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Conventional Energy to Renewable Energy: Perspectives for India

Ali Reja Osmani*

Abstract

There is a wide gap between India's energy production and energy consumption. Significantly the energy needs of the nation are met through conventional sources of energy. After the two oil shocks in 1970s, which caused energy crisis, the drive for renewable energy started in 1980s with setting up of institutions ranging from research and technology development to human resource development. Over the years India achieved significant progress in wind power in the world and in line to establish its strong hold in solar and biomass. This paper seeking to understand India's growth in renewable sector examines the institutional setup and the policy initiatives. It calls for the need to take steps to motivate the people towards renewable energy.

Keywords: climate change, energy efficiency, energy security, electricity, renewable energy sector in india.

Introduction

India's economy is one of the fastest growing economies in the world and has experienced an average 7 % growth rate in the last decade. India accounts for 2.4 % of world energy production and stands at eleventh position in the world in energy production. But the country accounts for 3.5 % of total energy consumption and holds the sixth position in energy consumption.[1] The wide gap between energy production and energy consumption calls for the need to increase the energy production. With 7% of the world's coal, India possesses fourth largest coal reserve in the world. India heavily relies on coal, which is one of the dirtiest hydrocarbon fuels, for its energy needs. The remaining energy needs is fulfilled mostly by oil, which is imported and the increasing oil price is

* *Ali Reja Osmani (aro85in@yahoo.co.in) is working as Research Associate for the Climate Change Programme at Centre for Science and Environment, New Delhi.*

also a burden for the growing economy. India is party to all the major environmental conventions and treaties, so due to its commitment towards environment India is opting policies for optimum use of renewable sources of energy.

The Prime Minister in his forward to the Eleventh Five Year Plan (2007-2012) document underscores the India's thrust for renewable energy, when he writes,

> *"Availability of affordable energy is critical for our growth. With international oil prices rising sharply over the last couple of years, and coal prices more recently, our efforts towards energy security have acquired urgency. The Eleventh Plan will work towards policies for various energy sectors that are consistent with the optimal use of the different sources of energy. The Plan emphasizes the need for energy conservation, increasing energy efficiency, and development of renewable sources of energy."*[2]

History of Renewable Energy in India

For last few decades renewable energy has been an important part of India's energy planning process. To ensure energy security and to reduce the dependence on oil imports, India started to develop and deploy alternative fuels such as hydrogen, bio-fuels and synthetic fuels and to increase clean power (renewable electricity) the technologies that were opted by India are bio, wind, hydro, solar, geothermal and tidal energy technologies.[3]

The increasing need to use renewable energy as a sustainable energy base was realized by the world in early 1970s with the imposition of an oil embargo by the Arab states within Organization of Petroleum Exporting Countries (OPEC).[4] The Arab state's embargo crippled the United States economy, creating lessons for many other countries of the world and it was felt that a country must adopt measures for its energy security. During the 1980s, when with the growing scientific evidence and experiments it is understood that the earth's temperature is steadily raising, political attention mounted for sustainable development; renewable energy was given more importance.

Since early 1980s India started to establish institutional framework to develop renewable energy in the country. In 1981 the Government constituted Commission for Additional Sources of Energy.[5] The Commission for Additional Sources of Energy was aimed to promote the development of renewable energy technologies for use in the different sectors of the country. The political commitment to renewable energy manifested in establishing a Department of Non-Conventional Energy Sources in the year 1982 under the Ministry of Energy and entrusted it with the charge to promote the development of non-conventional energy sources in the country.[6] In 1992, after a decade has elapsed, the Department of Non-Conventional Energy Sources was upgraded to a full-fledged Ministry of Non-Conventional Energy Sources (MNES). The creation of a full-fledged ministry for renewable energy was a landmark for the country and therefore India became the first country in the world to have a dedicated Ministry for renewable energy. In 2006 MNES has been renamed as Ministry of New and Renewable Energy (MNRE).[7]

