each of these factors as mentioned above.

Economic Benefit 2 - Energy Access in remote locations – DDG Applications

9.9 ***Rural Electrification in India*** **–** According to the census of 2001, only 44% of households in India had access to electricity services. Over the years, with implementation of Rural Electrification Programmes like the Rajiv Gandhi Grameen Vidyutikaran Yojna (RGGVY) etc., the number of villages and households with access to electricity has grown significantly. Despite this, delivering energy to remote villages is still one of the most challenging tasks being faced by Indian Policy Makers today. Under the RGGVY launched in 2004-05 to achieve the goal of universal electricity access, the Government of India had identified 18000 villages as remote and mandated their electrification through Renewable Energy based Decentralized Distributed Generation (DDG) plants.

9.10 By investing in RE systems for these villages, it would be possible to provide electricity and the associated social, environmental and economic benefits that accompany such investments. Investments in RE capacity for electrification of these villages are likely to have the following set of impacts:

- Increased access to clean energy which would also result in savings in fossil fuels (kerosene if lanterns were the main mode of lighting or diesel if DG sets were used). It is pertinent to note here that as per the Universal Service Obligation (USO), all households should have access to electricity by the end of the XI Five Year Plan. In case of remote villages, the only alternative is diesel based generation. Therefore any intervention in this area would lead to a reduction in diesel consumption.
- It is a well known fact that RE projects are more manpower intensive than conventional energy projects, especially biomass based projects, providing an impetus to local economy by increasing employment.

9.11 ***Approaches to Measurement of the economic benefits of RE based electrification*** **–** The benefits accruing from the electrification of remote villages and habitations through RE based projects can be measured using the following two approaches:

- For remote village electrification, a life cycle based, economic cost benefit can be undertaken for analysing the savings in diesel (by taking the economic cost of diesel) and the actual cost of the DDG project over the DDG project's life time. The rationale for taking diesel lies in the fact that in absence of the grid the only source of decentralised power (except RE) capable of supplying grid quality electricity (which is a must for achieving USO standards) is diesel through a diesel generating (DG) set. This life cycle based projections would also need to take into account not only the economic cost of diesel but also the escalations likely to occur in time due to increase in global crude oil prices over the life of the DG set.

- The benefits can also be measured through the calculation of the Economic Rate of Return (EIRR) of the investment, i.e. investment versus the returns in terms social and economic benefits. The EIRR can be calculated by monetising the benefits energy i.e. by looking at the impacts of energy services at the village level. However data requirements especially of primary data make this method of measuring the benefits from this application almost impossible.

Economic Benefit 3 – Enhanced Energy Security

9.12 ***India's Import based Energy Economy*** - India, like a majority of the other countries across the globe has had to rely on conventional sources of energy to meet its energy requirements. With the demand for energy increasing at a significant rate due to economic growth and a plateau in indigenous conventional energy production, India's reliance on imports has increased significantly over the last decade. Today India is the world's fifth biggest energy consumer and is projected to pass Japan and Russia to take the third place by 2030.

9.13 ***High Share of Energy Imports in Power Generation*** - The share of energy imports as a part of the energy mix for power generation has risen over the last few years and is expected to rise further in the coming few years. India imports a portion of three of its major sources of energy: oil, gas, and coal. Its dependence on imported oil is already greater (as a percentage of oil consumed) than that of the United States and China, and is expected to increase even further. India is at present importing 10% of its coal, which is likely to increase up to 16% by 2011. India also imports a large majority of its gas requirements. These imports expose the Indian energy market to volatility in global energy prices and risks of higher future payments for energy imports.

NTPC Faces Coal and Gas Shortages

One of the major reasons for the shortfall in electricity supply over the last five years has been a shortage of coal and gas. In July 2005 twenty-two of seventy-five coal power stations (with a capacity of 61,000 MW) faced severe coal shortages even though all stations are required to maintain fifteen to thirty days of coal stocks for emergencies. National Thermal Power Corporation Ltd. (NTPC), India's largest thermal power generator, ran short of gas to power its plants and had to resort to using the more expensive naphtha for powering some of these plants. More recently, its 1,000MW Simhadri project located in Andhra Pradesh faced similar shortage of coal, when its stock of coal was down to only four days of stock against a norm of 25 days[21].

9.14 ***Benefits of RE Investments for enhancing Energy Security*** - Addressing energy security through investments in RE can lead to two broad economic benefits. The first, replacement of conventional fuels such as gas, coal and oil, which can help mitigate the risks associated with volatility in the price of energy imports, especially in a market where demand is rapidly

[21] http://www.livemint.com/2008/08/2901

outpacing supply options. The second is long term energy security due to improvements in the economics of RE generation which would make it more viable.

1) **Fuel Diversification and risk hedging**

9.15 One of the main actions needed to improve energy security for the country is to reduce the market risks associated with the import of energy. High fluctuations in energy prices have the ability to adversely impact the economy of the country. One of the possible solutions to this problem lies in the diversification of energy supply options and the indigenization of the energy mix. This translates into a reduction in imports by substituting the imported fuels by domestic fuels, diversifying fuel choices for import as well as internal production and expanding the domestic energy resource base. RE resources meet all of the above mentioned criteria. RE is available from a variety of sources, is locally available and indigenous and reduces dependence on imports.

9.16 RE projects being indigenous, distributed, "recurring" and displaying a reducing marginal cost of production provide the perfect risk mitigation tool for policy makers when it comes to the procurement price of energy especially for an economy heavily dependent on fossil fuels. Investments in these technologies would result in reduction in import of conventional fuels (saving of foreign currency from the short to the long term) and greater circulation of monetary resources in the country which would have positive downstream impacts on the country's Gross Domestic Product (GDP). Most of these technologies require a one-time investment over the project life cycle and have very small variable costs which shield them from global market price fluctuations.

9.17 Approach for Measurement - The economic benefit accruing from RE investments or generation can be measured by undertaking a comparison of the cost of energy generation through RETs and conventional energy sources in the future in volatile global energy markets. The savings (in terms of fuel price escalation risks) can be calculated using optimistic, pessimistic and business as usual scenarios for the development and behaviour of the global energy market.

2) **Long term energy security**

9.18 One of the main concerns of energy policymakers globally is the possibility of an energy price shock in the future as global energy demand and consequently, prices increase. Therefore the focus of any long term energy strategy needs to be on ensuring a minimum long term marginal cost of energy generation through investments in the right technologies. New and emerging clean energy and RETs such as solar thermal, off shore wind, fuel cells and next generation bio-fuels are some of the options for reducing the long term marginal costs.

9.19 Considering the present scenario, certain investments cannot be justified even after all the above benefits have been factored in. The cost of these technologies is so prohibitively high that not even the combination of environmental benefits along with energy availability and fuel price escalation risk mitigation would be unable to justify any investment in these technologies. However, these investments have a very high probability of leading to cost reductions in new and emerging technologies that can be game changers in the future. These technologies have a very high potential for application and with decrease in cost of development, technology risk, indigenization etc, can contribute significantly in to long term energy security.

