Overview of
Sustainable Renewable Energy Potential of India

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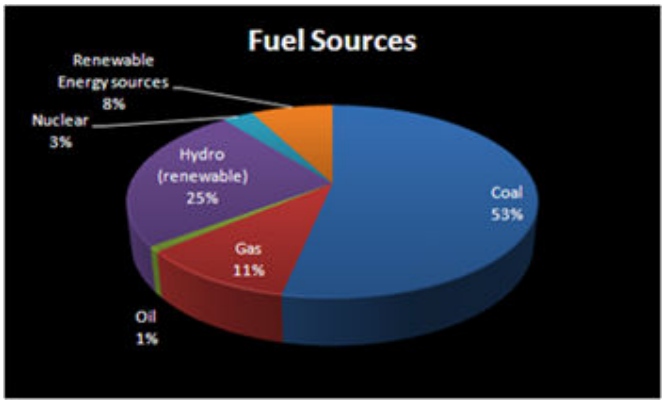
ABSTRACT

Emerging and developing countries have 80% of the world's population but consume only 30% of global commercial energy. As energy consumption rises with increases in population and living standards, the need to expand access to energy in new ways is growing as is the awareness of the environmental costs. Increased recognition of the contribution that renewable energy (RE) can make to energy independence, climate change mitigation, rural development, improved health and lower health costs (linked to air pollution), is shifting RE from the fringe to the mainstream of sustainable development.

India has a vast supply of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy products and systems. Indeed, it is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of Non-Conventional Energy Sources (MNES). Since its formation, the Ministry has launched one of the world's largest and most ambitious programs on renewable energy. Based on various promotional efforts put in place by MNES, significant progress is being made in power generation from renewable energy sources.

India currently has 15,326 MW of installed renewable energy sources as of July 2009 with distribution shown below.



Source: India Energy Data, Statistics and Analysis - Oil, Gas, Electricity, Coal

The key drivers for renewable energy are the following:

- The demand-supply gap, especially as population increases
- A large untapped potential
- Concern for the environment
- The need to strengthen India's energy security
- Pressure on high-emission industry sectors from their shareholders
- A viable solution for rural electrification

Coal is still the major source of electricity. Also, with a commitment to rural electrification, the Ministry of Power has accelerated the Rural Electrification Program with a target of 100,000 villages by 2012.

The Ministry of Power has set an agenda of providing Power to All by 2012. It seeks to achieve this objective through a comprehensive and holistic approach to power sector development envisaging a six level intervention strategy at the National, State, SEB, Distribution, Feeder and Consumer levels.

Introduction

Indian Energy Facts: The economy of India has the second-fastest rate of increase in GDP in the world – 7.1% in 2008. The country accounts for a third of the world's population without access to electricity. Five different ministries have structurally handled the Indian energy sector, among them the Ministry of New and Renewable Energy. India is probably the only country in the world with a dedicated ministry for renewable energy development. The country ranks sixth in the world in terms of total energy consumption and needs to accelerate development of the energy sector to meet its growth aspirations. Though rich in coal and abundantly endowed with renewable energy in the form of solar, wind, hydro and bio-energy, India has very small hydrocarbon reserves (0.4% of the world's total). Being a net importer of energy, more than 35% of the country's primary energy needs are ensured through import.

Unlimited potential for solar PV in India

India is a beautiful country well-known for spicy food, people and long hours of sunshine. Even the hours of sunshine in Spain can by no means compete with, for instance, the State of Rajasthan in India. This State, with between 1800 and 2200 hours of sun each year, is putting together a plan to develop at least 50 MW of PV power plants. And this is only the beginning. The potential for solar PV in Rajasthan, with its vast area of sunny desert, is infinite. And India has many more States with great potential, Gujarat, for example, where a 500 MW plan was commissioned recently. Although the feed-in tariff proposed by the Indian national government is not particularly attractive (15 INR/kWh for 10 years), Indian PV project developers are queuing up. More than three gigawatts of proposals have been submitted. Clearly, many developers recognize the long term potential of this country with its ever increasing GDP.

India's energy challenge

India needs more power day by day because of the increase in demand for power and growing population. Not only to cover its daily power shortfalls, but also to support its economic development. According to CEA, the peak demand in 2008 was 120 gigawatts of power, while only 98 gigawatts could be supplied. According to an analysis by the Indian PV project developer Aston field, quoting the President of India Energy Review, this deficit is likely to grow to 25 gigawatts by 2012. The targeted share of renewable energy is 24% for 2031, with the amount of solar energy increasing to 56 gigawatts of installed power.

The average electricity consumption in India is still among the lowest in the world at just 630 kWh per person per year, but this is expected to grow to 1000 kWh within coming years. Every

month, 8-10 million new mobile phones are connected in India. This is an interesting market segment for solar PV as well: thousands of new GSM poles will be needed across the country.

I. General Information: What are the energy trends in India?

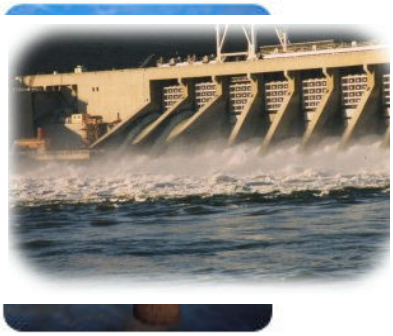
India emerged in 2008 as an aspiring producer of solar PV. Both National and State Governments announced new policies to support solar PV manufacturing in special economic zones, including capital investment subsidies of 20 percent. These policies led to USD 18 billion in new solar PV manufacturing investment plans or proposals by a large number of companies.

The optimum use and development of various forms of energy and making energy available at affordable rates is one of the primary concerns of the Government of India. India's energy supply comes from different sources: coal, hydropower, oil and gas, and various form of non-conventional energy. Looking at the need for an appropriate energy policy to sustain faster and more inclusive growth, the Government of India has recently brought out an Integrated Energy Policy linked with sustainable development that covers all sources of energy and takes into consideration all aspects of energy use and supply, including energy security, access and availability, affordability and pricing, as well as efficiency and environmental concerns. The Policy states that solar power particularly could be an important player in country attaining energy independence in the long run.

India is ranked the third most attractive country to invest in renewable energy, after USA and Germany, in the Ernst and Young Country attractiveness indices.

To better understand the current situation in India and the future of the renewable energies market, it is important to look at the trends in energy consumption, growth of the current grid, and the availability of transportation and equipment used there.

In line with additions to installed capacity, total generation by public utilities increased rapidly, from 5106 GWh in 1950 to 264,231 GWh in 1990/91, registering an annual growth rate of 10.4 percent over this period. Until the 1980s, the growth rate in hydro and thermal generation was comparable, but during the 1980s, hydro generation increased at a rate of only 4.4 percent compared to a growth rate of 11.6 percent in thermal generation.