Growth of Renewable Sources of Energy

Over the years, there has been a steady progress in the capacity addition of the renewable sources of energy. The major part of the capacity addition achieved till 31st January 2012 was dominated by Wind, which was 64% of the total capacity addition. Solar placed in the second position, i.e. 14%, followed by Small Hydro 8% and finally Bagasse Cogeneration (simultaneous generation of electricity and thermal energy) and Biomass accounts for 9% and 5% respectively.[8]

Since 1980s India has been paying attention to growth of renewable energy to ensure the objectives of ensuring energy security, energy self-sufficiency, sustainable development and extending energy access to remote village/hamlets etc. Different institutions for capacity building and R&D were set up to promote renewable sources of energy which include wind power, solar power, small hydro power and biogas. The data till 31st January 2012 indicate that of these renewable sources, wind power contributed to 64 % addition, followed by solar (14%), small hydropower (8%), Bagass (9%) and biogas (5%).

The Table 1 and Table 2 clearly explain the importance Government of India has given on renewable energy sector.

Table 1: Physical Target & Actual for Tenth FYP (2002-2007)

Programme Components	Targeted Generation of Power[(a)] (MW)	Actual Generation of Power[(b)] (MW)
Wind Power	1500	5415
Small Hydro Power	600	520
Biomass Power/Co-generation/ Gasification	750	750
Waste to energy	80	25
Solar PV Power	5	1
Solar Thermal Power	140	0
Total Power Generation	3075	6711

Source: (a) Planning Commission, *Tenth Five Year Plan (2002-2007): Sectoral Policies and Programmes*, Government of India, Vol. II 927, http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/10th_vol2.pdf

(b) Planning Commission, *Eleventh Five Year Plan (2007-2012): Agriculture, Rural Development, Industry, Services and Physical Infrastructure*, Government of India, Vol.III 387 (New Delhi: Oxford University Press, 2008), http://planningcommission.nic.in/plans/planrel/fiveyr/11th/11_v3/11th_vol3.pdf

Implementation and shortfall of Tenth FYP

During this Tenth plan period the overall renewable power generation has been satisfactory. Wind power capacity of 5415 MW has been created marking 3.6 times of the set target. Production capacities of Biomass power/Co-generation/Gasification generations are in line with set target. There are noticeable shortfalls in Small Hydro power generation and Waste to energy generation. However, achievement in Solar Thermal power was significantly lower.[9]

Apart from power generation schemes, programmes for rural energy, urban application and R&D have also been implemented during this period. Nearly 5000 remote villages/hamlets have been facilitated with electricity from renewable energy sources. primarily through solar energy. Nearly 5 lakh biogas plants have also been installed. Under the solar water heaters programme 12.5 lakh sq m collector areas of water heating systems have been installed in urban areas. R&D activities, including

in hydrogen energy, have also been carried out especially in the area of alternative fuel for transport.[10]

Table 2: Physical Target & Actual for Eleventh FYP (2007-2012)

Programme Components	Targeted Generation of Power (MW)	Actual Generation of Power (MW)
Grid-interactive Renewable Power(MW)		
Wind Power	10,500	10,260.00
Small Hydro Power	1,400	1,419.17
Biomass Power	1,200	1,369.70
Co-generation	500	626.00
Waste to energy	80	46.20
Solar power (grid/ off-grid)	50	939.74
Off-grid/Distributed Renewable Power (MWe)		
Waste to Power (Urban + Industrial)	58.00	85.15
Non-bag Cogen	255.00	336.59
Gasifiers	67.00	63.23
Acro-Gens/Hybrid Systems	1.75	1.14
SPV Systems	20	46.64
Total Power Generation	14131.75	15,192.86

Source: Planning Commission, *Twelfth Five Year Plan (2012-2017): Economic Sectors*, Government of India, Vol. II, (New Delhi: SAGE Publications, 2013), http://planningcommission.nic.in/plans/planrel/fiveyr/12th/pdf/12fyp_vol2.pdf