9.20 For example, at present levels of conversion efficiencies, high cost of production and site specific and distributed nature, certain RETs (geothermal, solar thermal, fuel cells, off shore wind, 2nd and 3rd generation bio-energy etc) are not in a position to replace en mass conventional energy sources such as coal, gas or oil.

9.21 A case in point is solar PV which has an efficiency of around 15% and a cost of production in the range of Rs 15 to 20 per kWh over a 20 year period22. Currently, its impossible for a developing economy like India to tap this costly energy source on a large scale. However it is in solar that India has the maximum potential and cost reduction potential in the long term. Therefore there is a need to either reduce the cost of production of solar equipment (which is in the range of Rs 19 to 20 crore per MW) or enhance the efficiency of solar PV technology. This requires investments in R&D, demonstration projects, capacity building and technology transfer and collaboration.

9.22 ***Approach for Measurement*** – The approach to be adopted for the measurement of the economic benefit is the gains in the marginal cost of energy generation in the future. This benefit can be compared to the cost of investments in basic R&D and demonstration projects to estimate the EIRR of the programme.

Economic Benefit 4 – Environmental Benefits

9.23 RETs contribute to the reduction of local and global environmental pollution and combat climate change.

9.24 ***Impact on Global Environment*** - RETs replace GHG emitting fossil fuels which contribute to global warming. As energy is essential for growth and development, it is critical to ensure energy supply and at the same time combat global warming. This can be achieved by replacing fossil fuels with RE generation.

9.25 ***Improvements in local environment*** - Besides carbon emissions, NOx/ SOx emissions are another downside of conventional energy generation. Since RE sources have negligible SOx, NOx emissions (wind, small hydro and solar have zero emissions while biomass has a significantly lower NOx/SOx emission than conventional fuels) and improve the local environment and living conditions in and around energy generation centers (which can range from large scale power plants to village DG sets).

1) Impact on Global Environment - Reduction in carbon emissions

9.26 RE an integral part of Climate Change Response – Global warming gas emissions result in an overall increase of the Earth’s temperatures resulting in adverse impacts on humans and other living creatures on the planet. In July 1996, 134 nations agreed in Geneva to negotiate and introduce legally binding emissions reductions of global warming gases based on the scientific consensus reached by Intergovernmental Panel on Climate Change in 1995. The panel projected adverse impacts on humans due to climate change ranging from sea-level rise and coastal flooding to severe stress on forests, wetlands, and other systems etc. Only early action by man may allow greater future flexibility in choosing strategies for stabilizing emissions of global warming gases. RE sources, by their very nature, lead to a reduction in carbon emissions and form a key component of the response to climate change.

[22] PwC estimates based on consultation with solar project developers

9.27 ***Approach for Measurement*** - Estimating the actual benefits of RE investments in reducing adverse events would be complicated and a long drawn out process, well beyond the scope of this assignment. To estimate and quantify the benefits however, the Economic Framework for Renewable Energy Development in India would estimate the potential from foreign exchange earnings due to CER trading.

2) Improvements in local environment quality

9.28 Power plants are responsible for a significant portion of nitrogen oxide (NOx) and sulphur dioxide (SOx) emissions globally. RE based power generation has the ability to reduce these air emissions, as well as reduce water consumption, thermal pollution, waste, noise, and adverse land-use impacts. Added to this, RE sources are sustainable energy resources and investments in these sources avoids depletion of natural resources for future generations. For e.g. wind, solar and small hydro completely eliminates SOx/ NOx emissions while biomass gasifiers result in significant reduction in these emissions.

9.29 ***Approaches for Measurement*** – There are two broad approaches that can be adopted for measuring the economic benefits associated with SOx/ NOx reduction.

- The first approach uses the avoided cost method and is based on international experience. International case studies have shown that a proxy indicator for estimating the cost of reducing SOx/ NOx emissions can be developed. This can be done by setting up a trading platform for SOx and NOx like the ones in the USA. The USA platform was set up much before trading in carbon emissions began. Such a platform can also be evaluated for India along with industry wise targets for SOx/ NOx reductions. For the purposes of capturing the benefits, the REF would use SOx/ NOx emission trading prices from the US market.
- The second approach calculates the cost of reversing the adverse impacts related to SOx/ NOx emissions. This is based on impact analysis and requires a lot of data based modelling which might be time and resource intensive. It is considered that the fits approach would be easier to implement and as it is market base, easier to manage.

Economic Benefit 5 – Development of India's OEM Industry

9.30 One of the main off-shoots of any scale-up process for RE investment and development would be more investment in the RE manufacturing and support industry. This in turn would lead to savings in foreign exchange (from the avoided import of RE equipment), allow development of equipment manufacturing and ancillary industries specific to RETs in India, generate employment and in the long term lead to cost reductions due to greater understanding and experience with equipment manufacturing and investments in R&D.

9.31 India imports a number of equipments used for setting up of RE projects. Vestas imports a number of components in the wind sector from its parent company located in Denmark, small hydro players have joint ventures with foreign players or are subsidiaries of foreign players and thus in times of need import completely manufactured kits from abroad. India imports almost all of its solar wafer requirements for the solar industry. India, today, has no equipment manufacturers providing services in solar thermal. Even in case of off shore wind, Suzlon is working on developing turbine with its foreign subsidiaries.

9.32 As pointed out above, the main off-shoot of any scale-up in RE investment and development would be higher investments in RE manufacturing industry in the country. Besides the usual benefits accruing to the economy with the development of any indigenous industry like savings in foreign exchange, development of new ancillary industries specific to RETs, generation of employment opportunities, the development of the RE OEM industry would also lead to in the medium to long term cost reductions in equipment capital cost due to greater understanding and experience with equipment manufacturing. Development of the RE OEM industry in India would also prompt higher investments in R&D which in turn would lead to long term energy security in the form of lower long term marginal cost of generation.

9.33 **Approach for Measurement -** Estimating the actual benefits of developing the OEM industry from RE investments is a little difficult as this one benefit has a number of downstream effects which might be difficult to map. However the following three indicators can be analysed for developing an approach to valuing this benefit:

- The economic benefit accruing from investment in RE equipment manufacturing can be measured by undertaking a comparison cost savings between importing the equipment and manufacturing the same in India.
- Valuation of the revenue generated by the OEM industry and the ancillary industries that are created to serve the OEM industry.

