

1. Introduction

India supports around 17 *per cent* of the world's population but its energy and electricity consumption is only around five *per cent* of the world's consumption. Its per capita consumption of energy and electricity is less than one-third of the world average. In order to sustain a growth rate of over eight *per cent* through the next two decades, India would need to grow its primary energy¹ supply by three to four times and electricity supply by at least five to seven times of its current consumption. The country might need to import over 90 *per cent* of its requirement of oil and over 45 *per cent* of its requirement of coal². Energy shortages are currently at an average of 8.7 *per cent* with peak deficit at nine *per cent*³.

Fossil fuels though cost effective and efficient, pollute the environment and contribute to the greenhouse effect and global warming. For instance, mining of coal results in the destruction of wide areas of forest land and is environmentally hazardous. Coal also produces sulphur dioxide which creates acid rain. All fossil fuels have a finite life - the deposits that exist cannot be replenished easily once these are used.

Renewable Energy (RE) is environment friendly and can provide energy security and offers distributed solutions. It is derived from natural processes that are replenished constantly such as sunlight, wind, rain, tides, waves and geothermal heat. RE has the potential to address the growing concern over indiscriminate use of fossil fuels and its impact on climate change. RE technologies are ideally suited to distributed applications and they have substantial potential to provide a reliable and secure energy supply as an alternative to grid extension or as a supplement to grid-provided power. The challenge is to make the RE technologies convenient, efficient, safe and affordable.

Recognising that climate change was a global challenge, India has been actively engaged in multilateral negotiations at the United Nations Framework Convention for Climate Change (UNFCCC) and made voluntary commitment to reduce its carbon emissions intensity by 20-25 *per cent* by 2020 in comparison with 2005 levels⁴. India launched the National Action Plan for Climate Change (NAPCC) in 2008 which had eight missions with a view to mitigate climate change. One of the missions under NAPCC was the National Solar Mission with an aim to install 20,000 MW solar power capacity by 2022. It also envisaged that RE would constitute 15 *per cent* of the energy mix of India by 2020.

¹ Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process.

² Address of the Minister MNRE delivered at Institute of International and European Affairs, Dublin, Ireland in June 2012 available at <http://mnre.gov.in>.

³ As per Energy Statistics 2013 of Central Statistics Office, Ministry of Statistics and Programme Implementation.

⁴ The Final Report of Expert Group on Low Carbon Strategies for Inclusive Growth of Planning Commission (April 2014)

The grid-connectable renewable power had estimated potential of 8,89,508⁵ MW. The Planning Commission in the 12th Five Year Plan (FYP) document has stated that the supply from renewables is expected to increase rapidly from 24,503 MW by the end of the 11thFYP to 54,503 MW by the end of the 12thFYP, and underlined the need for investments in RE.

The installed power generation capacity in India was 2,84,634 Mega Watt (MW) (March 2014) which mainly included 1,99,947 MW (70 *per cent*) from thermal, 40,531 MW (14 *per cent*) from hydro, 4,781 MW from nuclear (two *per cent*) sources and non-utilities⁶ accounted for 39,375 MW (14 *per cent*).

In April 2002, RE based power generation installed capacity was 3,475 MW which was two *per cent* of the total installed capacity in the country. As on 31 March 2014 it was 31,719 MW which was around 11 *per cent* of the installed capacity in the country. Grid connected RE installed capacity included Solar (2,656 MW), Wind (21,137 MW), Small Hydro (3,803 MW) and Biomass⁷ (4,123 MW). Ten⁸ States endowed with 78 *per cent* of the country's Renewable Energy potential varied in terms of potential exploited⁹.

Considering the significance of RE as an alternative to meet ever growing energy demand of India we decided to take up Performance Audit of Renewable Energy Sector in India for the period 2007-14.

