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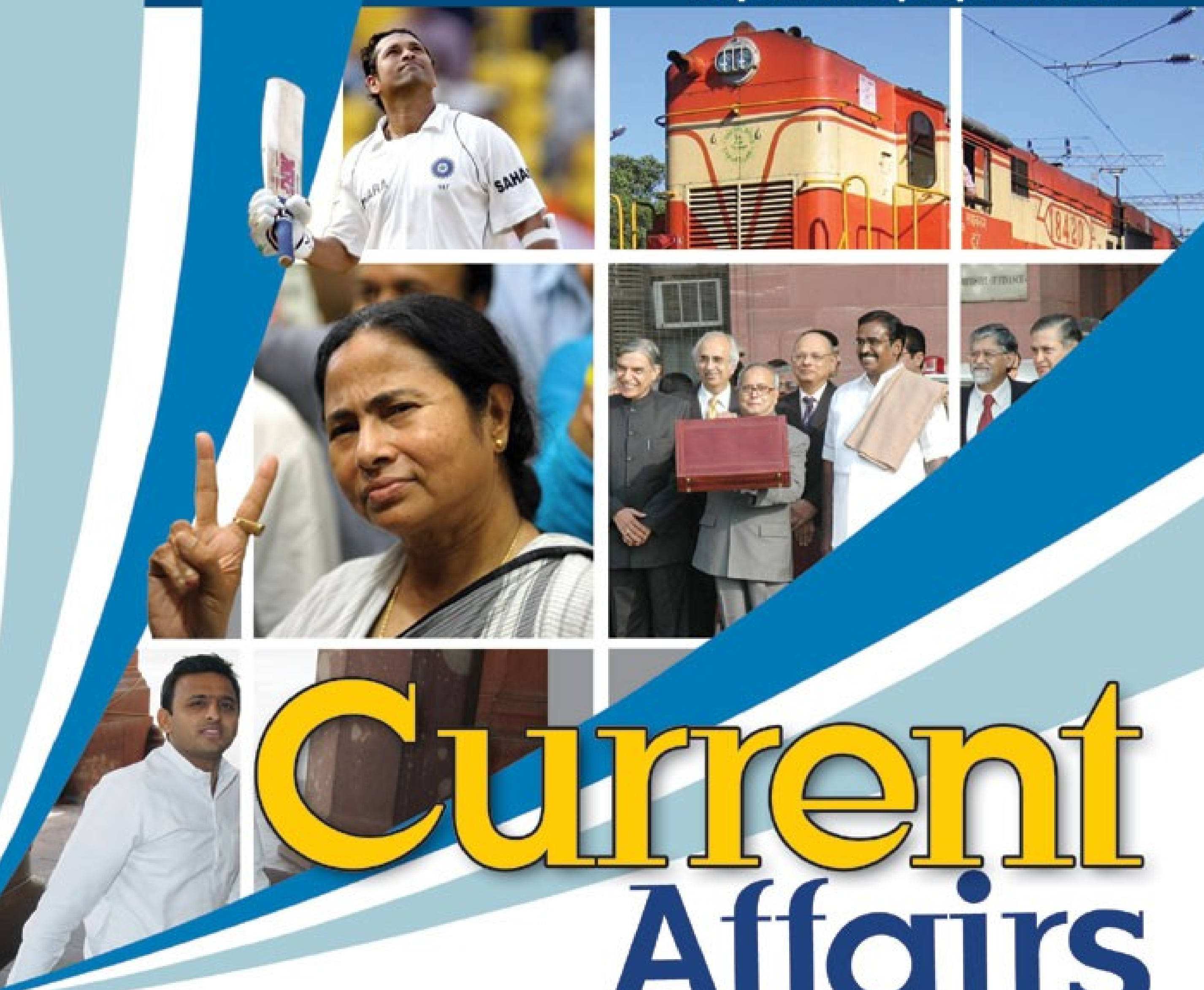

Current Affairs

for IAS (PRE) 2012

- News form 1st May 2011 to 31st March 2012
- Gist of Economic Survey
- Gist of Yojana Magazine
- Gist of Editorials & Articles
- Special Materials on Environment
- Special Materials on Science & Technology
- Special Materials on Energy

S. A. Majid

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Energy (Concept)

SOLAR POWER IN INDIA

India is densely populated and has high solar insolation, an ideal combination for using **solar power in India**. India is already a leader in wind power generation. In the solar energy sector, some large projects have been proposed, and a 35,000 km^2 area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 GW to 2,100 GW. In July 2009, India unveiled a US$19 billion plan to produce 20 GW of solar power by 2020. Under the plan, the use of solar-powered equipment and applications would be made compulsory in all government buildings, as well as hospitals and hotels. On November 18, 2009, it was reported that India was ready to launch its National Solar Mission under the National Action Plan on Climate Change, with plans to generate 1,000 MW of power by 2013.

According to a 2011 report by GTM Research and Bridge, India is facing a perfect storm of factors that will drive solar photovoltaic (PV) adoption at a "furious pace over the next five years and beyond". The falling prices of PV panels, mostly from China but also from the U.S., has coincided with the growing cost of grid power in India. Government support and ample solar resources have also helped to increase solar adoption, but perhaps the biggest factor has been need. India, "as a growing economy with a surging middle class, is now facing a severe electricity deficit that often runs between 10 and 13 percent of daily need with about 300 clear, sunny days in a year, India's theoretical solar power reception, on only its land area, is about 5 Petawatt-hours per year (PWh/yr) (i.e. 5 trillion kWh/yr or about 600 TW). The daily average solar energy incident over India varies from 4 to 7 kWh/m^2 with about 1500–2000 sunshine hours per year (depending upon location), which is far more than current total energy consumption. For example, assuming the efficiency of PV modules were as low as 10%, this would still be a thousand times greater than the domestic electricity demand projected for 2015.

INSTALLED CAPACITY

The amount of solar energy produced in India is less than 1% of the total energy demand. The grid-interactive solar power as of December 2010 was merely 10 MW. Government-funded solar energy in India only accounted for approximately 6.4 MW-yr of power as of 2005. However, as of October 2009, India is currently ranked number one along with the United States in terms of solar energy production per watt installed.