Since thermal generation is based on burning coal or oil, increases in CO2 emissions, which damage the environment and affect global warming, accompany this growth. As the graph below shows, it also increases the dependence on imports, which will continue into the future unless the policy changes.

a) Energy Generation and Consumption from 2000 to 2008

 # Table: Total Renewable Electricity Net Consumption (Billion Kilowatt-hours)

2000	2001	2002	2003	2004	2005	2006	2007	2008
76.604	76.829	67.777	79.783	89.951	108.817	122.688	135.515	130.568

 # Table: Total Electricity Net Consumption (Billion Kilowatt-hours)

2000	2001	2002	2003	2004	2005	2006	2007	2008
375.394	384.906	403.74	428.18	457.027	483.256	525.372	568.0002	NA

 # Table: Total Electricity Net Generation (Billion Kilowatt-hours)

2000	2001	2002	2003	2004	2005	2006	2007	2008
529.122	549.749	565.277	600.525	630.867	661.801	711.547	761.6742	787.5465

 # Table: Total Renewable Electricity Net Generation (Billion Kilowatt-hours)

2000	2001	2002	2003	2004	2005	2006	2007	2008
76.604	76.829	67.777	79.783	89.951	108.817	122.688	135.515	130.568

 # Table: Total Electricity Installed capacity:

2000	2001	2002	2003	2004	2005	2006	2007	2008
112.1854	122.725	127.013	131.662	137.292	142.932	149.669	158.953	NA

 # Table: Total Renewable Electricity Installed Capacity (Million Kilowatts)

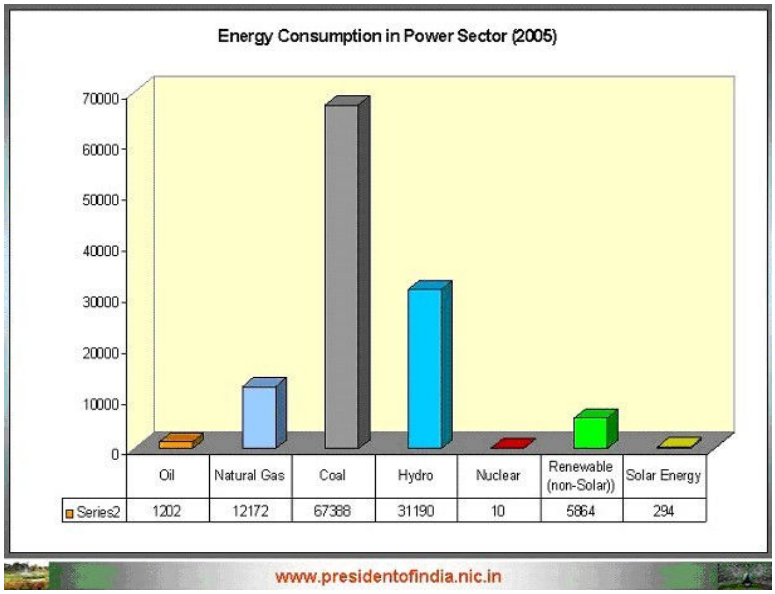
2000	2001	2002	2003	2004	2005	2006	2007	2008
26.81537	28.418	29.314	32.397	34.673	37.676	42.119	44.437	NA

NA=Not available

Source: International Energy Statistics, U.S energy information administration.

b) The breakdown of energy sources for power production of India in 2005

India is a large consumer of coal, which makes up more than 57% of its total consumption.
However, **more than 1/3 of energy consumed comes from renewable resources, predominantly from large hydropower**.



India relies heavily on coal energy to produce electricity. A strong second is hydro power, followed by natural gas. The consumption of all renewable energies represents fully one third of the total consumption. This is a significant figure, and we will see later that this sector has a great future.

Following is a table of the actual plants and installations for producing power based on to renewable energies. We will show that only a small fraction of the potential capacity of renewable energies is currently being tapped.

ACTUAL INSTALLED
RENEWABLE - BASED PLANTS IN INDIA

Source	Units	Installed
Windfarms	MW	557
Windpumps	Nos	3289
Small Hydro (upto 3 MW)	MW	122
Biomass Gasifiers	X 10 6	2.12
Solar PV	kW	825

Capacity exists to shift towards more renewable energy, since only a fraction of the available renewable energy potential has been tapped.