Implementation and shortfall in Eleventh FYP

In the Eleventh FYP the grid-interactive renewable power generation has been consistent with the planned target. However, actual generation was considerably lower than that of the targeted plan. The wind based power generation suffered due to the lack of evacuation infrastructure in resource rich states and also due to the lack of enforcement mechanisms and incentives for operational performance of the wind turbines. Therefore enforcement of 'Generation based incentives' is recommended in place of

earlier incentives, such as Accelerated Depreciation, which have not yielded expected outcome. Achievements in capacity addition have been satisfactory in respect of all sectors (programmes) except in waste to power sector.[11]

Solar and wind sectors have been facing following key challenges:

(i) Globally, development of storage technologies has not been in line with the technology developments in wind and solar, due to which capacity utilisation of grid connected solar and wind has been relatively poor.

(ii) Though most of the States have come up with the RPO obligation, proper enforcement and monitoring is an issue and 22 of the 29 states in the country have failed to meet their targets.[12]

Table 3: Financial Outlays Proposed for Tenth FYP (2002-2007)

Sectors	Amount (in Crore)
Grid Interactive and Distributed Renewable Power	609.00
Village Electrification Programme	962.00
Research Design Development and Demonstration	835.00
Infrastructure Development and Capacity Building Programme	489.00
Awareness and Extension Programme	210.00
MNES Institutions	3,497.00
Spillover liabilities for schemes transferred to States	15.00
Externally Aided Projects (EAP)	466.00
Total	7167.00

Source: Planning Commission, *Table: 38- Scheme Wise Break-up of Tenth Outlay on Ministry of Non-Conventional Energy Resources*, in Tenth Five Year Plan (2002-2007): Sectoral Policies and Programmes, Government of India, Vol. II A-52, http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/10th_vol2.pdf

Off-grid renewable sector is potentially much more competitive in comparison to conventional power as it avoids investment in transmission to remote places. During this plan period off-grid renewable power made a significant progress, but lack of scalable business models and non-availability of institutional finances were barriers to its growth. The

progress of schemes for remote villages/hamlets was not convincing. Another thrust area for this plan period is 'optimizing energy plantations by raising plants on degraded forest and community land', but policy models along with implementation guidelines for promoting energy plantations are yet to be worked out.[13]

Table 4: Financial Outlays Proposed for Eleventh FYP (2007-2012)

Sectors	Amount (in Crore)
Grid Interactive and Distributed Renewable Power	3925.00
Grid interactive renewable power	1800.00
Off-grid/distributed renewable power	2100.00
Performance testing	25.00
Renewable energy for rural applications	2250.00
Renewable energy for urban, industrial and commercial applications	685.00
Research, design, and development	1500.00
Programmes to support information, publicity and extension, international relations, HRD and training, equity for IREDA, and spill-over liabilities	2100.00
Total	10460.00

Source: Planning Commission, *Eleventh Five Year Plan (2007-2012): Agriculture, Rural Development, Industry, Services and Physical Infrastructure*, Government of India, Vol. III 388 (New Delhi: Oxford University Press, 2008), http://planningcommission.nic.in/plans/planrel/fiveyr/11th/11_v3/11th_vol3.pdf (accessed on 3rd September 2014); *see also* MNRE, *Report of the Working Group on New & Renewable Energy for XIth Five Year Plan (2007-2012),* Government of India, December 2006, http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_renewable.pdf

Factors Driving India's Renewable Energy Thrust

The following are some of the factors responsible for India's drive for renewable energy.

Energy Security

With the growing concern over country's energy security, renewable energy given more significance. After the two oil shocks of 1970s, energy self-sufficiency can be regarded as one of the major factors for growth

of renewable energy in the country.[14] India's energy needs are high and being a developing country the requirements are growing further. During the year 2008 the overall total electricity consumption in India was 839 TWh, out of which around 830 TWh electricity was generated within the country and the rest 9 TWh of electricity was imported, clearly shows the gap between the energy consumption and energy supply.[15] The Government started investing highly on oil and gas exploration to reduce the dependency on imported sources. But since these sources are not replenished, the energy security of the nation compels the country to look for renewable sources of energy.