India's largest photovoltaic (PV) power plants

Name of Plant	DC Peak Power (MW)	GW·h /year	Capacity factor	Notes
Reliance Power Pokaran Solar PV Plant, Rajasthan	40			Commissioning in March 2012
Adani Bitta Solar Plant,	40			To be Completed

Gujarat		December 2011
Sivaganga Photovoltaic Plant	5	Completed December 2010
Kolar Photovoltaic Plant	3	Completed May 2010
Itnal Photovoltaic Plant, Belgaum	3	Completed April 2010
Azure Power - Photovoltaic Plant	2	2009
Chesdin Power - Biomass and Solar Photovoltaic Plants	4.1	Completes December 2011
Jamuria Photovoltaic Plant	2	2009
NDPC Photovoltaic Plant	1	2010
Thyagaraj stadium Plant-Delhi	1	April, 2010
Gandhinagar Solar Plant	1	January 21, 2011
Tata - Mulshi, Maharashtra	3	Commissioned April 2011
Azure Power - Sabarkantha, Gujarat	10	Commissioned June 2011
Moser Baer - Patan, Gujarat	30	To Be Commissioned July 2011
Tata - Mayiladuthurai, Tamil Nadu	1	Commissioned July 2011
REHPL - Sadeipali, (Bolangir) Orissa	1	Commissioned July 2011
Tata - Patapur, Orissa	1	Commissioned August 2011
Tata - Osmanabad, Maharastra	1	Commissioned 1st Aug 2011
Abengoa - Gwal Pahari, Haryana	3	Commissioned September 2011
Chandraleela Power Energy - Narnaul, Haryana (EPC by Aryav Green Energy Solutions Pvt. Ltd.)	0.8	To be Commissioned December 2011
Green Infra Solar Energy Limited-Rajkot, Gujarat	10	Commissioned November 2011
Total	**162.9**	

SOLAR ENGINEERING TRAINING

The Australian government has awarded UNSW A$5.2 million to train next-generation solar energy engineers from Asia-Pacific nations, specifically India and China, as part of the Asia-Pacific Partnership on Clean Development and Climate (APP). Certain programmes are designed to target for rural solar usage development.

FUTURE APPLICATIONS

Rural Electrification

Lack of electricity infrastructure is one of the main hurdles in the development of rural India. India's grid system is considerably under-developed, with major sections of its populace still surviving off-grid. As of 2004 there are about 80,000 unelectrified villages in the country. Of these villages, 18,000 could not be electrified through extension of the conventional grid. A target for electrifying 5,000 such villages was set for the Tenth National Five Year Plan (2002–2007). As of 2004, more than 2,700 villages and hamlets had been electrified, mainly using solar photovoltaic systems. Developments in cheap solar technology are considered as a potential alternative that allows an electricity infrastructure consisting of a network of local-grid clusters with distributed electricity generation. It could allow bypassing (or at least relieving) the need to install expensive, lossy, long-distance, centralised power delivery systems and yet bring cheap electricity to the masses.

Projects currently planned include 3000 villages of Orissa, which will be lighted with solar power by 2014.

Agricultural support

Solar PV water pumping systems are used for irrigation and drinking water. The majority of the pumps are fitted with a 200–3,000 watt motor that are powered with 1,800 Wp PV array which can deliver about 140,000 liters of water per day from a total head of 10 meters. By 30 September, 2006, a total of 7,068 solar PV water pumping systems had been installed.

Solar driers are used to dry harvests before storage.

Solar water heaters

Bangalore has the largest deployment of rooftop solar water heaters in India. These heaters will generate an energy equivalent of 200 MW every day.

Bangalore is also the first city in the country to put in place an incentive mechanism by providing a rebate (which has just been[when?] increased to ₹50) on monthly electricity bills for residents using roof-top thermal systems. These systems are now mandatory for all new structures.

Pune, another city in the western part of India, has also recently made installation of solar water heaters in new buildings mandatory.

Challenges and opportunities

Land is a scarce resource in India and per capita land availability is low. Dedication of land area for exclusive installation of solar arrays might have to compete with other necessities that require land. The amount of land required for utility-scale solar power plants—currently approximately 1 km^2 for every 20–60 megawatts (MW) generated—could pose a strain on India's available land resource. The architecture more suitable for most of India would be a highly-distributed set of individual rooftop power generation systems, all connected via a local grid. However, erecting such an infrastructure, which does not enjoy the economies of scale possible in mass, utility-scale, solar panel deployment, needs the market price of solar technology deployment to substantially decline, so that it attracts the individual and average family size household consumer. That might be possible in the future, because PV is projected to continue its current cost reductions for the next decades and be able to compete with fossil fuel.

Some noted think-tanks recommend that India should adopt a policy of developing solar power as a dominant component of the renewable energy mix, since being a densely populated region[44] in the sunny tropical belt, the subcontinent has the ideal combination of both high solar insolation and therefore a big potential consumer base density. In one of the analyzed scenarios, India can make renewable resources such as solar the backbone of its economy by 2050, reining in its long-term carbon emissions without compromising its economic growth potential.

According to a 2011 report by GTM Research and Bridge, India is facing a perfect storm of factors that will drive solar photovoltaic (PV) adoption at a "furious pace over the next five years and beyond". The falling prices of PV panels, mostly from China but also from the U.S., has coincided with the growing cost of grid power in India. Government support and ample solar resources have also helped to increase solar adoption, but perhaps the biggest factor has been need. India, "as a growing economy with a surging middle class, is now facing a severe electricity deficit that often runs between 10 and 13 percent of daily need".

Government support

The government of India is promoting the use of solar energy through various strategies. In the latest budget for 2010/11, the government has announced an allocation of 10 billion (US$190 million) towards the Jawaharlal Nehru National Solar Mission and the establishment of a clean energy fund. It is an increase of 3.8 billion (US$72.2 million) from the previous budget. This new budget has also encouraged private solar companies by reducing customs duty on solar panels by 5% and exempting excise duty on solar photovoltaic panels. This is expected to reduce the cost of a roof-top solar panel installation by 15–20%. The budget also proposed a coal tax of US$1 per metric ton on domestic and imported coal used for power generation. Additionally, the government has initiated a Renewable Energy Certificate (REC) scheme, which is designed to drive investment in low-carbon energy projects. The Ministry of New and Renewable Energy (MNRE)provides 70 percent subsidy on the installation cost of a solar photovoltaic power plant in North-East states and 30 percentage subsidy on other regions. The detailed outlay of the National Solar Mission highlights various targets set by the government to increase solar energy in the country's energy portfolio.

WIND ENERGY PROGRAMME IN INDIA

The Wind power programme in India was initiated towards the end of the Sixth Plan, in 1983-84. A market-oriented strategy was adopted from inception, which has led to the successful commercial development of the technology. The broad based National programme includes wind resource assessment activities; research and development support; implementation of demonstration projects to create awareness and opening up of new sites; involvement of utilities and industry; development of infrastructure capability and capacity for manufacture, installation, operation and maintenance of wind electric generators; and policy support. The programme aims at catalyzing commerciali-sation of wind power generation in the country. The Wind Resources Assessment Programme is being implemented through the State Nodal Agencies, Field Research Unit of Indian Institute of Tropical Meteorology (IITM-FRU) and Center for Wind Energy Technology (C-WET).