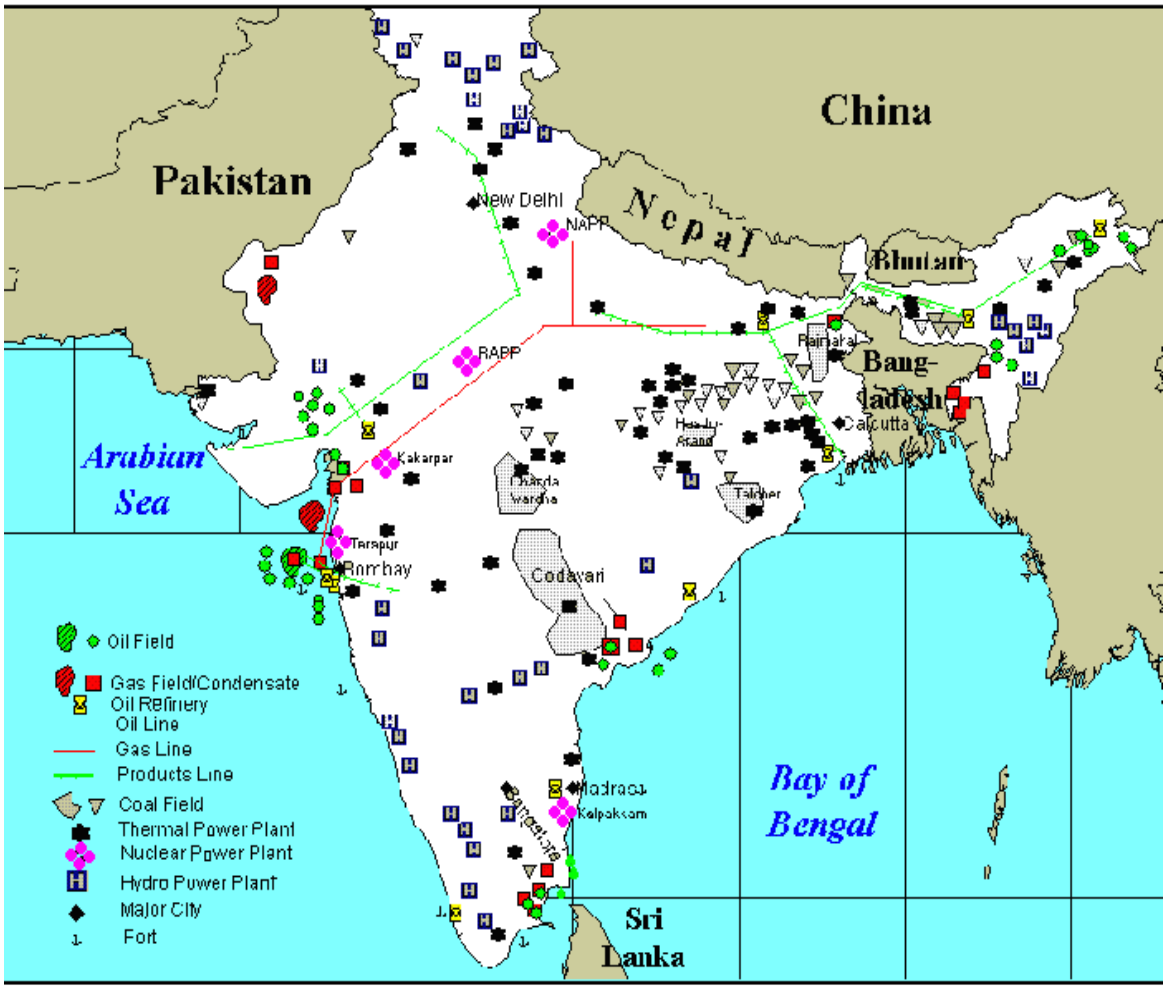
Source: www.greenbusinesscentre.com

c) Distribution of the different kinds of plants and lines of transportation

As mentioned, India relies principally on coal for 57% of total energy consumption. As we can see on the map, coal production is extensive and is located in central and north-eastern parts of the country. Hydro power plants are distributed along the west coast from the southern tip to about ¾ the way up the coast, in the extreme north, and some in the east from rivers flowing from the Himalayas.

Except for the fact that the gas and products line don't extend, the country has the largest railway network in Asia and the second largest in the world under a single management. Roads are taking developmental changes to the most remote corners of the country.

ENERGY MAP OF INDIA

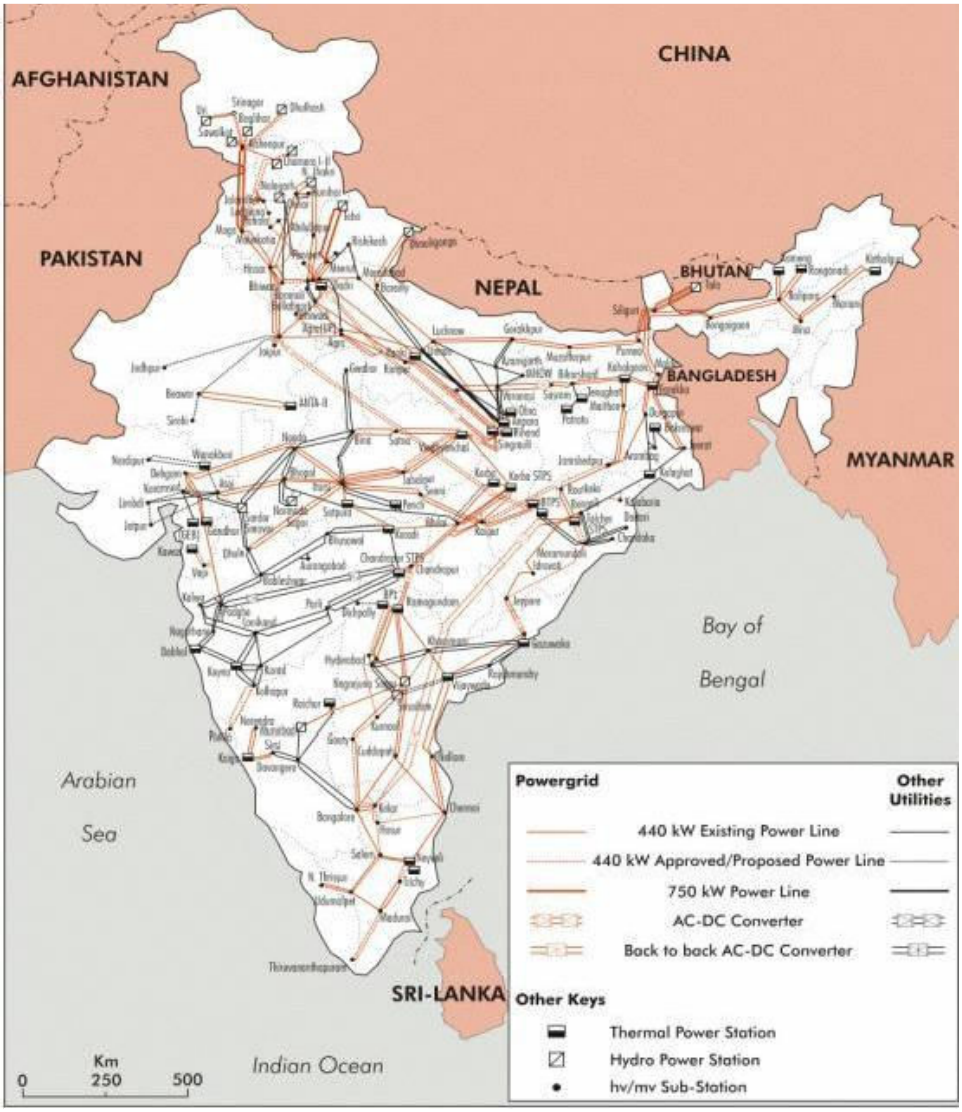


Source: http://www.eia.doe.gov/emeu/cabs/india/indiamap.htm

d) India Energy grid

Transmission of electricity is defined as bulk transfer of power over a long distance at a high voltage, generally of 132 kV and above. In India bulk transmission has increased from 3708 ckm in 1950 to more than 265,000 ckm today. The entire country has been divided into five regions for transmission systems, namely, Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. The interconnected transmission system within each region is also called the regional grid.

Nearly 85% of the villages have been electrified, and there is a nationwide grid for the transmission and distribution of power.



Source: www.geni.org

The electric network is extensive throughout India with 440 kW or 750 kW power lines. The main power grid is still concentrated in the north on a north-west/south-east axis, from Afghanistan to the Bay of Bengal and on a second axis from Bombay on the central west coast to the north-east of India, through Bhutan.

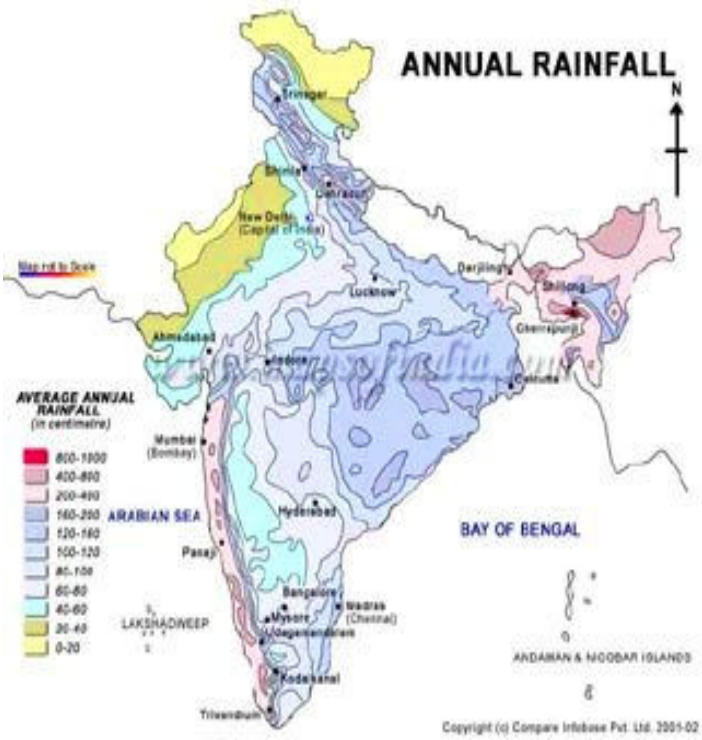
The above map indicates that new 440kW power lines have been approved or proposed to expand the network further. Those proposed lines will be located mainly on the east coast.