Sustainable Development

India is home to nearly one-third of the world's poor, mostly dependent on natural resources for their livelihood. In pursuance of *Bali Action Plan,* India launched the *National Action Plan on Climate Change*[16] (NAPCC) to address climate mitigation and adaption. The NAPCC has eight national priorities, National Missions that represent the countries' long-term strategy for achieving its climate related goals. Out of all eight priorities, the missions that are related with renewable sector include National Solar Mission, National Mission for enhanced Energy Efficiency, National Mission on Sustainable Habitat, and National Mission for Sustainable Agriculture.

The plan incorporates a commitment to ensure that India's per capita greenhouse gas emissions level never exceeds those of the developed countries at any point of time in future. The plan sought to create balance between the need to maintain steady and higher economic growth on one hand and to mitigate the ill-effects of climate change on the other hand. Apart from these objectives, the plan also seeks to identify measures that promote development priorities simultaneously addressing the threats posed by climate change effectively.[17]

After the Clean Development Mechanism Executive Board had decided that a project activity under a Programme of Activity can be registered as a single Clean Development Mechanism project activity. Without much delay the MNRE conducted a study to understand and develop a framework for programmatic Clean Development Mechanism projects in renewable sectors. The study mainly covered the areas of solar water heating, solar cooking, biogas plants for individual families,

medium & large size biogas plants, cooking stove, application of biomass in industry and village electrification.[18]

Access to Electricity and Other Source of Energy for Rural India

Rural electrification is one of the factors which accelerated the speed of renewable energy growth in India. Approximately three quarters of the population live in rural areas of the country, where thousands of villages are yet to be electrified. Being an agriculture based nation, rural electrification is very important for irrigation as well as other purposes. The non-electrification is not only affecting the quality of life in rural India, but also a hurdle in economic upliftment. Due to non-availability of electricity, kerosene is widely used for lighting and for cooking, wood and animal dung is used as fuel. Consuming energy in this way leads to health and environmental hazards.

To accelerate the process of rural electrification the Government launched two renewable energy schemes for rural India namely (i) Remote Village Renewable energy Programme, further divided in two sections such as, (a) Village Energy Security Programme, and (b) Remote Village Solar Lighting Programme; and (ii) Grid-Connected Village Renewable Energy Programme, which is also divided into two sections such as, (a) Solar Thermal System and (b) Biogas Plant.

Institutional Development for Renewable Energy

As per the Renewable Energy Country Attractiveness Index (RECAI) of February 2014, India has been ranked seventh in the world, preceded by U.S., China, Germany, Japan, Canada and U.K. respectively.[19] According to the Technology Specific Indices (reflect a weighted average across macro, energy market and technology-specific parameters) of February 2014, India stands fourth in respect of Solar CSP preceded by U.S., Chile and Australia and stands fifth in respect of Solar PV preceded by China, U.S., Japan and Germany. In respect of both On-shore wind and Hydro and Marine, India has been ranked eighth. For On-shore wind, India is preceded by U.S., China, Germany, U.K., Canada, Ireland and Sweden and for Hydro and Marine, India is preceded by China, U.S., Japan, Canada, Brazil, Peru and Norway. For Biomass, Geothermal and Off-shore wind India ranked as seventeenth, eighteenth and twenty-first respectively.[20]

The credit for India's success and growth in the field renewable energy also goes to its early institutional setups. For the overall development of the renewable sector the Government of India established numerous institutions ranging from technology development, R&D, manpower development to financial institution. Some of the key institutions in the sector are as follows:

Alternate Hydro Energy Centre

The Alternate Hydro Energy Centre (AHEC), an academic centre at the Indian Institute of Technology, Roorkee, was established by MNRE in 1982. The AHEC was established with an aim to provide short-term and long-term training courses for professional development in the area of small hydropower.[21]