Wind in India are influenced by the strong south-west summer monsoon, which starts in May-June, when cool, humid air moves towards the land and the weaker north-east winter monsoon, which starts in October, when cool, dry sir moves towards the ocean. During the period march to August, the winds are uniformly strong over the whole Indian Peninsula, except the eastern peninsular coast. Wind speeds during the period November to march are relatively weak, though higher winds are available during a part of the period on the Tamil Nadu coastline. A notable feature of the Indian programme has been the interest among private investors/ developers in setting up of commercial wind power projects. The gross potential is 48,561 MW (source C-wet) and a total of about 14,158.00 MW of commercial projects have been established until March 31, 2011. The break-up of projects implemented in prominent wind potential states (as on March 31, 2011) is as given below.

State-wise Wind Power Installed Capacity in India

State	Gross Potential (MW)	Total Capacity (MW)till 31.03.11
Andhra Pradesh	8968	200.2
Gujarat	10,645	2175.6
Karnataka	11,531	1730.1
Kerala	1171	32.8
Madhya Pradesh	1019	275.5
Maharashtra	4584	2310.7
Orissa	255	-
Rajasthan	4858	1524.7
Tamil Nadu	5530	5904.4
Others		4
Total (All India)	**48,561**	**14,158**

*Recently revised by state Government to 5200 MW

Wind power potential has been assessed assuming 1% of land availability for wind farms requiring @12 ha/MW in sites having wind power density in excess of 200 W/sq.m. at 50 m hub-height.

State-Wise Cumulative Wind Generation Data in (BU) (As on 31.01.2011)

S.No.	Name of the State	Upto 2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	Up to Jan. 2011	Cumulative
1	Andhra Pradesh	0.721	0.079	0.111	0.101	0.333	.106	.067	**1.518**
2	Gujarat	1.332	0.286	0.455	0.851	2.104	2.988	2.309	**10.325**
3	Karnataka	1.409	0.935	1.397	1.840	1.723	2.895	2.362	**12.561**
4	Kerala	0.047	0.000	0.000	0.000	0.000	.065	.059	**0.171**
5	Madhya Pradesh	0.300	0.030	0.070	0.069	0.003	.082	.039	**0.593**
6	Maharashtra	2.650	0.790	1.714	1.804	2.207	2.778	2.368	**14.311**
7	Rajasthan	0.494	0.427	0.532	0.682	0.758	1.127	1.049	**5.069**
8	Tamil Nadu	11.970	3.444	5.268	6.066	6.206	8.146	8.017	**49.117**
	Total	**18.925**	**5.991**	**9.547**	**11.413**	**13.334**	**18.187**	**16.270**	**93.665**

Installed Capacity per state (MW)

State	March 2011	March 2010	March 2009	March 2008	March 2007	March 2006
Tamilnadu	5904.4	4907	4304.5	3873.4	3492.7	2894.6
Karnataka	1730	1473	1327.4	1011.4	821.1	584.5
Maharashtra	2310.8	2078	1938.9	1755.9	1487.7	1001.3
Rajasthan	1524.8	1088	738.4	538.8	469.8	358.1
Andhra Pradesh	200.2	236	122.5	122.5	122.5	121.1
Madhya Pradesh	275.5	229	212.8	187.7	57.3	40.3
Kerala	32.8	28	27.0	10.5	2	2
Gujarat	2175.5	1864	1566.5	1252.9	636.6	338
Others	0	4	1.1	1.1	1.1	1.1
Total	**14158**	**11807**	**10242.3**	**8754.0**	**7090.8**	**5341**

THE ENERGY CONSERVATION BUILDING CODE

The Energy Conservation Building Code (ECBC), launched on 28 June 2007, is a document that specifies the energy performance requirements for all commercial buildings that are to be constructed in India. Buildings with an electrical connected load of 500 kW or more are covered by the ECBC.

The ECBC was developed by an Expert Committee, set up by India's Bureau of Energy Efficiency, with support and guidance from United States Agency for International Development (USAID) and significant inputs from various other stakeholders such as practicing architects, consultants, educational institutions and other government organizations.

The successful implementation of the code requires development of compliance procedures (compliance forms and development of field-test compliance forms and procedures), in addition to building capacity of architects/designers/builders/contractors and government official in States and Urban and Local Bodies (ULBs). It is also dependent on availability of materials and equipment that meet or exceed performance specifications specified in ECBC.

BEE with the support of USAID ECO- III Project is promoting ECBC awareness and voluntary adoption through training and capacity building programmes, pilot demonstration projects, and identifying steps for compliance check and monitoring of ECBC. ECBC User Guide was developed to support ECBC implementation by providing detailed guidance to the users on how to comply with the Code. Four ECBC tip sheets on Energy Simulation, Building Envelope, Lighting Design and HVAC are also available and provide useful information on Code compliance at the system level and through Whole Building Performance approach that require knowledge of energy simulation to model the proposed building.

The ECBC provides design norms for:

- Building envelope, including thermal performance requirements for walls, roofs, and windows;
- Lighting system, including daylighting, and lamps and luminaire performance requirements;
- HVAC system, including energy performance of chillers and air distribution systems;
- Electrical system; and
- Water heating and pumping systems, including requirements for solar hot-water systems.

The code provides three options for compliance:

1. Compliance with the performance requirements for each subsystem and system;
2. Compliance with the performance requirements of each system, but with tradeoffs between subsystems; and
3. Building-level performance compliance.

During the development of ECBC, analysis conducted through energy simulation indicated that ECBC-compliant buildings may use 40 to 60% less energy than similar buildings being designed and constructed at that time.

NUCLEAR POWER IN INDIA

Nuclear power is the fourth-largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. As of 2010, India has 20 nuclear reactors in operation in six nuclear power plants, generating 4,780 MW while seven other reactors are under construction and are expected to generate an additional 5,300 MW.

In October 2010, India drew up "an ambitious plan to reach a nuclear power capacity of 63,000 MW in 2032". However, especially since the March 2011 Japanese Fukushima nuclear disaster, "populations around proposed Indian NPP sites have launched protests that are now finding resonance around the country, raising questions about atomic energy as a clean and safe alternative to fossil fuels". Assurances by Prime Minister Manmohan Singh that all safety measures will be implemented, have not been heeded, and there have thus been mass protests against the French-backed 9900 MW Jaitapur Nuclear Power Project in Maharashtra and the 2000 MW Koodankulam Nuclear Power Plant in Tamil Nadu. The state government of West Bengal state has also refused permission to a proposed 6000 MW facility near the town of Haripur that intended to host six Russian reactors.