Approach for Operationalizing the Economic Benefits of Renewable Energy

9.34 The purpose for the development of an Economic Framework for Renewable Energy Development would be to provide to policy makers an approach for integrating in energy pricing with the economic benefits associated with RE generation. This would require a multi pronged approach consisting of the following 5 steps which have been highlighted in the figure below and subsequently discussed in detail:

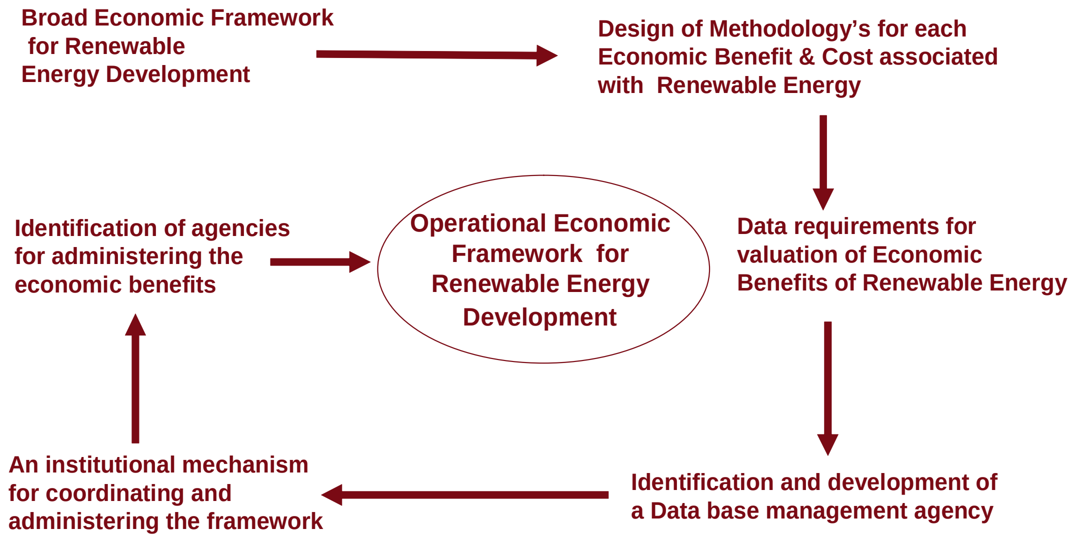

Figure 27: Approach to Operationalsing the Economic Framework for RE Development

- ***Development of a methodology for valuing the economic benefit and identification of the agency responsible for it -*** For each of the seven identified economic benefits a detailed methodology for their valuating their benefit as well as the costs would have to be developed. It is recommended that this methodology be developed by the agency best equipped to address this particular issue. For example in case of energy availability, it is the State or the Central Electricity Regulatory Commissions, who have the mandate and the knowledge to understand and value energy provision that should be made responsible (with inputs and capacity building from the Ministry of Power and the Ministry of New and Renewable Energy). In case of benefits associated with energy security, it is recommended that a central ministry or body like the Planning Commission or the Ministry of Power or Finance be made responsible for methodology development as these have a more global view of the emerging energy markets and are more equipped to deal with trends at the international level.

- ***Data requirements for valuing the economic benefit*** – Valuing economic benefits would require data spanning a wide variety of macro parameters. For example, there would be a need to predict the trends in coal, gas and oil prices, behavior of CER pricing with time and the manner in which SOx/ NOx trading can be quantified and converted to an index for valuation. If this data is already being captured in some form, then that data can be procured directly by this agency otherwise, a suitable agency would have to be identified, its capacity built and a mandate for data management would have to be provided to this agency. For example the Ministry of Environment and Forest's Central Pollution Control Board would be the best agency to monitor NOx/ SOx emissions and the prices at which their emission reductions are being traded in places such as the European Union and the United States of America.

- ***Data base management for parameters impacting economic benefits of renewable energy investments*** – To manage all the date related to the above parameters, there is a need to develop a Renewable Energy Information System. This information system would capture, at the national and state level, various data points from various agencies and pass on the same to the relevant decision makers. The Renewable Energy Information System can be shared across SERCs, CERC, MNRE and the Planning Commission for decision making related to the development of Five Year Plans, RPO target setting etc.

- ***An institutional mechanism for coordinating and administering the framework*** – RE capacity and technology development has larger implications for the country in the form of energy security and availability as well as environmental protection. As of now most institutions alone are not in a position to address all the issues highlighted in the economic framework. Therefore in order to promote this framework, there would be a need for a mechanism for greater coordination amongst SERCs, MNRE, CERC, Planning Commission and other agencies. Direct linkages would have to be established between MNRE, which is the nodal ministry for RE development, the SERCs, MoP and the Planning Commission through an institutional networking mechanism, whereby all these institutions are able to consult, share knowledge and experience and active in a cohesive manner. Most of these institutions such as the SERCs, typically work with limited staff and would need more skilled manpower to develop and use appropriate analytical tools to review and analyse the economic benefits of renewable energy.
- ***Identification of the agencies for administering economic benefits*** – Another key issue that would require brainstorming and consensus would be the choice of a body or agency best suited to administer each of the benefits and integrate these into RE pricing. For example in case of availability of energy it might be a very easy decision with the SERCs responsible for the administering of the benefit in its feed in tariff. However complications would occur when benefits associated with energy security, energy access or local environmental impacts need to be integrated into RE pricing. In case of energy security, it needs to be examines whether it would be possible for the GoI to value the economic benefit and provide it as a part of a special 'generation based incentive' or it might transfer this fund to be directly made a part of the feed-in-tariff.

Mapping of policy & regulatory instruments with economic benefits of RE investment in India

Table 13 - Mapping Policy & Regulatory Instruments against Economic Benefits

Economic Benefits → / Promotion Instruments ↓	Availability of Energy	Energy Access – DDG	Reduction in risks from Fuel Imports	Long term Energy Security	Global Environmental Impact	Local Environmental Impact	Development of the OEM Industry
Feed in Tariff	√		√	√		√	
Renewable Purchase Obligations (RPO/RPS)	√		√	√		√	
Production Subsidies (GBI)	√		√	√		√	
Carbon Trading					√		
Capital Subsidy	√	√	√	√			√
R&D Grants	√	√		√			√
RE Funds/ Guarantee Funds	√	√		√		√	√
Soft Loans	√	√		√			√
Exemption from Import Duty against RE	√	√				√	

Economic Benefits → / Promotion Instruments ↓	Availability of Energy	Energy Access – DDG	Reduction in risks from Fuel Imports	Long term Energy Security	Global Environmental Impact	Local Environmental Impact	Development of the OEM Industry
equipment							
Exemption from Excise Duty against RE equipment manufacturing	**√**	**√**				**√**	
Direct Tax exemptions/ Tax Holidays	√	√					√
Demonstration Projects	√	√		√		√	√
Renewable Energy Certificates	√		√	√		√	√
Green Certificates		√	√	√		√	√
Net Metering	√	√				√	√
NOx, SOx Trading						√	
Green Tax	√	√	√			√	
Contingency Insurance	√						

Key Messages from the Framework:

The table above has highlighted eighteen instruments, of which twelve have been used in India for the promotion of RE in India. From the table and the study of instruments, the following inferences were arrived at:

- Inference 1 – Capital subsidy, RE Funds and Demonstration Projects address the maximum number of benefits (5 of the 7 benefits)
- Inference 2 – Need to focus on the two benefits of reduction in risks from fuel imports and global environmental impact
- Inference 3 – To spur RE generation and investment, focus has to be on instruments which involve retail investors which include instruments such as REC's, Net Metering, Green Certificates and Contingency Insurance.
- Inference 4 - No government backed (financially) instrument addresses benefits associated with global environmental impact
- Inference 5 – Limited focus on long term energy security and OEM industry development
- Inference 6 – RPO's need to be introduced with REC's for RPO's to be effective.
- Inference 7 – RPO/ REC combination and FIT should ideally not exist together in the same market or market segment for these three instruments to be effective in promoting RE.