Solar Energy Centre

In 1982 the MNRE established the Solar Energy Centre, a dedicated institution for the development of solar energy technologies, science and engineering related with it. Since then the Solar Energy Centre is jointly working with other research organization and implementing bodies to attain its objective.[22] In early 2010 the Union Minister for MNRE has laid down the foundation stone of facilities for Solar Thermal Testing, Research and Simulation at Solar Energy Centre.[23]

Indian Renewable Energy Development Agency

To speed up the promotion of renewable energy technology and systems, the MNRE under its administrative control established a Public Limited Government Company named Indian Renewable Energy Development Agency Limited (IREDA) on 11th March, 1987. IREDA intends to promote, develop and extend financial assistance for renewable energy and energy efficiency/conservation projects in the country.[24]

Centre for Wind Energy Technology

The Centre for Wind Energy Technology (C-WET) is an autonomous organization under the administrative control of MNRE established in 1998 to carry out research and development specifically in the field

of wind energy. With the technical and partial financial support from Danish International Development Agency (DANIDA), C-WET has also established a Wind Turbine Testing Station, wherein testing and certifying of Wind Turbine Generator Systems are conducted as per international standards as well as Indian Certification Scheme for wind turbine.[25]

National Institute Of Renewable Energy

The Sardar Swaran Singh National Institute of Renewable Energy (SSSNIRE) is an autonomous institution under MNRE established with a vision for premier R&D institution to undertake research and development especially in the field of bio-energy, human resource development at all levels, conducting post-doctoral research, promoting commercialization of renewable energy technologies and attending to energy needs in rural areas.[26]

Renewable Energy Regulatory Framework in India

The favourable policy initiatives also contributed to the growth of renewable sector in the country. The Electricity Act of 2003 was the first comprehensive framework, which speeded development of renewable energy in the country by providing a developing regulatory structure containing preferential tariffs, renewable purchase obligation, renewable energy certificate, etc. The Government also introduced various alternative combinations of fiscal and financial incentives to promote renewable energy, such as capital and interest subsidy, nil or concessional excise and custom duties in a case to case basis, and generation based incentives or feed-in-tariffs.[27]

The Government came out with the Renewable Purchase Obligation (RPO) scheme, under which each state has to set a state –level target for renewable energy purchase by 'Obligated Entities'. The national target for RPO was set at 5% for 2010, which will increase by 1% annually till it reaches to 15% over a decade's time i.e. by 2020. Till April 2010, 18 states have taken initiatives for RPOs, some of them already established RPOs and in some states the draft regulation for RPO under consideration.[28] As states has varying renewable energy sources, keeping this into mind the Central Electricity Regulatory Commission (CERC) has introduced a market based instrument in the form of Renewable

Energy Certificate (REC), to facilitate the states to meet their obligation. Therefore the obligation can be met through following ways- (a) by directly purchasing renewable energy, (b) by generating renewable energy, and (c) by purchasing RECs.[29]

The Jawaharlal Nehru National Solar Mission (JNNSM) was launched on 29th November 2009, marked as the foundation stone in India's endeavour to solar energy, popularly known as 'Solar India'. India's solar energy potential is almost 5000 trillion KWh.[30] The ambitious National Solar Mission will be implemented in 3 phases- the Phase-I started during the last few months of the Eleventh Five Year Plan and last till the end of the first year of the Twelfth Five Year Plan i.e. 2012-2013, the Phase-II will be developed over the remaining four years of the Twelfth Five Year Plan i.e. over 2013-2017 and the Phase-III will be developed during the Thirteenth Five Year Plan i.e. 2017-2022 period. The Government of India entrusted the NTPC Vidyut Vyapar Nigam Ltd (NVVN), a trading subsidiary of National Thermal Power Corporation Ltd (NTPC) as the nodal agency to enter into Power Purchase Agreement with the solar power plant developers.[31]