A Public Interest Litigation (PIL) has also been filed against the government's civil nuclear program at the apex Supreme Court. The PIL specifically asks for the "staying of all proposed nuclear power plants till satisfactory safety measures and cost-benefit analyses are completed by independent agencies".

India is involved in the development of nuclear fusion reactors through its participation in the ITER project and is a global leader in the development of thorium-based fast breeder reactors.

Nuclear fuel Reserves

India's domestic uranium reserves are small and the country is dependent on uranium imports to fuel its nuclear power industry. Since early 1990s, Russia has been a major supplier of nuclear fuel to India. Due to dwindling domestic uranium reserves, electricity generation from nuclear power in India declined by 12.83% from 2006 to 2008. Following a waiver from the Nuclear Suppliers Groupin September 2008 which allowed it to commence international nuclear trade, India has signed bilateral deals on civilian nuclear energy technology cooperation with several other countries, includingFrance, the United States, the United Kingdom, Canada and South Korea. India has also uranium supply agreements with Russia, Mongolia, Kazakhstan, Argentina and Namibia. An Indian private company won a uranium exploration contract in Niger.

Large deposits of natural uranium, which promises to be one of the top 20 of the world's reserves, have been found in the Tummalapalle belt in the southern part of the Kadapa basin in Andhra Pradeshin March 2011. The Atomic Minerals Directorate for Exploration and Research (AMD) of India, which explores uranium in the country, has so far discovered 44,000 tonnes of natural uranium (U3O8) in just 15 km of the 160-kilometre-long belt.

Nuclear agreements with other nations

The nuclear agreement with USA led to India issuing a Letter of Intent for purchasing 10,000 MW from the USA. However, liability concerns and a few other issues are preventing further progress on the issue.

Russia has an ongoing agreement of 1988 vintage with India regarding establishing of two VVER 1000 MW reactors (water-cooled water-moderated light water power reactors) at Koodankulam in Tamil Nadu.[J]A 2008 agreement caters for provision of an additional four third generation VVER-1200 reactors of capacity 1170 MW each. Russia has assisted in India's efforts to design a nuclear plant for itsnuclear submarine. In 2009, the Russians stated that Russia would not agree to curbs on export of sensitive technology to India. A new accord signed in Dec 2009 with Russia gives India freedom to proceed with the closed fuel cycle, which includes mining, preparation of the fuel for use in reactors, and reprocessing of spent fuel.

France was the first country to sign a civilian nuclear agreement with India on 30 September 2008 after the complete waiver provided by the NSG. During the December 2010 visit of the French President Nicholas Sarkozy to India, framework agreements were signed for the setting up two third-generation EPR reactors of 1650 MW each at Jaitapur, Maharashtra by the French company Areva. The deal caters for the first set of two of six planned reactors and the supply of nuclear fuel for 25 years. The contract and pricing is yet to be finalised. Construction is unlikely to start before 2014 because of regulatory issues and difficulty in sourcing major components from Japan due to India not being a signatory to the Nuclear Non-Proliferation Treaty. India and Mongolia signed a crucial civil nuclear agreement on 15 Jun 2009 for supply of Uranium to India, during Prime Minister

Manmohan Singh's visit to Mongolia making it the fifth nation in the world to seal a civil nuclear pact with India. The MoU on "development of cooperation in the field of peaceful uses of radioactive minerals and nuclear energy" was signed by senior officials in the department of atomic energy of the two countries.

On 02 September 2009, India and Namibia signed five agreements, including one on civil nuclear energy which allows for supply of Uranium from the African country. This was signed during President Hifikepunye Pohamba's five-day visit to India in May 2009. Nambia is the fifth largest producer of uranium in the world. The Indo-Namibian agreement in peaceful uses of nuclear energy allows for supply of Uranium and setting up of nuclear reactors.

On 14 Oct 2009, India and Argentina signed an agreement in New Delhi on civil nuclear cooperation and nine other pacts to establish strategic partnership. According to official sources, the agreement was signed by Vivek Katju, Secretary in the Ministry of External Affairs and Argentine foreign minister Jorge Talana. Taking into consideration their respective capabilities and experience in the peaceful uses of nuclear energy, both India and Argentina have agreed to encourage and support scientific, technical and commercial cooperation for mutual benefit in this field.

The Prime Ministers of India and Canada signed a civil nuclear cooperation agreement in Toronto on 28 Jun 2010 which when all steps are taken, will provide access for Canada's nuclear industry to India's expanding nuclear market and also fuel for India's reactors. Canada is the world's largest exporter of Uranium and the two countries are the only users of heavy water nuclear technology.

On April 16, 2011, India and Kazakhstan signed an inter-governmental agreement for Cooperation in Peaceful Uses of Atomic Energy, that envisages a legal framework for supply of fuel, construction and operation of atomic power plants, exploration and joint mining of uranium, exchange of scientific and research information, reactor safety mechanisms and use of radiation technologies for healthcare. PM Manmohan Singh visited Astana where a deal was signed. After the talks, the Kazakh President Nazarbaev announced that his country would supply India with 2100 tonnes of uranium and was ready to do more. India and Kazakhstan already have civil nuclear cooperation since January 2009 when Nuclear Power Corporation of India Limited (NPCIL) and Kazakh nuclear company Kaz Atom Prom signed an MoU during the visit of Nazarbaev to Delhi. Under the contract, Kaz Atom Prom supplies uranium which is used by Indian reactors.

South Korea became the latest country to sign a nuclear agreement with India after it got the waiver from the Nuclear Suppliers' Group (NSG) in 2008. On 25 July 2011 India and South Korea signed a nuclear agreement on Monday which will allow provides South Korea with a legal foundation to participate in India's nuclear expansion program, and to bid for constructing nuclear power plants in India.

Nuclear power growth in India

India now envisages to increase the contribution of nuclear power to overall electricity generation capacity from 2.8% to 9% within 25 years. By 2017, India's installed nuclear power generation capacity will increase to 10,080 MW. As of 2009, India stands 9th in the world in terms of number of operational nuclear power reactors. Indigenous atomic reactors include TAPS-3, and -4, both of which are 540 MW reactors. India's US$717 million fast breeder reactor project is expected to be operational by 2012-13.

The Indian nuclear power industry is expected to undergo a significant expansion in the coming years thanks in part to the passing of the U.S.-India Civil Nuclear Agreement. This agreement will allow India to carry out trade of nuclear fuel and technologies with other countries and significantly enhance its power generation capacity. When the agreement goes through, India is expected to generate an additional 25,000 MW of nuclear power by 2020, bringing total estimated nuclear power generation to 45,000 MW.