The total installed generating capacity in the country in year March 2004 was 1,12,058 MW and the total number of consumers was over 130 million. Apart from an extensive transmission system network at 400 kV, 220 kV, 132 kV and 66 kV which has developed to transmit the power from the generating stations to the grid substations, a vast network of subtransmission and distribution system has also come up for the utilization of the power by the ultimate consumers.

II) Sources of renewable energy available in India: What renewable energies are in the Indian market?

We know where the non renewable energies – coal, oil and gas – are located and how these fuels are transported, combusted, and the power transmitted throughout the country over the power grid. Now, let's look at the renewable energies – hydro, solar, wind and biomass – and see where they are found.

a) Hydro power



The hydroelectric power refers to the energy produced from water (rainfall flowing into rivers, etc). Consequently, rainfall can be a good indicator to investors looking for a location to implement or build a new hydroelectric power plant in India.

It is, in fact, the case, if we compare the map of Annual Rainfall and the "Energy Map of India" on page 6, that hydropower plants are situated in regions of the major rainfall.

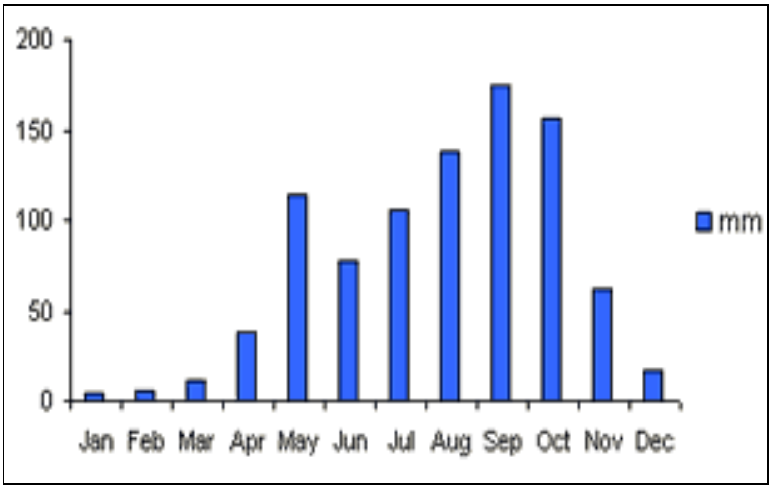
The dominant annual rainfall is located on the north/eastern part of India: Arunachal Pradesh, Assam, Nagaland, Manipur and Mizoram, and also on the west coast between Mumbai (Bombay) and Mahe.

Source: http://www.mapsofindia.com/maps/india/annualrainfall.htm

India utilizes twelve primary hydroelectric power plants: Bihar (3), Punjab, Uttaranchal, Karnataka, Uttar Pradesh, Sikkim, Jammu & Kashmir, Gujarat, and Andhra Pradesh (2).

If we consider the annual rainfall of Bangalore (central south), we see that most of the rainfall occurs from May to November. Consequently, we can predict that hydro energy could be harnessed during the rainy season. Good water management and storage allows for continuous electrical generation throughout the year.

Annual rainfall in Bangalore



Source : http://www.globalsurfers.com/Weather/India.gif

Advantages of Hydro power

In India, small hydro is the most utilized renewable energy source for energy production. Some key figures concerning small hydro in India:

- Less than 25 MW is in the "small hydro" designation
- There is a potential of 15,000 MW
- Installed is 1,520 MW to date
- 4,096 potential sites have been identified
- Technology is mature and reliable
- Two types of technology are used:
  - High-head systems
  - Low-head systems
- Ministry of Non-conventional Energy Sources is focused on:
  - nation-wide resource assessment
  - setting up of commercial projects
  - renovation and modernization
  - development and up-gradation of water mills
  - industry based research and development

b) Solar Energy

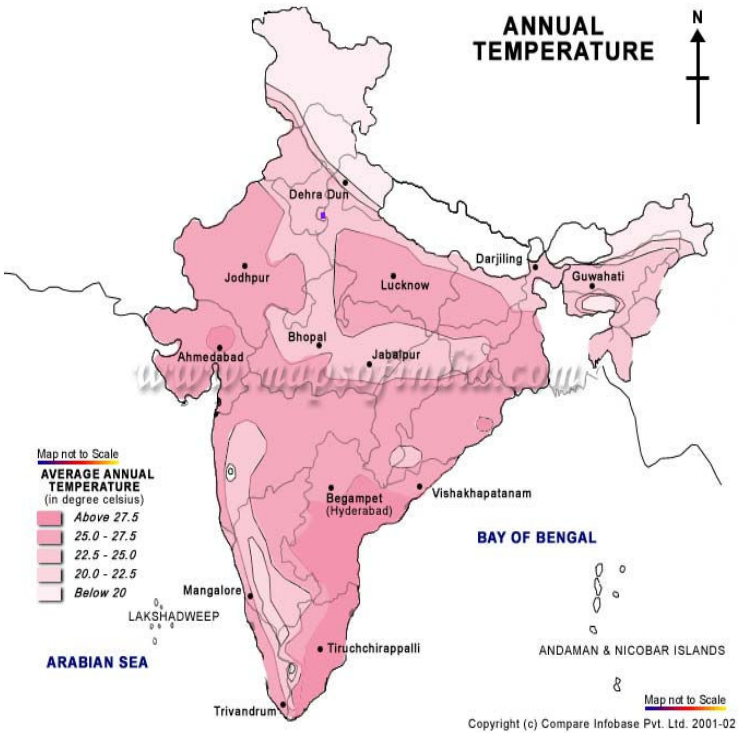
India promises to become one of the world's largest photovoltaic solar energy markets. The country has the best solar resources in the world with 260-300 clear sunny days per year; on the other hand, it is confronted with continuous electricity shortages. Over the past few years, these power deficits have increased. Millions of Indian households have already been helped with solar light solutions. But with a population of 1.17 billion people, around 100,000 villages and 450 million people still do not have electricity. Recently the Government of India announced The National Solar Mission targeting 20,000 megawatts of cumulative installed solar power by 2020.

The Rapidly Increasing Energy Needs: India is the world's sixth largest energy consumer with an installed power capacity of 150, 323, MW. However India's demand/supply gap is 12% on average and the progressive states see a gap in access of 15%. Being one of the fastest growing economies, the average energy usage per capita is expected to increase from 632kWh per annum today to 1000kWh by the beginning of 2013. This is still less than half of the current usage in western economies. In the 11^{th} five year plan, the government of India targets an increase in Renewable Energy to 16% by 2012.

Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature that ranges from 25°C – 27.5 °C. This means that India has huge solar potential. The sunniest parts are situated in the south/east coast, from Calcutta to Madras.

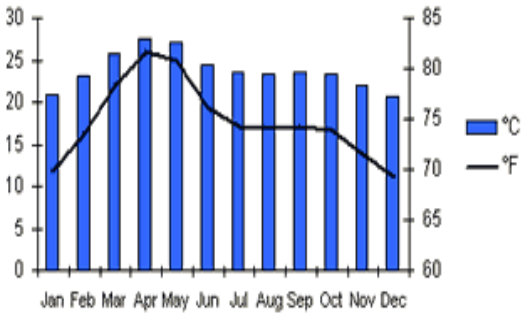
Solar energy has several applications: photovoltaic (PV) cells are placed on the roof top of houses or commercial buildings, and collectors such as mirrors or parabolic dishes that can move and track the sun throughout the day are also used. This mechanism is being used for concentrated lighting in buildings.

Photovoltaic (PV) cells have a low efficiency factor, yet power generation systems using photovoltaic materials have the advantage of having no moving parts. PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid. The efficiency of solar photovoltaic cells with single crystal silicon is about 13 % - 17%. High efficiency cells with concentrators are being manufactured which can operate with low sunlight intensities.



Source: http://www.mapsofindia.com/maps/india

Annual temperature in Bangalore



Source : http://www.globalsurfers.com/Weather/India.gif

India has an expanding solar energy sector: 9 solar cell manufactures, 22 PV module manufactures, and 50 PV systems manufacturers. Therefore, technology resources exist in country and a growing market would lead to job growth in country.

c) Wind Energy

India ranks fifth in the world in wind energy with installed capacity of 10,891 MW (as on Oct 31, 2009). Indian Wind Energy Association has estimated that with the current level of technology, the 'on-shore' potential for utilization of wind energy for electricity generation is of the order of 65,000 MW.

In December 2009, India's Ministry of New and Renewable Energy said it is offering new incentives for grid-connected renewable wind power generation. Wind electricity producers will

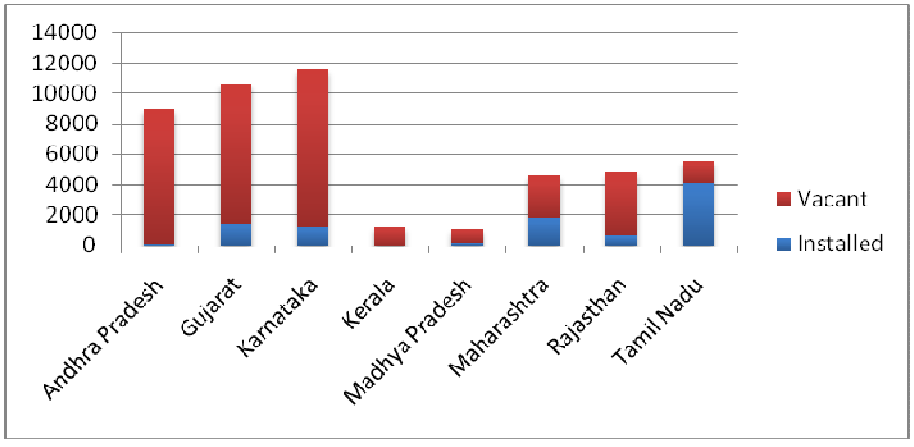
now receive a generation-based incentive of 0.50 rupees ($0.01) per unit of electricity fed into the grid.

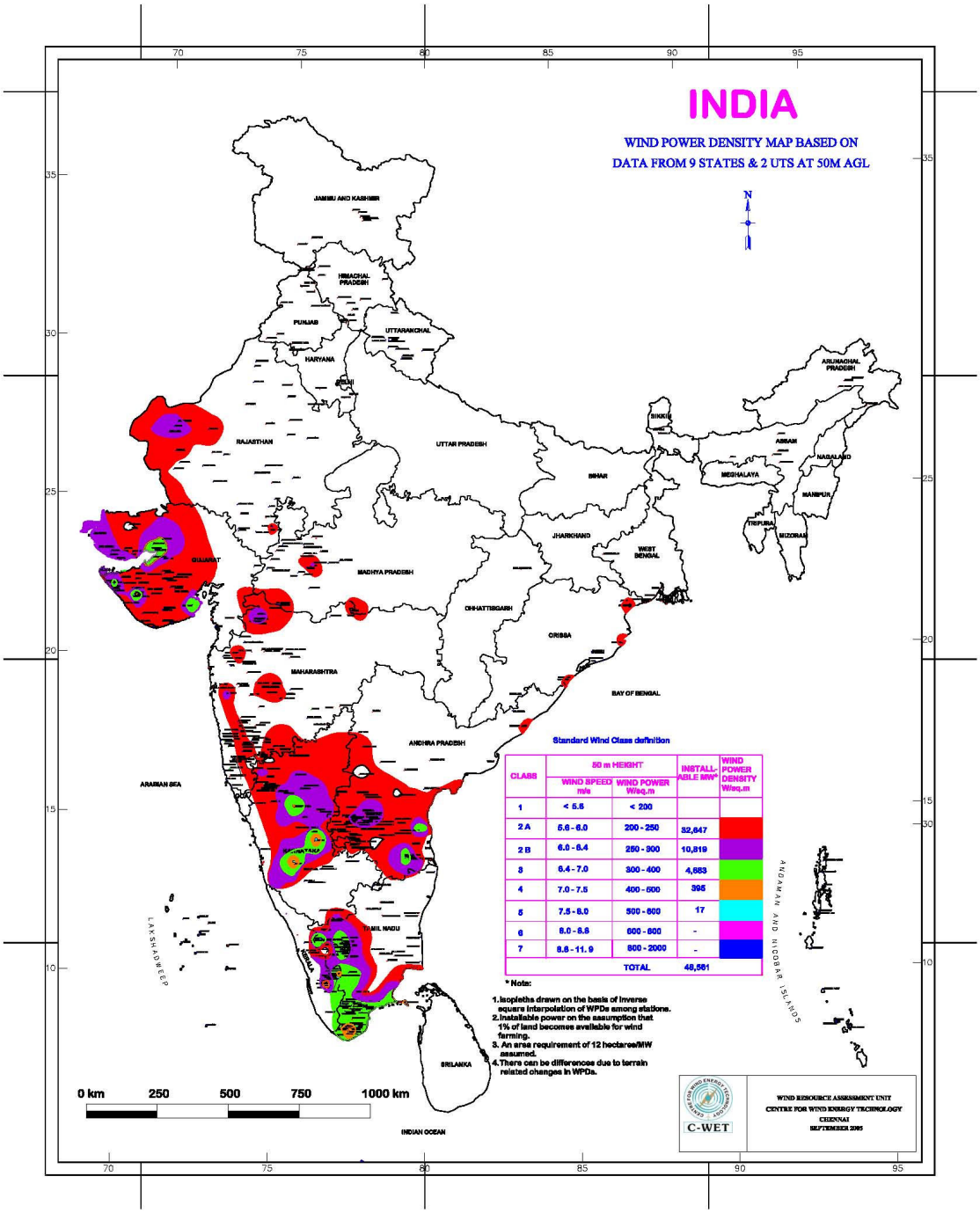
Advantages of Wind Power:

- It is one of the most environment friendly, clean and safe energy resources.
- It has the lowest gestation period as compared to conventional energy.
- Equipment erection and commissioning involve only a few months.
- There is no fuel consumption, hence low operating costs.
- Maintenance costs are low.
- The capital cost is comparable with conventional power plants. For a wind farm, the capital cost ranges between 4.5 crores to 5.5 crores, depending on the site and the wind electric generator (WEG) selected for installation.