The IREDA will facilitate the mission by extending financial support i.e. credits for 10 years with an interest rate of 5 % per annum. For monitoring of all these activities there will be a Solar Research Council, which shall look after implementation of strategy, by taking into consideration existing projects, capacity building and possibilities of foreign collaboration.[32] A remarkable success has also been achieved in this regard, whereby two research projects, specifically concentrated on photovoltaic, launched jointly by the Research Councils UK and Department of Science and Technology, Government of India.[33] The renewable energy sector has always been given a 'Priority Sector' status by the Reserve Bank of India for the purpose of providing loans through banks. Due to these initiatives the Indian renewable energy sector has created a significant manufacturing base with the cooperation of International Industrial Partnerships.[34]

To invest in entrepreneurial ventures and research in the field of clean energy technologies the Finance Bill 2010-11 provided for creation of a corpus called National Clean Energy Fund. Subsequently the Cabinet Committee on Economic Affairs (CCEF) has approved the constitution of NCEF in the Public Accounts of the country. The CCEF also laid down

the guideline and principles for approval of projects that are to be funded by National Clean Energy Fund and Inter-Ministerial Group has also been formed, consisting (i) Secretary (Finance): Chairperson, (ii) Secretary (Expenditure): Member, (iii) Secretary (Revenue): Member, and (iv) Representatives from Ministries of Power, Coal, Chemicals & Fertilizers, Petroleum & Natural Gas, New & Renewable Energy and Environment & Forests.[35]In the Budget 2012 the Government of India has considered to create a separate fund out of the existing National Clean Energy Fund to finance RE projects with subsidised loans.[36]

Renewable Energy Initiatives for Rural Applications

The MNRE has introduced the Remote Village Electrification Programme (RVEP) during the Eleventh Five Year Plan period to provide financial support for electrification of those remote non-electrified villages and hamlets where grid-extension is either not feasible or not cost effective and also to those villages and hamlets which are not covered under the scheme of Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) for grid electrification.[37] Although the RVEP is complementary to the RGGVY the National Rural Electrification Policy, 2006 expressly says that the provision for renewable energy based electrification cannot jeopardize the right of the villager's and hamlets that are grid connected under the scheme RGGVY.[38] It can be inferred from the provision that the policy makers' intention is to expand the renewable energy electrification even to those villages and hamlets which have access to grid connectivity.

The National Biogas and Manure Management Programme mainly promotes installation of family type biogas plant, has been in implementation since early 1980s. The programme provide subsidy, training of entrepreneurs, masons and to the usurers and also provide financial support for repair of old non-functional plants etc. Out of estimated 12 million plants, nearly 4.31 million plants has already been setup.

Renewable Energy Initiatives for Urban, Industrial and Commercial Applications

The MNER has proposed the Solar City Programme during the Eleventh Five Year Plan. The programme is designed to encourage and support

the Urban Local Bodies to prepare a framework for guiding the city towards a Solar City or Renewable Energy City, to meet both increasing electricity demand of the cities and to promote the growing use of renewable energies in urban areas. Although the programme seems to be a solar specific initiative, the local authority can consider any source of renewable energy depending the need and availability of source. For the Eleventh Five Year Plan period a total of 60 cities have been considered by the MNER.[39] To implement the programme INR 300 million expected to be spent during Eleventh Five Year Plan period only, which shall be taken out of the budget allocated for solar thermal energy programmes.[40]

For the easy access and the after sale services of solar energy products, the MNRE has started promoting and establishing Akshay Urja Shops (earlier known as Aditya Sholar Shops) in major cities. During the Ninth Five Year Plan the State Nodal Agencies, Associations of Manufacturers of solar energy products and Non-Government Organisations (NGO) also started establishing these shops. Subsequently in the Tenth Five Year Plan the private entrepreneurs were also allowed to establish these shops. The main objective of the programme is to establish and run one shop of such kind in each district of the country for easy availability of renewal energy technology. The participation of private entrepreneurs will expand the network and NGOs will be set up to operate the shops.[41]

The MNRE is also undertaking programmes on "Biomass Energy and Cogeneration (non-bagasse) in industries" with the objective of promoting the development of biomass energy system and generating and supplying power to meet the captive need of industries and institutions. Till 31st January 2011, total 20 projects have been completed with a generation capacity of over 60 MW and another 8 projects with aggregate generation capacity of 30 MW under process.[42]