India has already been using imported enriched uranium for light-water reactors that are currently under IAEA safeguards, but it has developed other aspects of the nuclear fuel cycle to support its reactors. Development of select technologies has been strongly affected by limited imports. Use of heavy water reactors has been particularly attractive for the nation because it allows Uranium to be burnt with little to no enrichment capabilities. India has also done a great amount of work in the development of a thorium centered fuel cycle. While Uranium deposits in the nation are limited (see next paragraph) there are much greater reserves of thorium and it could provide hundreds of times the energy with the same mass of fuel. The fact that thorium can theoretically be utilized in heavy water reactors has tied the development of the two. A prototype reactor that would burn Uranium-Plutonium fuel while irradiating a thorium blanket is under construction at the Madras/Kalpakkam Atomic Power Station.

Uranium used for the weapons program has been separate from the power program, using uranium from indigenous reserves. This domestic reserve of 80,000 to 112,000 tons of uranium (approx 1% of global uranium reserves) is large enough to supply all of India's commercial and military reactors as well as supply all the needs of India's nuclear weapons arsenal. Currently, India's nuclear power reactors consume, at most, 478 tonnes of uranium per year. Even if India were quadruple its nuclear power output (and reactor base) to 20 GW by 2020, nuclear power generation would only consume 2000 tonnes of uranium per annum. Based on India's known commercially viable reserves of 80,000 to 112,000 tons of uranium, this represents a 40–50 years uranium supply for India's nuclear power reactors (note with reprocessing and breeder reactor technology, this supply could be stretched out many times over). Furthermore, the uranium requirements of India's Nuclear Arsenal are only a fifteenth (1/15) of that required for power generation (approx. 32 tonnes), meaning that India's domestic fissile material supply is more than enough to meet all needs for it strategic nuclear arsenal. Therefore, India has sufficient uranium resources to meet its strategic and power requirements for the foreseeable future.

Nuclear Power Plants

Currently, twenty nuclear power reactors produce 4,780.00 MW (2.9% of total installed base).

Power Station	Operator	State	Type	Units	Total capacity (MW)
Kaiga	NPCIL	Karnataka	PHWR	220 x 4	880
Kakrapar	NPCIL	Gujarat	PHWR	220 x 2	440
Kalpakkam	NPCIL	Tamil Nadu	PHWR	220 x 2	440
Narora	NPCIL	Uttar Pradesh	PHWR	220 x 2	440
Rawatbhata	NPCIL	Rajasthan	PHWR	100 x 1 200 x 1 220 x 4	1180
Tarapur	NPCIL	Maharashtra	BWR (PHWR)	160 x 2 540 x 2	1400
			Total	**20**	**4780**

The projects under construction are:

Power station	Operator	State	Type	Units	Total capacity (MW)
Kudankulam	NPCIL	Tamil Nadu	VVER-1000	1000 x 2	2000

Kalpakkam	BHAVINI	Tamil Nadu	PFBR	500 x 1	500
Kakrapar	NPCIL	Gujarat	PHWR	700 x 2	1400
Rawatbhata	NPCIL	Rajasthan	PHWR	700 x 2	1400
Banswara	NPCIL	Rajasthan	PHWR	700 x 2	1400
			Total	**9**	**6700**

Accidents

Nuclear power plant accidents in India

Date	Location	Description	Cost (in millions 2006 US$)
4 May 1987	Kalpakkam, Tamil Nadu, India	Fast Breeder Test Reactor at Kalpakkam refueling accident that ruptures the reactor core, resulting in a two-year shutdown.	300
10 September 1989	Tarapur, Maharashtra, India	Operators at the Tarapur Atomic Power Station find that the reactor had been leaking radioactive iodine at more than 700 times normal levels. Repairs to the reactor take more than a year.	78
13 May 1992	Tarapur, Maharashtra, India	A malfunctioning tube causes the Tarapur Atomic Power Station to release 12 curies of radioactivity.	2
31 March 1993	Bulandshahr, Uttar Pradesh, India	The Narora Atomic Power Station suffers a fire at two of its steam turbine blades, no damage to the reactor. All major cables burnt.	220
2 February 1995	Kota, Rajasthan,	The Rajasthan Atomic Power Station leaks radioactive helium and heavy water into the Rana Pratap Sagar dam, necessitating a two-year shutdown for repairs.	280
22 October 2005	Kalpakkam,	Almost 100 kg radioactive sodium at a fast breeder reactor leaks into a purification cabin, ruining a number of valves and operating systems.	30

It is estimated that before the accident at Tarapur, lack of proper maintenance exposed more than 3000 Indian personnel to "very high" and "hazardous" radiation levels. Researchers at the American University calculated at least 124 "hazardous incidents" at nuclear plants in India between 1993 and 1995.

ANTI-NUCLEAR PROTESTS

Following the Fukushima disaster, many are questioning the mass roll-out of new plants in India, including the World Bank, the former Indian Environment Minister, Jairam Ramesh, and the former head of the country's nuclear regulatory body, A. Gopalakrishnan. The massive Jaitapur Nuclear

Power Project is the focus of concern — "931 hectares of farmland will be needed to build the reactors, land that is now home to 10,000 people, their mango orchards, cashew trees and rice fields" — and it has attracted many protests. Fishermen in the region say their livelihoods will be wiped out.

Environmentalists, local farmers and fishermen have been protesting for months over the planned six-reactor nuclear power complex on the plains of Jaitapur, 420 km south of Mumbai. If built, it would be one of the world's largest nuclear power complexes. Protests have escalated in the wake of Japan's Fukushima I nuclear accidents. During two days of violent rallies in April 2011, a local man was killed and dozens were injured.

As of October 2011, thousands of protesters and villagers living around the Russian-built Koodankulam nuclear plant in the southern Tamil Nadu province, are blocking highways and staging hunger strikes, preventing further construction work, and demanding its closure as they distrust federal government assurances regarding safety. They fear there will be a nuclear accident similar to the radiation leak in March at Japan's Fukushima nuclear disaster.

A Public Interest Litigation (PIL) has also been filed against the government's civil nuclear program at the apex Supreme Court. The PIL specifically asks for the "staying of all proposed nuclear power plants till satisfactory safety measures and cost-benefit analyses are completed by independent agencies".

JAWAHARLAL NEHRU NATIONAL SOLAR MISSION

INTRODUCTION

India is an energy starved country whose economy is growing at a breakneck speed. The current installed generation capacity is about 162 GW which, with high T&D losses, translates into a peak time shortage of 12.7% and this is the situation when more than 400 million Indians still don't have access to electricity. India currently faces a threefold challenge of meeting the current demand, fighting climate change and attaining energy security. This implies that nuclear power and renewables would play a very crucial role in India. India unfortunately has very limited potential for wind power and that for geothermal is still unknown, but luckily India gets good sun fall almost all through the year. Solar power in India has huge potential and it is environment friendly as it has zero emissions while generating and is obviously the most secure.