Wind Energy Potential in India

	State	Potential (in MW)	Installed (In MW)
1	Andhra Pradesh	8968	122
2	Gujarat	10645	1433
3	Karnataka	11531	1184
4	Kerala	1171	23
5	Madhya Pradesh	1019	188
6	Maharashtra	4584	1838
7	Orissa	255	
8	Rajasthan	4858	671
9	Tamil Nadu	5530	4124
	Total	**48561**	**10891**





Source : http://www.cwet.tn.nic.in/html/departments_wpdmap.html#

Comparison between Fossil Fuels and Wind

	Wind	Fossil Fuel
Availability	Usable as it exists	Have to be procured and made usable through laborious and environmentally damaging processes
Limitation on availability	Inexhaustible resource	Limited in reserves, expected to be completely exhausted in the coming 60 years
Transportation	Used where it is available or transported where needed	Has to be transported from its source site for further processing, exposing the environment to pollution from accidents
Environmental effect of use	Zero emission	Used in producing electricity, releasing green house gasses
Geo-political implications	Reduces our reliance on oil, safeguarding national security. Allows for self sufficiency. There is no adverse effect on global environment. The whole system is pollution free and environment friendly.	Over-reliance on oil as a resource has undermined India's energy security, e.g. OPEC crises of 1973, Gulf War of 1991 and the Iraq War of 2003.

The pollution saving from a WEG

With an average output of 4,000 kWh per year, savings have been estimated as follows:

- Sulphur - dioxide (SO2): 2 to 3.2 tonnes
- Nitrogen - oxide (NO) ; 1.2 to 2.4 tonnes
- Carbon - dioxide (CO2) : 300 to 500 tonnes
- Particulates: 150 to 280 kg.

The essential requirements for a Wind farm

An area where a number of wind electric generators are installed is known as a wind farm. The essential requirements for establishment of a wind farm for optimal exploitation of the wind are the following:

- High wind resource at particular site.
- Adequate land availability
- Suitable terrain and good soil condition
- Maintenance access to site
- Suitable power grid nearby
- Techno-economic selection of specific turbines
- Scientifically prepared layout

Wind energy generation has limitations which will influence the extent and type of role it will ultimately play in overall generation of electricity in India.

Limitation of a Wind farm

- Wind machines must be located where strong, dependable winds are available most of the time.
- Because winds do not blow strongly enough to produce power all the time. Energy from wind machines is considered "intermittent," that is, it comes and goes. Therefore, electricity from wind farms must have a back-up supply from another source.
- As wind power is "intermittent," utility companies can use it for only part of their total energy needs.
- Wind towers and turbine blades are subject to damage from high winds and lighting. Rotating parts, which are located high off the ground can be difficult and expensive to repair.
- Electricity produced by wind power sometimes fluctuates in voltage and power factor, which can cause difficulties in linking its power to a utility system.
- The noise made by rotating wind machine blades can be annoying to nearby neighbors.
- Some environmental groups have complained about aesthetics and avian mortality from wind machines

d) Biomass energy

Biomass includes solid biomass (organic, non-fossil material of biological origins), biogas (principally methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power), liquid biofuels (bio-based liquid fuel from biomass transformation, mainly used in transportation applications), and municipal waste (wastes produced by the residential, commercial and public services sectors and incinerated in specific installations to produce heat and/or power).

The most successful forms of biomass are sugar cane bagasse in agriculture, pulp and paper residues in forestry and manure in livestock residues. It is argued that biomass can directly substitute fossil fuels, as more effective in decreasing atmospheric CO2 than carbon sequestration in trees. The Kyoto Protocol encourages further use of biomass energy.

Biomass may be used in a number of ways to produce energy. The most common methods are:

- Combustion
- Gasification
- Fermentation
- Anaerobic digestion

India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from bagasse-based cogeneration and 16,000 MW from surplus biomass). Currently, India has 537 MW commissioned and 536 MW under construction. The facts reinforce the idea of a commitment by India to develop these resources of power production.

Following is a list of some States with most potential for biomass production:

- Andhra Pradesh (200 MW)
- Bihar (200 MW)
- Gujarat (200 MW)
- Karnataka (300 MW)
- Maharashtra (1,000 MW)
- Punjab (150 MW)
- Tamil Nadu (350 MW)
- Uttar Pradesh (1,000 MW)

The potential available and the installed capacities for Biomass and Bagasse

Source	Potential	Installed
Biomass	16,000 MW	222 MW
Bagasse (Co-generation) in existing sugar mills	3,500 MW	332 MW

Source: http://www.greenbusinesscentre.com/renenbio.asp

The following table demonstrates the current capacity utilization of alternative sources of energy and their potential

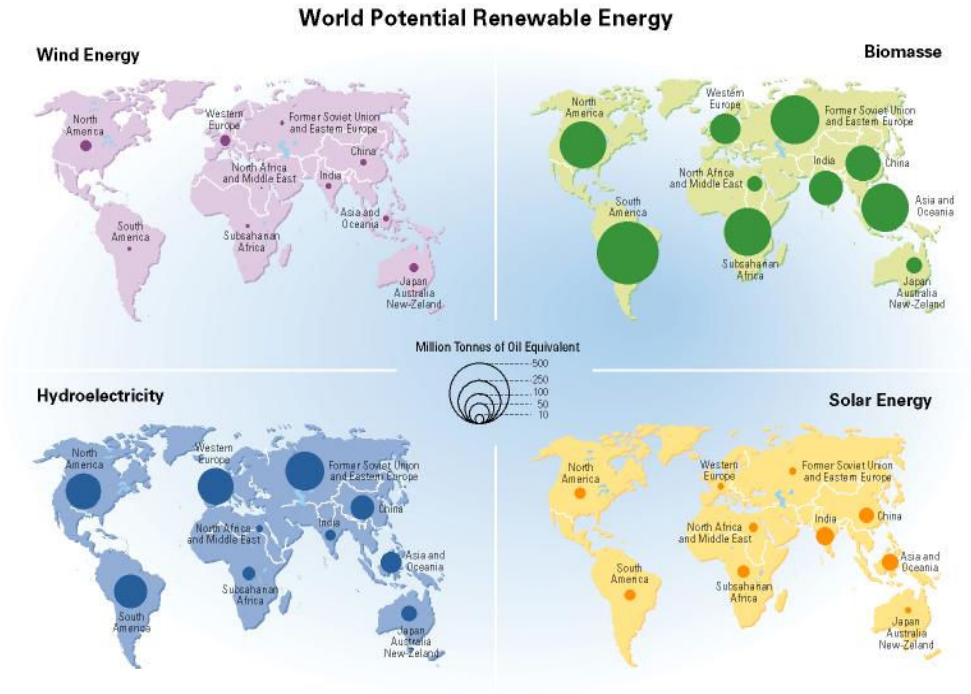
S.No	Alternative Energy	Current Capacity (MW)	Potential (MW)
1	Wind Power	10242.5	45195
2	Bio power (agro residues and plantations)	703.3	16881
3	Bagasse co-generation	1048.73	5000
4	Small hydropower (upto 25 mw)	2429.67	15000
5	Energy recovery from waste	92.97	2700
6	Solar photovoltaic power	2.12	
7	Biomass/cogenerations	170.78	
8	Biomass gasifier	105.46	
	Total	**14795.53**	