Renewable Power Generation Target for Twelfth Plan Period

In the years to come renewable energy is very obviously going to play an aggressive role in attaining energy security, energy self-sufficiency and energy access for all. The share of renewable electricity in the electricity mix which was 7% during 2011-12 is expected to reach to 12% by 2016-17. At present installed capacity of renewable power is around 25,000 MW and the renewable energy capacity addition required for the Twelfth Plan period would be more than 30,000 MW. The financial outlay for the

Twelfth FYP under the MNRE is Rs.33,003 crores. [43]The Table 5 below provides component-wise break up of physical targets for the Twelfth Plan period.

Table 5: Physical Targets for Twelfth FYP (2012-2017)

Programme Component	Proposed Target
Grid-interactive Renewable Power(MW)	*30,000*
Grid Interactive Solar	10,000
Grid Connected Wind	15,000
Other Renewable Sources	5,000
Off-grid/Distributed Renewable Power (MWe)	*3,400*
Cogeneration from bagasse	2,000
Solar Off-Grid Applications	1,000
Waste to Energy	200
Bio Gas Based Decentralised Power	50
Others (Biomass Gasifiers, Micro-hydel)	150
Renewables for Rural applications (Cooking)	
Biogas Plants (million)	0.7
National Biomass Cook stoves Programme (million)	3.5
Solar Cookers (Box type + Dish type)	3.5
Solar Cooking in schools for mid-day scheme (Schools in lakhs)	5.0
Renewable Energy for Urban, Industrial and Commercial Applications	
Solar Water Heating Systems (million sq.m of collector area)	6
Solar Air Heating System (sq m.)	50,000
CST based systems for community cooking (sq.m.)	40,000
CST based system for air-conditioning (125 systems, 30TR)	37,000
CST based systems for process heat (225 systems, 250 sq.m. area each)	53,750
Solar Cities	
New Solar Cities in addition to existing target of 60 cities and pending liabilities	15
Model and Pilot Solar Cities.	25
Green Townships.	150
Tourist/Religious/ Important Places	100
Alternate Fuel Vehicles (in numbers)	2,75,000
Power Generation from Hydrogen	
Stationery Power Generation (KW)	4,000
Hydrogen/H-CNG Stations (nos)	10
Demonstration projects for Hydrogen/H-CNG vehicles	500
Power Generation from Fuel Cell	
Stationery Power Generation (KW)	10.0
Back- up units for telecom towers (MW/nos)	10/2,000
Fuel cell Vehicles	100

Source: Planning Commission, *Twelfth Five Year Plan (2012-2017): Economic Sectors*, Government of India, Vol. II, 194, (New Delhi: SAGE Publications, 2013), http://planningcommission.gov.in/plans/planrel/12thplan/pdf/vol_2.pdf (accessed on 3rd September 2014)

Conclusion

India's renewable energy sector is now more than three decades old. Initially the development of renewable energy started with the idea of energy security and self-sufficiency after the energy crisis of 1970s. Subsequently it combined with environmental concerns and concerns for poverty alleviation, rural electrification and access to electricity for all. The early institutional development included setting up of institutions ranging from Alternate Hydro Energy Centre, Solar Energy Centre, Renewable Energy Development Agency, Centre for Wind Energy Technology and the academic institution for R&D, human resource development etc. The institutional set up was accompanied by progressive policy framework for the promotion of renewable energy such as, the Electricity Act, Renewable Purchase Obligation, Renewable Energy Certificate, Solar India, Clean Energy Fund initiative for renewable energy technologies etc. All these efforts helped the country to become a world leader in renewable energy technology, especially in wind power. The JNNSM i.e. 'Solar India' will certainly help the country to become a leader in solar energy too. Despite the progress achieved, there has been lack of adequate public awareness, public involvement and public acceptance for renewable energy. With more dedicated awareness programmes, India can achieve better results in renewable sector in the years to come. The country has to take serious concern to motivate its people to take to renewable energy for achieving its vision of development with concerns for equity and environment.

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