2. Strategy adopted by the Government of India (GoI) to develop and promote RE

RE had been an important component of India's energy planning process. The GoI's commitment to RE led to establishment of the Department of Non-Conventional Energy Sources in 1982, which was upgraded to a full-fledged Ministry of Non-Conventional Energy Sources (MNES) in 1992, subsequently renamed as Ministry of New and Renewable Energy (MNRE) in October 2006.

MNRE adopted a three-fold strategy for the development, promotion and use of RE technologies across the country. The salient features of the strategy were:

- (i) providing budgetary support for research, development and demonstration of technologies;
- (ii) facilitating institutional finance through various financial institutions; and
- (iii) promoting private investment through fiscal incentives, tax holidays, depreciation allowance and remunerative returns for power fed into the grid.

⁵ Solar-7,48,990 MW, Biomass-17,981 MW, Small Hydro-19,749 MW, Wind (at 80 metres)-1,02,788 MW.

⁶ RE, Captive Power etc.

⁷ Including biomass power, bagasse cogeneration, urban and industrial waste to energy.

⁸ Andhra Pradesh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Tamil Nadu.

⁹ State wise details are given in Chapters III, IV, V and VI.

3. Renewable Energy Programme

The RE programme of MNRE included deployment of RE based projects, systems and devices in the categories: (i) grid-connected¹⁰ renewable power, (ii) off-grid¹¹/captive renewable power, (iii) energy for rural applications and (iv) RE for urban, industrial and commercial application.

3.1. Grid Connected Renewable Power

This category comprised power generation mainly from - (i) Solar (ii) Wind (iii) Biomass/Bagasse¹² Cogeneration¹³ and (iv) Small Hydro resources. The growth of grid connected RE during the 11th and 12th Five Year Plan (FYP) is given in Table 1.

Table 1: Capacity addition since 9th Five Year Plan (in MW)

Resource	Estimated Potential	Capacity Addition			
		Prior to 11 th FYP	During 11 th FYP (2007-2012)	During 12 th FYP (2012-14)	Total capacity as on 31 March 2014
Solar power	7,48,990	Nil	940	1,716	2,656
Wind power	1,02,788	7,091	10,267	3,779	21,137
Small Hydro Power	19,749	1,976	1,419	408	3,803
Bio power*	17,981	1,185	2,042	896	4,123
Total	8,89,508	10,252	14,668	6,799	31,719

Source: MNRE. *Note – including biomass power, bagasse cogeneration, urban and industrial waste to energy.

3.2. Off-Grid Renewable Power

Programmes for deployment of off-grid/ distributed renewable power and decentralized energy systems for rural applications are given in Table 2.

Table 2: Deployment of off-grid RE systems upto 31 March 2014

S.No.	Resources	Cumulative Achievements (in MW)
Off-Grid/Distributed Renewable Power (including Captive/Cogeneration Plants)		
1.	Biomass Power / Cogeneration(non-bagasse) Plants	531.80
2.	Biomass Gasifier Plants	164.70
3.	Waste-to- Energy Projects	132.70
4.	Solar Photovoltaic Power Plants	174.40
5.	Aero-Generators/Hybrid Systems	2.30
6.	Water Mills/Micro Hydrel Power Projects	13.21
	Total	1,019.11

¹⁰ Energy systems connected with electricity grid for feeding the grid.

¹¹ Energy systems for local use not connected with electricity grid.

¹² Bagasse is sugarcane fibre waste left after juice extraction.

¹³ Cogeneration is the simultaneous generation of both electricity and heat from the same fuel, for useful purposes.

Decentralized Energy Systems		(in numbers or area as applicable)
1.	Family Type Biogas Plants	47.52 lakh
2.	Solar Photovoltaic Home Lighting Systems	11 lakh
3.	Solar Lanterns	9.60 lakh
4.	Solar Photovoltaic Street Lighting Systems	2.75 lakh
5.	Solar Photovoltaic Pumps	11,626
6.	Solar Water Heating - Collector Area ¹⁴	8.08 million sqm.

Source: MNRE.