Importance and Relevance of Solar Power in India

Cost of power: The solar panels available in the market today are very costly which makes the initial investment required very high, which in turn makes it prohibitive in a poor country like India. JNNSM aims at bringing this cost of power to grid parity by 2022 and at par with coal based power plants by 2030. But this would require global investments in R&D at a very large scale. Although it is a costly alternative for now, but going forward, with the progress in technology its cost will come down. Contrasting this aspect of solar with that of coal makes it a clear favourite as the cost of producing electricity using coal will only go higher as mineral reserves deplete in India and then we would be forced to import most of the total requirement, which will come a further higher price. Couple these with some major investments in developing the required infrastructure for importing coal and the transportation cost involved and we get to understand that solar has now become is inevitable.

Scalability: India is blessed with a huge and still untapped potential in terms of solar power as it receives high insolation. We get about 300 clear and bright sunny days per year, receive 4-7 kWh per square meter per year i.e. 1500-1700 kWh/m2/p.a. adding upto 5 zillion kWh per year. This potential, even at 10% conversion rate would mean an availability which is many times more than what India may need. The only concern regarding scalability is the availability of space as megawatt size plants occupy a lot of land. The size of land may vary according to the intensity of sun in the area of the plant (as per an estimate by Tata BP Solar, generating 100 MW in Delhi would require about 500 acres of land for much less in Rajasthan). The following solar map shows the region wise levels of insolation in India.

A Distributed Source of Energy: The solar form of energy provides the opportunity to generate power on a distributed basis enabling rapid generating capacity addition with very short lead times. It becomes much more important in case of countries like India which have poor T&D infrastructure.

Reaching Out to the Rural India: Solar power is very useful especially from the rural electrification point of view. In India, hundreds of millions of rural consumers are still not connected to the grid, and ones connected either don't receive quality supply or get no supply at all. Solar power has the capacity to completely revolutionize the prevalent scenario and change the living standards in the remote villages of India by efficiently meeting the electricity and heating needs of the people out there.

Environmental Impact: The best thing about solar is that it's environmentally benign as it produces no carbon or greenhouse gases or any other toxic waste while generating, doesn't burn oil, coal or gas to generated electricity. In addition to these, at solar power plants there are no chances of an environmentally devastating accident. In fact, the only pollutant which factors into solar power are those involved in the construction and transportation of its component parts. Implementing solar on a large scale would reduce India's carbon footprint to a tiny fraction of its current levels.

Security of Source: Energy security is very high on our national agenda and we are working very hard with our global partners to diversify the source of the resources that we use to generate the requisite amount of energy to run our economy. Solar is the most secure of all known resources. It may not be the cheapest source of energy as of now, unlike coal, but it is, and will always be, available in abundance and is waiting to be exploited. It is one source of energy we will never run out of, one source of energy which will always be available with us irrespective of how the geopolitics changes.

Jawaharlal Nehru National Solar Mission

The Jawaharlal Nehru National Solar Mission (JNNSM) was launched by the Prime Minister, on January 11 2010, under the National Action Plan for Climate Change (NAPCC) with the aim of promoting an eco friendly and sustainable growth while marching towards energy security for the nation and enhancing India's contribution to meet the global challenge of climate change. It aims at establishing India as a world leader in solar energy by creating policy conditions conducive to stimulate investments in installation and R&D.

Objectives and Targets

The objective of JNNSM is to transform India into a global leader in solar power by spreading awareness and promoting investments with the help of policies which encourage such initiatives. The National Solar Mission has set a target of generating 22,000 MW in 3 phases, 20,000 MW for grid-connected 2000 MW for off-grid applications. The first phase spans from the remaining period of the11th Plan at the time of launch and first year of the 12th Plan (up to 2012-13), the 2nd phase would be the remaining 4 years of the 12th Plan (2013-17) and the 13th Plan (2017-22) would be the 3rd Phase. There are provisions for mid-term evaluation of the progress made, review of capacity and targets of the subsequent phase according to the perceived cost and technological progress.

The first phase of the mission is focussing on two aspects: promoting off grid system applications and a modest capacity addition in the grid. And the second phase would target on aggressive capacity addition and improving the solar penetration. The targets stated in the JNNSM are:

To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.

To ramp up capacity of grid-connected solar power generation to 1000 MW within three years – by 2013; and an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff. This capacity can be more than doubled reaching 10,000MW installed power by 2017 or more, based on the enhanced and enabled international finance and technology transfer.

To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.

To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022 To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022. To deploy 20 million solar lighting systems for rural areas by 2022.

Source: JNNSM mission document

Mission strategy Phase 1

The first phase (up to march 2013) of the mission targets majorly on two aspects,

1. Off-grid and Decentralized applications
2. Capacity addition to the grid

It provides an enabling framework to support entrepreneurs in order to develop markets. Supporting viable business models to enhance the spirit of investors is another focus in this phase. The success of the scheme depends big time on the flexibility factor that it has incorporated as the market is currently demand-driven, and that is why it offers a wide range of incentives where an interested investor can tailor the best suited package as per his/her requirements.

Off-grid and Decentralized Solar Applications

The off-grid applications include meeting energy requirements both in the form of electricity and heat. The main objectives of this section of the scheme are:

- To promote off-grid applications for meeting the targets set in the JNNSM.
- To create awareness about the usage of solar systems
- To encourage and promote sustainable business models
- To support channel partners and potential beneficiaries
- To organize consultancy services and seminars, awareness campaigns.
- To help replace kerosene and diesel, wherever possible

Various off-grid SPV applications which have a maximum capacity of 100 kWp per site and decentralized solar thermal applications are eligible for being covered in this scheme. Even mini-grids for rural electrification with applications upto 250 kW stand to benefit from it. To help promote technology upgradation and expansion in production facilities soft loans would be made available to SME manufacturers through Indian Renewable Energy Development Agency (IREDA). Various channel partners are being used for facilitating faster implementation and minimizing transaction cost and time. These channels are:

- RESCOs (renewable energy service providing companies): These companies install, own and operate the renewable energy systems.
- Financial and Microfinance institutions: These institutions are mainly into providing loans to the consumer and accessing the interest subsidies through refinancing.
- Financial Integrators: These firms serve the manufactures and service providers by integrating different sources of finance available for them.
- System Integrators: These entities are the ones which provide design, supply, integration and installation and O&M to the clients.
- Programme Administrators: Administrators include central and state ministries and departments, state nodal agencies, utilities, PSUs and reputed NGOs. These bodies are responsible for implementing the scheme.