CHAPTER-10: REVIEW OF INSTITUTIONAL ARRANGEMENTS FOR RE DEVELOPMENT

Institutional Structure for the Promotion of RE in India

10.1 In India, a number of institutions are involved at the Centre and State levels for promotion of RE sources.

10.2 These institutions include at the Centre, the Ministry of New and Renewable Energy (MNRE) and the CERC (Central Electricity Regulatory Commission) andat the state level, the State Electricity Regulatory Commissions (SERCs), State Governments and State Renewable Energy Development Agencies alo referred to as State Nodal Agencies (SNAs), ,which have been mandated with the development and promotion of RE within the states.

10.3 The table given below highlights the different institutional functions required for the development of renewable energy sources and the existing institutions undertaking the functions:

Table 14 : RE promotion & Institutional functions

Institutional Functions	Existing Institutions
Policy and Regulatory	
Development of Renewable Energy Policy and Law	MNRE
Policy advice and technical standards for the renewable energy generators	MNRE
Tariff Determination Methodology(s)	CERC, SERCs
Regulations on Minimum procurement, Wheeling, Open Access, Third Party Sale	SERCs
Promotion and Advocacy	
Resource Assessment for various renewable energy sources	MNRE, SNAs
Escorting Services	
- Facilitate clearances, land acquisition	SNA’s
- Coordinate with Distribution Network Operator/ GRIDCO for connectivity	SNA’s
- Conduct competitive bidding process	SNA’s
Support R&D in renewable energy technologies	MNRE & GoI
Promotion of decentralised distributed generation based on renewables	MNRE & SNA’s
- Creating awareness, support in financing, execution, training for O&M,	MNRE, IREDA, SNA’s
Effective utilisation of IT for renewables, database management, forecasting techniques	MNRE
Design of Renewable Energy Certificate System and Administration	MNRE,CERC, SERCs

Create awareness and educate masses for adoption of renewable energy sources in their activities	MNRE
Prepare educational curriculum on efficient use	MNRE
Financing	
Financing of Renewable Energy Projects	IREDA
Subsidy Administration	MNRE, SNA's
CDM	
Designated National Authority	Ministry of Environment and Forests
Bundling of projects/Aggregator, facilitate registration	Ministry of Environment and Forests
Monitoring and Evaluation	
Review of implementation programs to understand efficacy	MNRE
Apply learnings and best practices to future programs	MNRE

Source: PwC Research

10.4 The above table clearly indicates that there are multiple institutions involved in promoting investments in the RE sector. The MNRE is responsible for policy making for the RE sector at the country level. Besides administering the RE sector, MNRE also promotes RE investments through its financing arm, the Indian Renewable Energy Development Agency (IREDA). The Ministry also, facilitates R&D for the adoption of new RE technologies, undertakes capacity building of RE stakeholders and awareness generation.

10.5 The role of CERC includes determination of tariff of generation companies owned or controlled by the Central Government or to generators selling electricity to more than one state, guidelines on open access and inter-state transactions.

10.6 Likewise, at the state level SERC's are responsible for determining the Feed in Tariffs for different RE technologies and specify a percentage for purchase by distribution licensees from renewable sources.

10.7 Many State Governments have recognised the need for promoting renewable energy and played their role as policy making institution. They have also encouraged the involvement of State nodal agencies (SNA) in the development of the RE sources in their respective states, for facilitating licenses, clearances and coordination with State Governments.

10.8 There have been contributions from each of the above mentioned institutions, but they differ in degree and scale in different states. The existence of multiple institutions is, in some sense, unavoidable given the federal structure of the government and the legislative framework which recognises the role of institutions at both central and state levels. While this is understood, it does not take away the need for greater coordination amongst the institutions involved as it leads to a systematic and accelerated development of the sector. Institutions driven by their respective legislative framework often tend to act in isolation. This could perhaps be avoided by a specific legislation and supporting policy which addresses the development of the RE sector in a comprehensive manner and brings together the institutions involved.

10.9 On the other hand, there are issues related to the institutional capacity within each of the above mentioned institution and addressing them, will help in a better appreciation of the importance of renewable energy to the local, state and national economy and trigger actions accordingly All of these issues have been addressed in detail in the subsequent sections.

National Level Gap - Lack of Legislation for the Promotion of Renewable Energy
Why a National Legislation
Increasing RE investment and generation requires a proactive approach from the state. Although a number of policies and regulations exist, a gap still exists in terms of a focused legislation and policy framework for the RE sector. For example the Electricity Act 2003 has been able to provide the overall framework for the development of the Indian Power Sector by bringing together generation company, transmission company, distribution company, CEA, SLDC, regulators, governments at both centre and states under one legislation.

Till date, two laws, the Energy Conservation Act 2001 and the Electricity Act 2003, have addressed certain issues related to the development of RE sector in India. Both these laws have addressed application of RE in specific conditions related to their primary interest area. For example, the EA2003 has addressed RE development for power procurement and ECA 2001 has addressed RE development for energy management, conservation and efficiency improvements. However both these acts have been unable to address the larger and the long term issues related to the development of the RE sector such as sustainability, long term viability, scalability, demonstration, Research & Development etc.

At the same time, renewable energy is a concurrent subject and no action seems to have been initiated at any of the state's level for providing a comprehensive legislative or policy framework for the development of the renewable energy sector at the state level. Although, certain states have come up with policies, the centre still needs to come up with a RE policy that gives direction on long term RE development by addressing issues such as R&D, future technologies to tap, RE market development at the national level, export of RE equipment etc. For example, state regulations and policies also do not address issues related to further development of 2nd generation biofuels, solar thermal, biogas, fuel cells, geothermal, tidal, offshore wind etc. There is a need for an overarching framework which will guide the development of the sector and the SERCs, who are guided by the EA2003.

Gap Analysis: Institutional Review For RE promotion

1) The Ministry of New and Renewable Energy (MNRE), Government of India

10.10 **MNRE's Broad Aims:** MNRE is the nodal Ministry for the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. The ministry facilitates the research, design, development, manufacture and deployment of new and renewable energy systems/devices in rural, urban, industrial and commercial sectors.

10.11 **MNRE's Performance** – MNRE has been quite successful in laying the foundation for the development of India's RE sector, attracting private investments in areas such as wind and small hydro. The ministry has also provided incentives for energy access in the rural areas through RE to developing technical capacity in the country for RE (Solar Energy Centre). Wind, small hydro and biomass are the three main sectors that have benefited from MNRE interventions. MNRE's interventions in wind monitoring, the MNRE Feed in Tariff between 1993-94 and 2004, facilitating accelerated depreciation for wind assessment have resulted in substantial capacity addition over the last decade.