4. Agencies involved in promotion of Renewable Energy

While MNRE provides the policy direction and monitors the implementation and the impact of the policies, various agencies at the Centre and the States are responsible for implementation of the schemes. A brief description of these agencies and their functions are given below:

4.1. State Government and State Nodal Agencies (SNAs)

Apart from the Central Government's initiatives to promote RE, the State Governments work towards formulating concomitant State policies and implementation of the policies.

SNAs play a critical role in the development of a long-term renewable policy and implementation of sustainable energy programmes across the States. SNAs promote RE technologies and energy conservation measures and popularize them through schemes and programmes formulated in the light of the Central and State policies, viz socially oriented schemes for urban, tribal, remote and underdeveloped regions; commercially oriented schemes; demonstration projects and programmes; aid in the form of subsidies for production and dissemination of RE technologies; support to Research & Development (R&D) activities, and information and education activities, etc.

4.2. Indian Renewable Energy Development Agency (IREDA)

IREDA is a Government Company that was registered as Non-Banking Finance Company with the Reserve Bank of India in 2008. The main objective of IREDA is to give financial support to specific projects and schemes for generating electricity and / or energy through new and renewable sources and conserving energy through energy efficiency. Report No.12 of 2015 Union Government (Ministry of New and Renewable Energy) of the Comptroller and Auditor General of India deals with the Financing of RE Projects by IREDA.

4.3. NTPC Vidyut Vyapar Nigam Limited (NVTN) and Power Grid Corporation of India Ltd. (PGCIL)

NVTN and PGCIL are Government Companies under the Ministry of Power. The main objective of NVTN is to carry on the business of purchase and sale of all forms of electrical power, both conventional and non-conventional. It was decided by MNRE that NVTN would

¹⁴ A Solar Water Heater comprises of an array of solar collectors to collect solar energy and an insulated tank to store hot water.

be the agency responsible for achievement of the target of 1,000 MW of grid connected solar power plants up to March 2013 under the Jawaharlal Nehru National Solar Mission.

PGCIL is the Central Transmission Utility. Its objectives are to undertake transmission of electric power through Inter-State Transmission System; discharge all functions of planning and coordination relating to Inter-State Transmission System with State Transmission Utilities and other stakeholders; and ensure development of an efficient, coordinated and economical system of Inter-State Transmission lines for smooth flow of electricity from generating stations to the load dispatch centres.

4.4. Institutes under MNRE

There are three institutes under MNRE engaged in R&D activity.

4.4.1. National Institute of Wind Energy (NIWE)

NIWE (formerly C-WET¹⁵) located at Chennai, Tamil Nadu, was established as a technical focal point for wind power development in India to promote and accelerate the pace of utilization of wind energy. A Wind Turbine Test Station had also been established at Kayathar, Tamil Nadu, with technical and financial support from DANIDA, an agency of the Government of Denmark.

MNRE through NIWE had initiated a major project on Solar Radiation Resource Assessment (SRRA) across the nation to assess and quantify the solar radiation availability along with weather parameters with a view to develop Solar Atlas. NIWE had installed a network of 51 SRRA stations in the first phase in different States.

4.4.2. National Institute of Solar Energy (NISE)

NISE (formerly SEC¹⁶) located at Gurgaon, Haryana, is a dedicated unit of MNRE for development of solar energy technologies and its related science and engineering. To achieve its objective, NISE had been working on various aspects of solar resource utilization and technology development in collaboration with implementing agencies and industry. Over the years, it had developed a variety of technical facilities for technology evaluation and validation, testing and standardization, performance reliability, monitoring and data analysis apart from training.

4.4.3. Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE)

SSS-NIRE located at Kapurthala, Punjab, is an up-coming R&D centre with mandate to focus on Bio-energy and develop innovative technologies in the area of renewables and biofuels.

¹⁵ Centre for Wind Energy Technology.

¹⁶ Solar Energy Centre.