Funding Patterns

Because of the high set up cost, proper funding arrangements are of crucial importance in order to build an encouraging environment for solar generation. Funding is available in two modes:

A. Project Mode: To avail the facilities through this mode there needs to be a project report and monitoring arrangements. The project report would, inter alia, include client details, technical and financial details and O&M specifications. The total cost is funded through a mix of debt & equity, where promoter's equity contribution has to be at least 20%. MNRE provides a combination of 30% subsidy and/or 5% interest bearing loans. Further a benchmark project cost is worked out by the MNRE, on which a capital subsidy of 60% is given. However, in case of special category states like north eastern states, Himachal Pradesh and Uttarakhand, 90% subsidy would be given. These subsidies can be accessed only by the 'Programme Administrators'.

B. Market Mode: Through market mode different 'Channel Partners' are enabled to access various capital subsidies and soft loans. The channel partners would tie up with some lending institutions and these lenders would get into an agreement of refinance with IREDA, then IRDEA gets fund handling charges by MNRE at the rate of 2%.

INCENTIVES

Although, off-grid connections are meant for personal or small scale users, it does take off the burden of generation and distribution to quite an extent. Apart from this, using solar energy to either supplement or complement one's energy requirements helps in fighting climate change and reducing country's carbon footprint. So it makes sense to promote its usage and so a slew of incentives have been announced to encourage the potential investors for participation. These benefits are provided in forms of RE vouchers, capital subsidies, interest subsidies and green energy bonds.

RELEASE OF FUNDS

Release of funds under JNNSM is conducted in two ways. For the projects which are to be developed by administrators (government ministries, PSUs and NGOs), fund release could be front-ended, it would be done in two instalments, 70% on sanction and 30% on completion. Release of funds in case of private channel partners would be back-ended i.e. it will be in the form of reimbursement of the cost incurred and would be given after a proper verification of completion and efficiency of the project.

ADDING GENERATION CAPACITY

The second objective of the first phase of JNNSM is to add capacity to the grid by installing both 'Large PV and thermal plants' as well as 'Small and Rooftop PV systems'. In order to facilitate generation, a concept of 'Bundled Power' has been introduced, which means that the costly power generated through solar plants would be bundled with the cheaper power available under the unallocated quota of the MoP generated at NTPC coal based plants. And this bundled power would then be sold to the distributors at a price determined by CERC. NVVN would act as the nodal agency for procuring the power generated from solar plants through PPAs. The objectives of these bundled power related guidelines are to:

- Facilitate quick start up of the JNNSM
- Ensure serious participation from investor for its projects
- Expedite implementation of the projects
- Boost the confidence of the potential developers
- Promote the solar manufacturing industry

The projects under the grid connected system are broadly divided in to two categories: rooftop & small solar plants and large solar power plants.

A. Rooftop and other small solar power plants

The projects under this scheme are those which are meant for very small scale generation and can further be categorized in two types.

a) Projects connected at HT level: Those projects whose generation capacity is between 100 kW and 2 MW and is connected to the grid at HT level (below 30 kV) will fall under this category. The envisaged capacity addition in the first phase through these plants is 90 MW.

b) Projects connected at LT level: The projects which have a capacity less than 100 kW and are connected to the grid at LT level will come under this category. These plants are expected to add 10 MW in the first phase.

Roles and Responsibilities of various entities for projects under this category:

- State governments: State governments are required to designate a competent authority which would be empowered to issue pre-registration certificates. These certificates are required for being registered with the programme administrator(s) and reporting on progress of implementation of projects.
- State Distribution Utilities: The state utilities would have to buy power from the developers

under PPA at a tariff decided by the concerned SERCs, and would have to make the necessary arrangements for evacuation of power. Utilities are also responsible for providing 'Certificate of Power Purchased' to the programme administrator on a monthly basis.

- Programme Administrators: For these projects, IREDA would act as a 'Programme Administrator'. IREDA will be responsible for registration of projects seeking GBI (Generation Based Incentives), maintenance of progress reports of projects, issuing certificates conforming GBI and disbursement of GBI to the distributors.

Large Solar Power Plants

This category includes power plants which have large generation capacity ranging from 5 MW to 100 MW and would connect to the transmission substation at 33 kV and above. Projects under this category can be subcategorized in two types:

a) **Solar PV Projects:** PV projects would have a capacity of 5 MW with a variation of ±5%. To promote local manufacturing of solar products, it's been made mandatory for these projects to procure components locally from 2011-12 onwards.

b) **Solar Thermal Projects:** The minimum capacity of the thermal projects would be 5 MW while the maximum would be 100 MW. And these projects are expect to make 30% of the procurement locally, excluding land.

Penalties for Delays:

In order to ensure quick implementation in order to achieve the targets set for the first phase, several disincentives for delays have been proposed in the JNNSM. Solar PV plants should be commissioned within 12 months of signing the PPA, while in case of solar thermal plants it is 28 months. Any delay in the commissioning and NVVN would start to encash the performance bank guarantee deposited by the developers. Following is the manner in which these guarantees would be encashed:

- Delay of upto 1 month: NVVN would encash 20%
- Delay of more than 1 month and upto 2 months: NVVN would encash 40%
- Delay of more than 2 months and upto 3 months: NVVN would encash all of the remaining.

Role of State Governments:

State government would play a very crucial role in the development of large solar plants. They would the responsible for appointing a state level agency to facilitate speedier implementation of the projects. State government will provide support to the developers in providing better access to the site area, land acquisition, water allocation and connectivity to the transmission substation.

The Road Beyond Phase 1

JNNSM has appreciated the need and importance of keeping the targets and policies flexible in a demand-driven market so as to be able to incorporate the best possible option available at any time. It clearly stipulates that the targets and guidelines of any subsequent phase would be based upon the learnings from the previous ones, evolving changes and other anticipated factors.

Solar Manufacturing in India

India is well endowed to take a global leadership position in solar, it has already built a PV manufacturing capacity of 700 MW and is growing rapidly. To further this pace of growth certain measures are being recommended. For example, zero import duty on raw materials, low interest rate loans, incentives under SIPs, single window clearance facility and creating a few solar manufacturing tech parks which will consist of manufacturing unit, research institutes, offices and housing. These would help the nation in gaining an edge over all the competitors and enable us to make the most the opportunities available.