Source: MNRE, Figures at the end of March, 2009

III) Forecasts: What are the general forecasts for the next decades?

Around the world, a growing number of nations have recognized the economic, social, and environmental benefits of renewable energy and are enacting tax incentives and other policy measures favorable to renewable technologies. In Germany, Japan, Spain, and a handful of other countries, clear government commitments to renewable energy and strong, effective policies have overcome barriers and created demand for these technologies, leading to dramatic growth in renewable industries and driving down costs.

a) The position of India in the world potential renewable energy



Thanks to its location and geography, India enjoys abundant potential to all of the renewable energies.

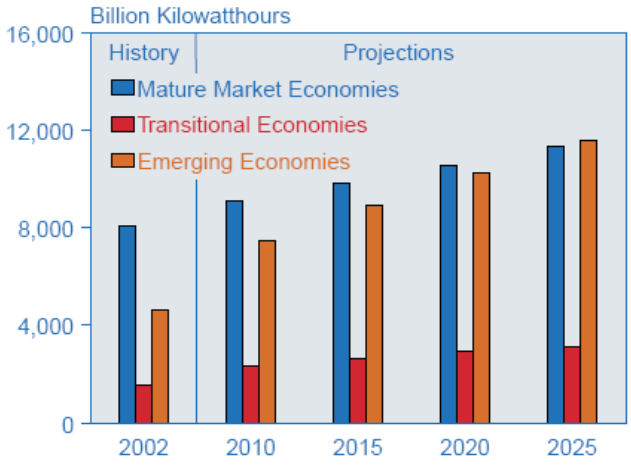
b) The electricity consumption and generation forecasts of India as part of the emerging economies.

Growth in net electricity consumption is expected to be most rapid among the emerging economies of the world, including India. According to the EIA, the annual average increase will be about 4.0 percent from 2002 to 2025.

Emerging economies are projected to more than double their net electricity consumption, from 4,645 billion kilowatt hours in 2002 to 11,554 billion in 2025. The projected growth in net electricity consumption for emerging market economies is driven in large party by gross domestic product (GDP) and population growth assumption.

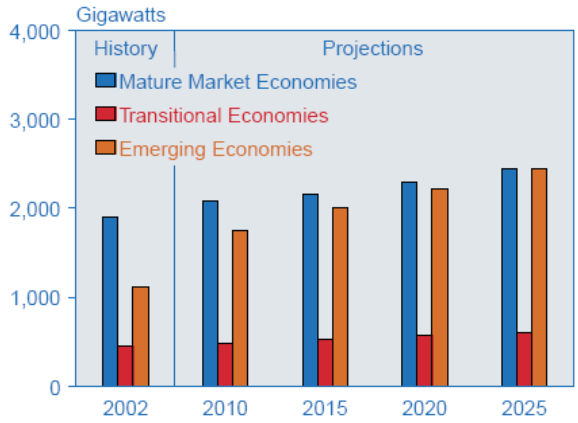
Because of the links between reliable electricity supply, GDP growth, and living standards, many of the nations with emerging economies are attempting to increase access to reliable electricity supply.

Figure 59. World Net Electricity Consumption by Region, 2002-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

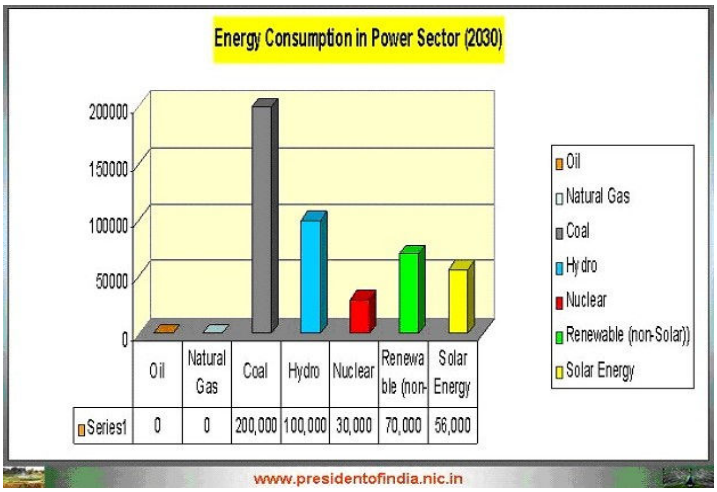
Figure 60. World Electricity Generation Capacity by Region, 2002-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

d) Projected energy consumption of India for 2030

Currently, 45 percent of households in India do not have access to electricity. New legislation has set a target of electrifying all households by 2010. As in the past, the ongoing challenge in providing electricity is the ability of the poor to pay. India announced plans in March, 2005, to continue subsidizing electricity consumption for rural and poor households that use less than 30 kilowatt hours per month.



Estimates of Potential Capacities from Renewable Energy Sources (in GWs)

table 6.1: india: projection of renewable electricity generation capacity under the energy [r]evolution scenario

IN GW

	2005	2010	2015	2020	2030	2040	2050
Wind	4	12	29	69	143	200	224
PV	0	0	2	10	118	486	1,093
Biomass	0	1	4	8	19	41	70
Geothermal	0	0	0	2	6	18	30
Solarthermal	0	0	0.5	3	23	70	151
Ocean energy	0	0	0	1	3	5	11
Total	**4**	**13**	**35**	**92**	**310**	**819**	**1,579**

Source: India Ministry of Non-Conventional Energy Sources

IV) GOVERNMENT REGULATIONS: What is the current commitment of the government regarding renewable energies?