5. Audit Objectives

The objectives of the Performance Audit of Renewable Energy Sector were to examine the progress made in:

- (i) Increasing the contribution of RE resources in India's energy mix/electricity mix;
- (ii) Increasing access to electricity/ lighting needs in remote and rural areas; and
- (iii) Promoting research, design, development and demonstration.

6. Scope of Audit

The all India Performance Audit of Renewable Energy Sector in India was taken up by the office of the Principal Director of Audit, Scientific Departments. It included the audit of MNRE and institutions under it - NISE, NIWE, SSS-NIRE. The period covered in audit was from 2007-08 to 2013-14.

The State Accountants General audited the State Nodal Agencies (SNAs) in 24 selected States¹⁷ and other related Departments. These States were selected for audit based on criteria of Central Financial Assistance released, the Renewable Energy potential in the State and the level of its exploitation.

The two offices of the Principal Directors of Commercial Audit & ex-officio Member Audit Board-III & IV, New Delhi audited NVVN, PGCIL and IREDA.

For this audit suitable sample were drawn for grid connected and off-grid programmes. In respect of grid connected programmes the sample is given in **Annexure I**.

7. Audit methodology

A stakeholder's workshop was held on 24 September 2013 in the office of the Comptroller and Auditor General of India to identify audit issues. Experts from MNRE, Regulatory Bodies¹⁸, State Nodal Agencies, Non Governmental Organisations (NGOs) and Generators Association attended the Conference. Subsequently, an Entry Conference was held on 6 August 2014 at MNRE wherein the audit objectives, audit scope and audit methodology were discussed. The meeting was attended by the officials of MNRE led by Secretary MNRE. MNRE agreed with the objectives and methodology adopted in this Performance Audit. The draft Audit Report on Performance Audit of Renewable Energy Sector in India was issued to MNRE on 27 January 2015, to seek their comments on the audit findings and to confirm the facts and figures mentioned in the report. MNRE furnished replies to the draft Audit Report on 18 May 2015.

¹⁷ Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

¹⁸ Central Electricity Regulatory Commission and Central Electricity Authority.

The draft Audit Report was revised based on the responses received from MNRE in May 2015 and shared with MNRE on 16 June 2015. The Exit Conference was held on 3 July 2015. Subsequent to the Exit Conference, MNRE furnished supplementary replies (July 2015), which have also been considered while finalizing this report.

8. Scope limitation - non production of records

8.1 Biomass projects

MNRE was the custodian of records for biomass projects including the proposals and their evaluation, based on which Central Financial Assistance (CFA) was released. Hence, it was very important to examine the project files of the biomass projects at MNRE with respect to determination of amount of eligible CFA, monitoring, electricity generation and functional/non-functional aspect of the projects.

MNRE did not provide any register, evidencing, in a chronological order, the comprehensive list of project proposals received and approved. These details were required for random selection of projects for audit scrutiny. Instead MNRE initially provided Audit with seven bagasse and five non bagasse case files of its own selection, which was not as per the required random check envisaged in the audit methodology. This limitation was brought to the attention of the Secretary, MNRE. Thereafter, MNRE furnished a list of 79 biomass bagasse and cogeneration projects which had been funded during 2007-14. The completeness of the list could not be assured in audit. A sample of 20 projects was selected for detailed scrutiny by Audit from this list, but MNRE did not provide project files for eight¹⁹ projects even after repeated request from Audit.

Similarly, MNRE did not furnish the list of non-bagasse project (except Captive Power) to which funds had been released. Audit observed that as per Industrial cogeneration report there were 75 such projects to which CFA had been released by MNRE. Audit requested MNRE to furnish project files for 24 projects of these 75 projects. MNRE furnished only 12 project files and the remaining 12²⁰ were not made available to Audit. MNRE provided 19 files of bagasse cogeneration and 17 files of non-bagasse projects.