10.12 A number of areas require the attention of the ministry as follows:

- ***Need for greater coordination amongst institutions involved in promotion of renewable energy:*** The power to develop RE policy and regulation lies with i.e. the MNRE, the CERC, the SERC's and the State Governments. The MNRE has been addressing the policy on promotion and subsidies with great emphasis. However, there has been a mixed experience on emphasis at the state level. States like Maharashtra, Gujarat, Rajasthan, TN, Karnataka and West Bengal have made significant commitments to promotion of renewable energy, while other states have made limited progress despite good potential. State governments may not address the requirements with same degree of priority as MNRE and there is a need for greater interaction and engagement amongst them. This is true for regulators as well, as there is limited engagement amongst regulators and governments on the subject of renewable energy. The Electricity Act, 2003 u/s 166 (2) and 166 (4) does provide a formal means by a coordination forum to be constituted amongst regulators, government and utilities, but this has been put to limited use, in our experience. Likewise, there is no formal engagement or process amongst SERCs and State Nodal Agencies or CERC and MNRE and although informal consultations do take place a formal structure and process, through appropriate changes in legislation and policies will provide greater motivation and responsiveness, in particular for the State Nodal Agencies
- ***Neglect of certain RE sub sectors:*** Over time MNRE has neglected the development of certain sub sectors within the RE space such as bio-fuels, solar thermal (decentralized applications) etc. Even within the MNRE the focus often shifts from one technology to the other.
- ***Issue of sustainability of select programmes****: A number of MNRE's programmes* especially for decentralised rural electrification like solar home lighting systems have failed the sustainability test due to issues in their design and roll out. At times, the targets set for different programmes were not adequately supported by institutional arrangement and resources. The failures lead to a lot of resources being inefficiently utilised**.**
- ***No clarity on GBI implementation*** – More than a year has gone by and no movement has been observed by project developers on the allocation of GBI incentives. This has caused a lot of uncertainty among developers in the market and could result in a number of developers moving to other sectors with their investments.
- ***Limited Capacity of SNA's*** - In a number of states it has been seen that SNA's lack adequate resources at their disposal and also have low priority with the state governments. The MNRE being the nodal ministry for these SNA's needs to undertake capacity building of SNA's and provide them requisite funds for RE business development at the state level. We understand this aspect is now receiving attention as a specialised capacity building program has been initiated with assistance from USAID.

2) The State Governments

10.13 As state governments roll out state level RE policies for the promotion of RE investments, it is important to analyse and understand some of the major gaps that exist at the state level for the implementation of RE projects. Although these state policies prescribe incentives to attract RE investment in the state, but poor implementation of the policies and different programs has resulted in inadequate harness of the RE sources.

10.14 Issues in state RE Policies: A policy also lists the major incentives, thrust areas and other procedures related to investment in renewable energy projects in states. The PwC team undertook a review of a number of state policies (Maharashtra, Punjab, Karnataka and Gujarat) and had consultations with key stakeholders to arrive at the main issues that state policies try and address but fail:

- **Lack of short term and long term targets for the state & measures:** There is a need for each state to specify the short term and long term target for RE technologies (like wind, biomass, solar etc.). For example, Punjab's RE policy has adopted a short and long term target for the RE sector in the state. Gujarat on the other hand has only specified a short term target. These targets give confidence to the investors and provide a focus to the state machinery. There is a need for each state to issue a state RE policy to attract investment. An example of this can be seen in the Gujarat solar policy, which has attracted expressions of interest of more than 2 GW.
- **Clearly identified thrust areas:** There is a need for each state to identify its thrust areas and provide maximum benefits to these areas. Thrust area identification needs to be undertaken using the supply curve concept for the state in conjunction with RPO targets and FITs prevailing at the state level. Most states do not undertake the identification of thrust areas and leave it to the market and the regulatory commissions.
- **Single window clearance system –** Single window clearances which actually work is the need of the hour in this sector. A number of states have designed single window systems but these have not been implemented with the spirit with which they were designed.

SINGLE WINDOW CLEARANCE – CASE OF THE PUNJAB

States such as Punjab have adopted a single window clearance and fixed time limits within which clarifications, comments or objections to projects need to be sent to the state nodal agency or the state nodal agency grants all clearances to the project. Punjab has kept this time period as 45 days. However it has been seen that a number of departments only respond with minor queries and continue to delay decisions even after clarifications have been provided.. It is suggested that the state government set up an oversight committee, comprising of representatives from each department and headed by the power or energy secretary. In case clarifications or objections take more than 75 days, the projects file is escalated to the oversight committee. The oversight committee should be given the power to resolve the matters and bring them to conclusion.

- **Support for evacuation infrastructure:** Inadequate evacuation infrastructure and access roads have been one the critical issues hindering the development of RE. A few states like Maharashtra and Rajasthan have been proactive in setting up RE funds, which could be financed through a cess or surcharge. There is also a greater need for coordination amongst State Governments, nodal agencies and utilities to interact and resolve issues pertaining to grid connectivity in a proactive manner.

3) State Nodal Agencies

10.15 **Role of SNA's:** The State Nodal Agency is responsible for development and promotion of renewable energy technologies in the state. SNAs need to coordinate with the panchayats, various Departments of the State Government, Research Institutions, Non-Government Organizations and the local people for implementing a number of schemes and Renewable energy projects in the State.

- State Nodal Agencies (SNAs) are the designated agency for the registration of renewable energy projects in the respective states and are involved in facilitating approvals for these projects on behalf of developers and recommendation of grant/subsidy of the projects, if applicable.
- SNA's are also responsible to develop and support documentation services in area of renewable energy.
- Inviting expression of interest (EOIs)/ undertake bidding from project developers for setting up commercial or demonstration projects related to renewable energy in the state.

10.16 **Key Initiatives:** The active role of SNA's in certain states like Gujarat, Maharashtra has facilitated substantial capacity addition from renewable energy in the state.

- MEDA (Maharashtra Energy Development Agency) is responsible for the management of the Green Energy fund created for providing necessary support to RE projects in the state for the required evacuation and access infrastructure.
- West Bengal Govt. has formed a separate entity named West Bengal Green Energy Development Corporation Ltd (WBGEDCL) for promoting private investment in renewable energy sector in the state. WBGEDCL will cater specifically to provide facilitation services to the private investors interested in investing in RE projects in the state.
- In certain states like Gujarat, the SNA administers the functions of the land allocation committee and coordinates with other departments to ensure smooth transfer of land to RE project developers.

Issues:

10.17 SNA's are required to provide facilitation services to RE project developers. Inspite of the fact that a number of states have provided Single window clearance, SNA's have not been able to effectively implement the mechanism and assist in timely clearances to the RE projects. In a number of states it has been seen that SNA's lack adequate resources at their disposal and also have low priority with the state government hierarchy.

10.18 A number of SNAs are not able to establish and maintain a technical library, a data bank or information center and to collect and correlate information scientifically regarding the RE sources. The information is not updated frequently in certain cases. As per our interaction with developers, availability of accurate data related RE resources will influence the investment decision for the investors.