Research and Development

Major R&D programmes are about to be launched in India which would focus on bringing the cost down, improving the efficiency of the existing system, testing hybrid generation, developing cost effective storage and improving the space intensity. These programmes in R&D will deal with five categories:

I. Basic research focussing on long term aspect of innovation
II. Applied research based on improving the existing system
III. Technology validation & demonstration
IV. Development of R&D infrastructure
V. Support for incubation and start ups

Human Resource Development

With the rapid expansion expected in the solar energy sector, there would be a huge demand for skilled manpower and it would include engineering, management and R&D. The total estimated workforce required by the end of 2022 is around 1,00,000. To develop such an asset would require some rigorous steps in collaborating with top notch colleges and establishing new ones dedicated to this purpose.

International Collaborations

In order to keep up with the pace the innovations going on around the world and benefitting from them, it's imperative that we collaborate with others and this has been adequately recognized in the policies of MNRE. The collaborations are currently being worked out through joint research and technology transfer and industry partnership. MNRE has made several bilateral and multilateral arrangements with various countries, a research programme with the European Union is being felicitated, bilateral programmes under the Asia Pacific Partnership Programme with Japan and Australia are being implemented. With US also there is a project under implementation which would focus the radiation data collection.

Current Status

Back home the ambitious JNNSM is about to take off, the biddings for the first phase is being carried out, under which projects worth a total capacity of 650 MW would be awarded to 40 of the 350 bidders. CERC has set a price of Rs.17.91 for per unit of PV power and the ones ready to take the biggest discounts will be awarded. In the bidding process, there are three sets of bidders who are likely to emerge winners.

First is the companies who are in manufacturing would be able to go deeper on discounts, big companies are the second group who can afford these rates easily and third group is of the newly formed companies who would be aggressive to get started with.

But just getting the start is not good enough as there would be cases where experienced companies who have implemented similar projects would lose out in the process of bidding. Few days ago, even Tata, the biggest private generation company in India, announced that it would not be bidding for the projects because it thinks that making profit at such high cost would be very difficult.

Such cases would hamper the quality of the very foundation of solar mission. Projects execution done by the companies with financial strength and experience brings long term benefits and quality and these two things are of the essence for something as ambitious as JNNSM.

Conclusion

Using the power of sun to meet our energy requirements has numerous advantages and is harmless to the environment as it allows the user to attain an ecologically sustainable growth and India duly recognizes the potential of this solar energy.

It is reflected by the targets set in JNNSM and the enthusiasm with which it has been launched. India is one of the global leaders in using solar and is making sincere efforts to improve fast and gain substantial generation capacity, but a lot would depend on the success of JNNSM and how the industry takes these opportunities.

Investments in conducting R&D and developing a pool of human resource are critical for the way forward. But all said and done, it's time we looked up to SUN.

ADMINISTRATIVE APPROVAL OF RENEWABLE ENERGY PROGRAMMES

Sector	Programme
Rural Energy	• National Biogas and Manure Management Programme (NBMMP) during 11th Five Year Plan. • Addendum - Inclusion of new models of family type Biogas plants in National Biogas and Manure Management Programme (NBMMP) during 11th Five Year Plan – Administrative Approval – reg. • VESP-Guidelines for Test Projects.
Solar Energy	• Incentives to banks / micro financing institutions to support installation of solar home lighting and other small solar systems through loans in the country during 2010-11. • Solar Thermal Energy Demonstration Programme during 2010-11. • Promotion of Solar Thermal Systems for air heating/steam generating applications, Solar Buildings and Akshay Urja Shops during 2010-11. • Accelerated development and deployment of solar water heating systems in domestic, industrial and commercial sectors during 2010-11 • Technology Evaluation Projects on Large Area Solar Disk Concentrator (Arun-160) for Industrial Process Heat Systems, during 2010-11 • Programme on “Off-grid and Decentralized Solar Applications” for first phase of the Jawaharlal Nehru National Solar Mission (JNNSM) till 31st March, 2013, during 2010-11 • Programme on “Rooftop PV & Small Solar Power Generation Programme” (RPSSGP) for first phase of the Jawaharlal Nehru National Solar Mission (JNNSM) till 31st March 2013, during 2010-11 • Implementation of a Payment Security Scheme (PSS) for Grid connected Solar Power projects under Phase I of Jawaharlal Nehru National Solar Mission (JNNSM) during the year 2011-12 • Amendment/Addition in the Programme on “Off-grid and Decentralized Solar Applications” for implementation during 2011-12"
Power Generation	• Scheme for Implementation of Generation Based Incentives (GBI) for Grid Interactive Wind Power Projects • Small Hydro Power Programme (upto 25 MW Capacity) – for the year 2009-10 & remaining period of 11th Plan • Demonstration Programme on Generation Based Incentive for Grid Interactive Wind Power Projects • Revised Guidelines for Wind Power Projects – self certification regarding • Guidelines for Wind Measurement by Private Sector and subsequent development.

	• Small Wind Energy and Hybrid Systems during 2010-11 and 2011-12 • Biomass Gasifier Programme - Revised guidelines for the implementation during 2010-11 and remaining period of the 11th Plan
Urban Industrial & commercial applications (UICA)	• Programme on Energy Recovery from Urban Wastes for the Year 2011-12 • Programme on Energy Recovery from Municipal Solid Waste for the Year 2011-12 • Programme on Recovery of Energy from Industrial Wastes for the Year 2011-12 • Implementation of the programme on "Development of Solar Cities" during 11th Plan period including 2011-12 • Scheme on Energy Efficiency Solar/Green Buildings during 11th Plan
Remote village Electrification(RVE)	• Remote Village Electrification Programme for the year 2011-12
New Technology Gruop	• New Technology Programmes/Schemes for the Year 2010-2011 • Programme for Implementation of Alternate Fuels for Surface Transportation Programme (AFSTP) for the remaining period of 11th Plan for the years 2010-2011 and 2011-12 (Posted on 12.12.2011).
Planning, R&D Technology Information forcasting, Assessment and Databank	• Non-Conventional Energy Technology Commercialization Fund (NETCOF) • Technology Information Forecasting, Assessment and Databank • Planning & Coordination • International Co-operation • Research & Development Co-ordination • Research & Development in Bio-Energy • HRD Programme in New and Renewable Energy for the remaining period of 11th Five-year Plan • HRD Programme short term technicians training programme on installation, operation maintenance and repair of renewable energy systems to be conducted by SNAs • National Solar Science Fellowship Programme
Information and Public Awareness	• Implementation of Special Area Demonstration Project Scheme during 2010 and remaining period of 11th plan • Seminars and Symposia Programme in New and Renewable Energy for the year 2011-12 • Information & Public Awareness • Information & Public Awareness Programme during 2011-12
National Level monitors (NLMs)	• Implementation of Scheme for Monitoring of Programmes being implemented by MNRE through Independent National Level Monitors (NLMs) on pilot basis for six months
National Institutes of Renewable Energy (NIRE)	• Bio Energy Development Programme for the year 2007-08

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