8.2 Small Hydro Projects

MNRE did not provide a complete list of Small Hydro Power (SHP) projects approved by it but provided the list of sanctions of CFA for the projects. 18 SHP projects implemented by private developers were selected for audit scrutiny from the list of sanctioned CFA, however

¹⁹ M/s Sahabad Cooperative Sugar Mil Ltd, Haryana; M/s Athani Farmers Sugar Factory Ltd, Karnataka; M/s Malegaon SSK Ltd, Maharashtra; M/s Vikas SSK Ltd, Maharashtra; M/s Shreenath Mhaskoha Sakhar Karkhana Ltd, Maharashtra; M/s Gurudatta Sugar Ltd, Maharashtra; M/s Sarvana Sugar Ltd, Tamil Nadu and M/s Kesar Industries Ltd, Uttar Pradesh.

²⁰ M/s Vijaynagar Biotech Ltd, Andhra Pradesh; M/s Bharat Starch Industries, Haryana; M/s Ruchira Papers Ltd Kala Amb, Himachal Pradesh; M/s Diamond Food Products, Kerala; M/s Lanxess India Pvt Ltd, Birlagram, Madhya Pradesh; M/s Mallu Papers Ltd, Maharashtra; M/s Maa Durga Rice Products Pvt. Ltd, Odisha; M/s ABC papers Ltd, Punjab; M/s SEL Manufacturing Company Pvt. Ltd, Punjab; M/s Anand Triplex Board, Meerut, Uttar Pradesh; M/s Sidarth Papers Ltd, Uttarakhand and M/s Paramount Rice Mills, West Bengal.

files and documents pertaining to the same were not provided to Audit by MNRE during the period of audit.

8.3 Research, Design, Development and Demonstration (RDDD)

Audit sought details of projects sanctioned during 2007-08 to 2013-14 from the concerned divisions of MNRE. In response, all divisions of MNRE provided the information, except Solar Photovoltaic and Solar Thermal divisions, which did not provide details of six projects each²¹. Based on this information, detailed records of 117 projects were called for, of which MNRE provided only 58 project records.

Non production of records and production of incomplete records placed a significant constraint and hindrance to audit scrutiny and is reported as scope limitation to audit.

9. Acknowledgement

Audit acknowledges the cooperation received from MNRE, IREDA, NRVN, PGCIL, NIWE, NISE, SSS-NIRE, concerned State Governments and State Nodal Agencies at each stage of this audit. Audit also acknowledges co-operation received from Central Electricity Regulatory Commission and Central Electricity Authority in providing pertinent information.

10. Arrangement of Audit Findings

The audit findings are discussed in four sections with Chapters II to XII. Chapter I of this report provides an introductory perspective.

- **Section I:** National Action Plan on Climate Change – Renewable Purchase Obligation and Clean Development Mechanism.
Chapter II of this report deals with compliance with Renewable Purchase Obligation and availing benefits of Clean Development Mechanism.
- **Section II:** Grid Connected Renewable Power
Chapter III of this report deals with Solar Power.
Chapter IV of this report deals with Wind Power.
Chapter V of this report deals with Small Hydro Power.
Chapter VI of this report deals with Biomass Power.
- **Section III:** Off-Grid Renewable Power
Chapter VII of this report deals with Solar Photovoltaic Systems.
Chapter VIII of this report deals with National Biogas and Manure Management Programme.
Chapter IX of this report deals with Remote Village Electrification.
Chapter X of this report deals with Ladakh Renewable Energy Initiative.

²¹ Total number of projects sanctioned for Solar Photovoltaic were 27 and for Solar Thermal were 22.

Chapter XI of this report deals with Prime Minister's Special Package for Arunachal Pradesh.

- **Section IV:** Research, Design, Development and Demonstration Activities

Chapter XII of this report deals with Research, Design, Development and Demonstration Activities in the Renewable Energy Sector.

All audit findings and data pertaining to Andhra Pradesh in this Audit Report refers to the position before bifurcation into separate States of Andhra Pradesh and Telangana.