10.19 Lack of capacity of SNA's is a major hurdle in effective implementation of RE programs in the state as these departments have limited budgets, lack access to experts due to inability to pay, have to rely on personnel on deputation from utilities and most of the time have limited power to influence the working of other government departments.

4) The Central (CERC) and State Electricity Regulatory Commissions (SERC's)

10.20 **Limited role of CERC:** In the present context CERC has a very limited role as far as formulation of regulations for renewable energy is concerned. Renewable energy sector hitherto is largely driven by SERCs for initiatives on regulatory fronts. However, with the rising interest of central PSU like NTPC, NHPC, GSPC etc., the CERC is expected to play a more active role. For example, the onus of determination of tariff will lie on CERC for these central PSU's renewable energy initiatives.

10.21 **CERC's initiatives:** It has been mentioned earlier that SERCs differ in their approach to determine tariffs for renewable based generation. With the intent to bring in uniformity in tariff determination approach CERC is presently working on benchmarking on capital costs for renewable projects. In addition, we understand, the CERC is also working on implementation of REC mechanism in India to facilitate inter-state transactions of RECs for meeting RPO compliance.

10.22 The scope of involvement of CERC in addressing some of the regulatory requirements should be widened, through their participation in the Forum of Regulators. This has already been initiated and is indeed a good development in the interest of harmonisation of approach and methodologies adopted by regulators.

10.23 **SERC role in promoting RE critical:** As has been pointed out in the preceding chapters on wind, small hydro and biomass, the most proactive support being provided to renewable energy developers (especially as these sectors are adding the bulk of the capacity within RE) is through the State Electricity Regulatory Commissions. In a number of cases SERCs have either been very generous with RE tariffs or been too conservative, limiting the sectors growth. The SERCs have a very delicate balance to maintain, between promoting RE and ensuring sector efficiency.

- Tariff: The SERCs across the country have undertaken various steps for promoting RE sources of energy and these initiatives have also started showing results. A number of developers maintain that the feed in tariff is the most crucial factors in making investment in a specific renewable energy project in any state. The importance of FIT and SERC's interventions can be gauged by considering the example of Madhya Pradesh. The state regulator issued biomass tariff order in August 2007 and till now the state has received applications close to 280 MW against the current installed capacity of 3 MW.
- **Renewable Energy Purchase Obligation (RPO):** SERCs are also mandated to specify a percentage of renewable based procurement by utilities of the total consumption of electricity in the area of a licensee. 17 states have issued target under RPO for utilities.

10.24 Main competence and experience rooted in the power sector: Although the SERC's are at the forefront of promoting RE in India, institutional gaps still impact the design of these two instruments, i.e. the FIT and RPOs. State regulators are mandated to determine tariffs for renewable energy technologies and assign targets for renewable purchase obligation. These tasks are complex and need an energy- economy focus rather than a utility focus. Most regulatory commissions and their staff's background and past experience lies with utilities in operations, administration or commercial. Regulators rarely hire RE technology specific staff or energy economists who would have an appreciation of the larger economic benefits of RE. Regulators do engage in consultations with industry, consumers & other stakeholders and hire consultants, however their adequacy and impact appears to be limited as it is often observed that renewable generators often file for a review of the tariffs awarded.

10.25 SERC's lack methodologies, adequate data and sector knowledge for balanced FIT development: Tariff orders reviewed lack adequate discussion on capital costs of renewable technologies, the basis of their acceptability and assumptions for tariff. Most regulators go by industry norms and there seems to be limited engagement to discover improvements in efficiencies possible in capital costs or operating norms, at least from the discussions in tariff orders. This is the main reason for the inability of the SERCs to build in technology improvement or scale up factors into FIT design. SERC's lack adequate data on the main components of FIT like capital costs and have to rely on the data provided by developers or equipment manufacturers. Regulators also lack resources and infrastructure to monitor and analyse the RE sector. For example, most regulators still treat RE power as power from any other source and use a cost plus approach in pricing it without taking into account the economic benefits associated with RE generation.

10.26 SERCs need to ensure that RPOs are set based on a sound approach – No standard approach is followed by different SERC's while setting Renewable Purchase Obligation (RPO) targets. Although some of the SERC's consult utilities, the state renewable development agencies and the state governments, most SERC's do not provide adequate lead time for the development of different RE technology projects from which to procure RE power. An example of ad hoc RPO target setting is seen in cases such as Madhya Pradesh or Himachal Pradesh . In case of Himachal Pradesh, the RPO increases from 10% to 20% over a period of 5 years whereas the average lead time for the development of a small hydro project is around 4 years, which would mean meeting targets for procurement within the state is almost impossible. In case of MP, the commission set a 10% target without providing a proper trajectory for transition. As a result such states could not back up the RPO targets with a penalty for non compliance.

10.27 Adoption of RPO without an enforcement and REC trading mechanism will produce limited results- RPO's without appropriate penalties or compliance mechanisms will produce limited results.

Action Points for capacity enhancement of CERC/ SERC's

- CERC, in conjunction with the SERC's, needs to develop a Renewable Energy Regulatory Information System at the national and state level. This database and information system will capture and monitor the cost of RE projects and can be shared across SERC's.
- SERC's need to recruit RE sector specialists as well as rely more on economic analysis for RE FIT determination.
- SERC's need to undertake a detailed cost break up of RE projects and link these to basic inputs like steel, cement etc using factor analysis. This will reduce the dependence of the SERC's on developer inputs and increase efficiency in the sector. This database should be utilised by the SERC's and CERC to introduce a technology factor for RE technologies.
- CERC has come out with a draft regulation for determination of RE tariff. This will assist SERCs in adopting a uniform approach for determination of RE tariff. On the same lines, CERC should also come out with a approach for fixation of RPOs which can provide direction to states in fixing reasonable targets keeping into account different factors.
- SERCs should avoid fixing cap on the procurement of electricity from RE sources, keeping in mind the economic benefits from such sources

Mapping Institutional Interventions for adopting the Economic Framework

10.28 This section analyzes the role of institutions in promoting the economic benefits framework. A number of instruments are being used today for promotion for RE sources. However, a number of new instruments can be introduced to integrate the economic benefits associated with the RE sources. The introduction of these instruments will involve state as well as central level agencies. In order to assist with this analysis, categorisation based on economic benefits, instruments and the institutions administering these instruments has been undertaken in the table (Table 15) below.

Table 15 - Economic Benefits, Primary Decision Makers, New Instruments and Institutions for Implementing the Economic Framework

Economic Benefits	Primary Decision Makers - State / Federal	Instruments Available for Addressing Economic Benefits	New Instruments that can be introduced for Addressing Value Elements	Other Institutions also needed to address Economic Benefits
Availability of Energy	Centre (Federal) – MNRE and MoF State – SERC's	Feed in Tariffs, RPO's, Direct Tax Benefits – Accelerated Depreciation & Tax holidays, Production Subsidies, Capital and Interest Subsidy, RE Funds and Soft Loans, Green Tax, Exemption from Import and Excise Duty	Net Metering, REC's & Contingency Insurance	Planning Commission and Ministry of Power
Energy Access	State – State Government Centre (Federal) – MNRE	Capital Subsidy, RE Funds, Soft Loans and Demonstration Projects	Life Cycle Cost Analysis	State Electricity Utilities and REC (Rural Electrification Corporation)
Reduction in Fuel/ Equipment Imports	Centre (Federal) – Planning Commission	Not Available in India	Procurement Orders and Supply Curves and regular updating of the Integrated Energy Policy	Ministry of Coal, MoPNG
Long term Energy Security - Reduction in Energy Generation Cost	Centre (Federal) – MNRE	R&D Investments and Demonstration Projects	Venture Capital and Risk Capital Funds	Ministry of Science and Technology, Planning Commission
Global Environmental Impact	Centre (Federal) – MOEF	Trade in Carbon Emission Reductions	Carbon Funds	MNRE and Planning Commission
Local Environmental Impact	State – State Pollution Control Board	Not Available in India	SOx, NOx trading as followed in North America	State Governments

Inferences

10.29 **Inference 1 – A new approach for addressing economic benefits through networking and involvement of a number of institutions is necessary –** One of the options for implementing the economic framework approach at the national level can be through a two tiered structure at the national level. At tier 1, national level institutions need to be made responsible for the overall development and management of the country's RE programme. The tier 2 can be composed of 5 institutions, each in charge of a particular economic benefit. These institutions should be identified based on their direct linkage with that particular economic benefit. For example, energy security should ideally be addressed either by the Ministry of Finance or the Planning Commission. Environmental benefits should ideally be addressed by the Ministry of Environment and Forest. Each institution would have a group of facilitating institutions that would provide it with specific inputs for economic pricing of RE based on a particular benefit. For example, SERC's may need to take inputs from the Planning Commission on energy security implications of RE development. Similarly MoF or Planning Commission may seek MNRE's and Ministry of Science and Technology's advice for selection of future technologies for enhancing long term energy security.

10.30 **Inference 2 – State agencies need capacity enhancement as they promote the most crucial instruments –** RE in India is a concurrent subject. Two of the most crucial instruments (FIT & RPO) for RE promotion (specifically energy availability) are administered by the SERCs. Although the SERC is in the best position to price RE power at the state level, it does not have the capacity to integrate national level economic benefits into this pricing. There is a need to bring to their attention national level issues through larger consultations and specific inputs on the economic benefits accruing from RE. These inputs have to come through agencies such as MNRE, MOEF, and Planning Commission.

Action Points – Better Linking of MNRE with SERC's on RE

- Need for direct institutional linkage and increased coordination between SERCs and agencies such as MNRE, the planning commission and the Ministry of Environment and Forest for design of various RE promotion instruments at the state level.
- Need for enhancing data exchange, knowledge transfer and networking - a networking group with MNRE, CERC, SNA's, SERC's like FOR may be promoted for enhancing networking, discussions and capacity building on RE.
- SERC's need to be provided resources and the capacity (through more skilled manpower, advanced analysis and management tools) to build in these national level benefits into their regulations and orders.
- A national institutional and capacity building programme addressing RE regulation needs to be rolled out for regulators.

10.31 **Inference 3 – Need for institutions for adoption of New Instruments and methodologies to address economic benefits:** Table 15 highlights the institutions and instruments involved in promotion of specific economic benefits. A number of new instruments or methodologies can be introduced to address certain policy and regulatory gaps and promote investments in RE. Some of these have been captured under the action points below.

Action Points – Adoption of New Instruments and methodologies

Energy Availability – A number of instruments can be introduced in India for enhancing energy availability. The main ones are Renewable Energy Certificates (REC's) (in process of implementation), Net Metering (a start has been made in West Bengal (for 100 kW and above consumers) and Contingency Insurance (which would benefit SHP and solar producers a lot).

Energy Access – There needs to be a change in the approach to pricing of energy for remote areas especially un-electrifiable villages. This change in approach can be through a movement to life cycle analysis of the cost of delivery (per unit) between diesel and RE or development of an Economic IRR for RE investments for enhancing energy access.

Reduction in Fuel/ Equipment Imports – The planning commission is in a unique position to address issues related to energy security, especially related to the import of fuels such as oil, gas and coal. The Planning Commission should move towards the use of an integrated supply curve encompassing all energy types for undertaking future energy planning. This would allow better price discovery and more efficient resource allocation. There needs to be greater cooperation and consultation of the Planning Commission with the line ministries on developing supply curves for all energy sources.

Long term Energy Security - Reduction in Energy Generation Cost – The biggest focus in RE today needs to be on future development of RE resources through reduction in energy generation costs. The Government of India needs to kick start R&D and provide incentives for Indian RE players to bring about new innovations in this area. Till now R&D has primarily been undertake by government funded institutions. For example in solar, almost 98% of the funding for R&D in 2007-08 was provided by the government and R&D undertaken by state agencies. There is a need to increase private funding and R&D in the private sector. For example, the US and other European Union countries promote RE R&D in the private sector by providing soft loans and venture capital funds for research and development, assist in commercialisation of RE technologies, technology transfer and licensing. India needs to study and adapt some of these models for pushing R&D and long term energy security in India.

CHAPTER-11: SUMMARY RECOMMENDATIONS

Legislation and Institutional

1. *Need for a new approach that takes into account the long term economic benefits of renewable energy*
    - Most approaches for evaluating energy investments (including RE) focus on short term costs/ benefits and ignore long term costs/ benefits accruing from emerging technologies and global environmental benefits.
    - Present approaches to energy investments ignore economic benefits like the environmental, social and energy security benefits accruing to society.

    There is a need for Indian Policy Makers, guiding the development of the renewable energy sector, to adopt an economic benefits framework for the development of the renewable energy sector.
2. *Need for a single National Level Legislation for the Promotion of Renewable Energy that* –
    - Addresses larger, long term issues related to the development of the RE sector such as sustainability, long term viability, scalability, demonstration, research & development (R&D) etc.
    - Provides institutional focus and clarity for renewable energy development.
3. *Need for introduction of new instruments*
    - The Indian RE sector still lacks instruments for addressing benefits associated with local environment improvement and energy security (risk mitigation over the short to long term from global fossil fuel price fluctuations and long term energy security).
    - The Indian RE sector also needs to introduce instruments such as net metering and Renewable Energy Certificates (REC’s).
4. *Need for better coordination to address economic benefits associated with RE*
    - For each economic benefit, a nodal agency needs to be identified and all incentives meant for that benefit should be forwarded to this agency for its administration.
    - A mechanism needs to be developed for greater coordination and knowledge sharing between the state level and central level agencies (SERC’s, MNRE, CERC and the planning commission) on issues related to national importance such as energy security, environment, national impact of renewable energy etc.
    - SERCs need to be provided resources and the capacity (through more skilled manpower and advanced analysis and management tools) to build these economic benefits into their regulations.

Regulatory and Policy

1. *Need to bring about greater uniformity in approach in regulatory interventions to mitigate high regulatory risk*

- There is a need for greater clarity and uniformity in approach for promoting RE across the country. CERC needs to provide overarching guidelines to the SERCs, especially for
    - Approach to Feed in Tariff design
    - Open Access
- Capital costs of renewable energy projects, especially wind and small hydro projects in India need to be properly and scientifically benchmarked, with the benchmarking norms linked to indexation formulae.
- Need for absolute clarity (no space for ambiguity) and strict enforcement of policies, regulations and contracts once prescribed by the state.

2. *RPO Design*
    - CERC should suggest a standard methodology and a minimum percentage of renewable energy procurement for each state.
    - CERC/ MNRE need to introduce trading instruments such as RECs to improve the effectiveness of the RPO.
    - The SERCs need to provide interim, transitory and realistic targets backed up by adequate enforcement mechanism for state utilities to meet RPO compliance.
3. *Need for the development of a Renewable Energy Regulatory Information System*
    - CERC and SERCs need to develop a Renewable Energy Regulatory Information System (RRIS) at the national and state level. This database and information system will capture and monitor the cost and performance of RE projects and can be shared across SERC's.

Evacuation Infrastructure for RE

1. *One of the most crucial issues/ barriers in scaling up renewable energy resources such as small hydro and wind has been the availability of evacuation infrastructure. To address this bottleneck, a multi-pronged customised approach which may consist of any of the following interventions:*
    - Renewable Energy Plants, especially small hydro plants need to be developed as clusters – Cluster formation would allow STU's to identify specific areas and optimise its resources. This will encourage state transmission utilities to set up pooling points for wind and SHP projects.
    - State regulators should allow STU to outsource (based on competitive bidding) for development of evacuation infrastructure: State regulators need to be more liberal in allowing utilities to provision expenditure in evacuation infrastructure in the Annual Revenue Requirements (ARR) and provide the STU with the provision of financial resources for building this infrastructure.
    - Mandate State Transmission Utilities to develop comprehensive 5 years transmission plan for RE at the state level.
    - Create a focused national or regional level RE transmission Development Corporation – Create a dedicated agency for the development of evacuation infrastructure for RE projects across the country or across regions like the North East which can source funds from the MNRE and the Ministry of Finance as well as through Clean Power Trading and State funds.

- Encourage STUs to form JVs with private firms at state level to develop such infrastructure - Allow Joint Ventures between STUs and private players as was the case between PGCIL & TATA Power or PGCIL and Reliance Energy and allow these agencies to develop transmission projects at the state level.

State Policy Level Recommendations

1. State level policy initiatives play a critical role in streamlining project development. There is a need for these policies to encourage efficiency and facilitate project development. Some of the recommendations for this are:
   - *Short term and long term targets for the state & measures:* States need to specify short and long term target for all renewable energy technologies to bring more clarity to the investors.
   - *Clearly identified thrust areas:* Each state to identify its thrust areas and provide maximum benefits to these areas. Thrust area identification can be undertaken using the supply curve concept for the state in conjunction with RPO targets.
   - *Single window clearance system* – Single window clearances which actually work is the need of the hour in this sector. A number of states have designed single window systems but these have not been implemented with the spirit with which they were designed. Regular monitoring of the performance of all of the projects approved and have a time bound plan for their development is required.
   - *Need for proactive support by state government on procumbent and acquisition of land* – There is a need to facilitate transparent, fair and timely acquisition of land through a schedule at the state level.

Sector Specific Recommendations

Wind Energy

1. *Need for new norms for Wind Resource Assessment* **–** New norms need to be introduced for wind monitoring which mandate wind monitoring and wind data collection for at least 2 seasons. Norms also need to be fixed for the number of meteorological masts per unit area and the pattern of fixing these masts for identification of wind potential.
2. *Scaling up of GBI scheme from 49 MW* **–** Based on the tremendous response for the GBI scheme for wind, there is a need to increase allocation under this scheme and streamline its time bound implementation.
3. *Need to move to an RPO based competitive procurement route* **–** The wind energy sector in India has attained enough scale and is nearing maturity. Sufficient scale, competition and capacity exists in the sector to go for RPO based competitive procurement.

Small Hydro

1. *Bundling of Internal Approvals* – Internal approvals from state departments like irrigation, water resources, utility local government approval etc need to be bundled together by the State Nodal Agency and provided to the developers as a ‘package of clearances’ at the time of signing the

Implementation Agreement. This will require the state government to undertake business process re-engineering (BPR) of the whole project approval process.

2. *Shrinking project development cycle:* Another BPR exercise needs to be undertaken for shrinking project development cycle to 4 years from the present 8 to 9 years through execution of parallel activities.
3. *SPV approach for Project allocation:* Use of a SPV based approach, where all clearances and DPR's are parked, needs to be examined for allocation of SHP projects.
4. *Enhancing SHP manufacturing capacity:* Need for the Central government to facilitate the development of capacity for SHP equipment manufacturing to attain self sufficiency and reduce overall costs.

Biomass

1. *Periodical Biomass Resource Assessment* – Need for a periodic assessment of biomass resources so as to take into account the effects of change in agriculture output and alternative usages of biomass, which depends upon agro climatic conditions and the prevailing regional industrial growth respectively.
2. *Improved Project Allocation mechanism-* Biomass project allocation mechanism must consider the total biomass potential available in its area, availability of the basic infrastructure i.e. water and road connectivity and the alternate usage of biomass in the region while allocating the biomass projects and deciding on the project command/catchment area.
3. *Organized/ structured market for biomass:* Need to develop organized/structured market for biomass procurement to overcome the problems posed by the existence of multiple middlemen (transporters, traders etc.) in the biomass feedstock value chain, and to streamline the interaction between feedstock sellers and the buyers.
4. *Fuel cost adjustment methodology* – To facilitate pass through of fuel cost adjustment for tariff determination as and when required, there is a need for the development of a methodology for assessing the fluctuations in fuel costs. This methodology needs to be developed at the national level and a monitoring agency at the state level needs to be mandated to monitor the price of fuel (including the extraction, collection, transport, storage cost etc) and revise it at every quarter.

Solar

1. *Enhancing the R&D and manufacturing capability:* Need to upgrade the R&D and enhance the manufacturing capability to leverage the low cost manufacturing capabilities and capitalize the inherent advantages in the solar sector in India.
2. *Separate RPO for Solar:* The current cost of generation of solar is quite high in comparison to other renewable energy sources. Very few states have issued technology specific RPO. In order to encourage capacity addition from solar based projects, states need to specify separate procurement obligation from solar energy.
3. *Promoting indigenization:* Policy and regulatory mechanisms should be designed to encourage indigenization of solar manufacturing capabilities.

4. *Augmenting GBI:* The response to GBI for solar project has been quite good. Keeping in mind the initial stages of development of grid connected solar based projects in India, there is need to increase the existing cap of 50 MW for GBI.