India is one of the country's most involved in developing the use of renewable energies and is trying to make the opportunity for investors more attractive than costly.

a) Financing Sources and Incentives

To promote renewable energy technologies in the country, the government has put in place some subsidies & fiscal incentives. The Indian Renewable Energy Development Agency has been set

up under Ministry for Non-Conventional Energy Sources and is a specialized financing agency to promote and finance renewable energy projects. Following is a short list of new measures:

- Income tax breaks
- Accelerated depreciation
- Custom duty/duty free import concessions
- Capital/Interest subsidy
- Incentives for preparation of Detailed Project Reports (DPR) and feasibility reports

More details are as follows:

- 100 percent income tax exemption for any continuous block of power for 10 years in the first 15 years of operations
- providers of finance to such projects are exempt from tax on any income by way of dividends, interest or long-term capital gains from investment made in such projects on or after June 1, 1998 by way of shares or long-term finance
- accelerated 100-percent depreciation on specified renewable energy-based devices or projects
- accelerated depreciation of 80 percent in the first year of operations
- interest rate subsidies to promote commercialization of new technology
- lower customs and excise duties for specified equipment
- Exemption or reduced rates of central and state taxes.

Ministry for Non-Conventional Energy Sources mix of fiscal and financial benefits:

- 2/3rd of the project cost subject to a maximum of Rs. 2.00 crore per 100 KW for procurement of modules, structures, power conditioning units, cabling etc. to the implementing agency. The balance cost on land, extension of grid lines, transformers, civil works, foundation and erection and commissioning, etc. is met by the implementing agency.
- Up to Rs.1.0 lakh for the preparation of Detailed Project Report (DPR) for the grid interactive SPV power projects.
- 2.5 percent of its share of project cost, subject to a maximum of Rs.5 lakhs for performance evaluation, monitoring, report writing, etc. to the State Nodal Agency.
- Interest subsidy of up to 4 percent to Financial Institutions including IREDA, Nationalized Banks etc. for captive power projects of maximum capacity 200 KW by industry.

b) Environmental Legislation

2001 Energy Conservation Act

- Focus on energy efficiency
- Standards and labeling
- Designated consumers requirements
- Energy conservation building codes
- Energy conservation fund
- Bureau of Energy Efficiency

2003 Electricity Act

- Combined several existing pieces of legislation
- Intended to accelerate growth of power sector
- Targets additional 10 percent from renewable by 2012 (1000 MW/year capacity)
- Competitive market-based
- Features include:
    - National Electricity Policy
    - Delicensing of generation and captive generation
    - Public ownership of transmission companies
    - Open access in transmission
    - Freedom for distribution licenses

- Establishment of State Electricity Regulatory Commissions
- License-free generation and distribution in rural areas

Provisions and activities impacting the power sector:

- Elimination of ceiling on foreign equity participation
- Streamlining the procedure for clearance of power projects
- Establishment of the Central Electricity Regulatory Commission
- Formulating an action plan to set up the National Grid

State reforms impacting the power sector:

- unbundling the State Electricity Boards (SEB) into separate generation, transmission and distribution companies
- privatizing the generation, transmission and distribution companies
- setting up independent state electricity regulatory commissions
- making subsidy payments for subsidized categories of customers by state governments
- making tariff reforms by state governments
- enabling legislation and operational support extended to the SEB/utility
- improving operations of SEBs, particularly with regard to better management practices, reduction of transmission and distribution losses, better metering and reduction of power theft

Summary and Conclusion: Could India meet all energy needs with renewable energy?

India is a nation in transition. Considered an "emerging economy," increasing GDP is driving the demand for additional electrical energy, as well as transportation fuels. India is a nation of extremes. Poverty remains in areas with no energy services, while wealth grows in the new business hubs.

Coal fired generation currently provides two thirds of the generation capacity, and hydropower supplies the other third. Yet, India is blessed with vast resources of renewable energy in solar, wind, biomass and small hydro. In fact, the technical potential of these renewables exceeds the present installed generation capacity.

Unique in the world, India has the only Ministry that is dedicated to the development of renewable energies: Ministry of Non-Conventional Energy Sources (MNES). This bodes well for the acceleration of renewable development throughout the nation -- both to meet the underserved needs of millions of rural residents and the growing demand of an energy hungry economy.

The development and deployment of renewable energy, products, and services in India is driven by the need to

- decrease dependence on energy imports
- sustain accelerated deployment of renewable energy system and devices
- expand cost-effective energy supply
- augment energy supply to remote and deficient areas to provide normative consumption levels to all section of the population across the country
- And finally, switch fuels through new and renewable energy system/ device deployment.

In a report on the Indian economy by Deutsche Bank, in which countries were ranked by attractiveness for outsourcing and off-shoring, India came in #1, well ahead of China.

India is currently experiencing strong economic growth, while at the same time attempting to extend modern power services to millions still in poverty. Expanding electrical capacity is essential. Renewable energy remains a small fraction of installed capacity, yet India is blessed with over 150,000MW of exploitable renewables.

It makes sense to the authors that all efforts and investment should consider accelerating these sustainable energy resources before committing to the same fossil fuel path as western nations. The fossil fuel strategy will surely bring price volatility from dwindling supplies and added pollution from carbon combustion.

Tapping India's wind, solar, biomass, and hydro could bring high quality jobs from a domestic resource. Extending the electric grid between all states, and ultimately between neighbour nations will expand international trade and co-operation on the subcontinent.

This report is meant only as an overview in hopes that it will encourage even more rapid and extensive development of the renewable energy resources on the Indian subcontinent.

How to protect the Indian PV industry…

Shadows are being cast over India's PV cell and module manufacturers. Companies are currently investing in capacity expansion, while module prices on the global market are plummeting. The major Spanish market will lose more than 2.5 gigawatts of volume in 2009 due to cut backs in its support program. This serious fall in global demand for PV modules and the rapid expansion of the more than 400 module manufacturers worldwide are putting module prices under pressure. Oversupply, coupled with the global financial crisis, is hitting the solar industry very badly. Banks are getting hesitant to finance new projects and developers are waiting for better returns in a climate of decreasing module prices. More than that follows the worsened dollar-euro ratio. The result is that exports to Europe will collapse.

All this poses a serious threat to the export of Indian solar modules. Manufacturers already have many megawatts of high quality modules in stock. At the same time, their current investments in capacity expansion require high levels of cash. In maintaining their cash flow, they will encounter fierce competition with all the Chinese companies also desperate for cash flow. With only a tiny domestic market, around 2.5 MW in 2008, the Indian PV industry is in a dangerous position. It needs the funds for expansion, but lacks sufficient sales to Europe in a market climate of rapidly decreasing prices. As the PV market and industry matures, several market experts and analysts foresee a global consolidation in the PV industry. The Indian PV manufacturers could well become victims of this development.

The only thing that could be of help here would be stronger domestic market. That could put India in a better position than China, where production of solar modules is now 99% dependent on export to Europe and the USA. To achieve this, India needs a strong PV industry lobby and platform. The Indian Semiconductor Association is picking up this role, representing several of the Indian PV manufacturers. Such a strong lobby could inform the government about the current delicate global market situation and what is needed to save its own solar industry. A strong domestic market could prevent Indian manufacturers from collapsing as competition in European markets increases.

Ways to ignite domestic market growth

Continuing support to the proposed feed-in tariff for more than the current 10 years, and higher rates, would be good initial actions to take. The feed-in tariff presented does not currently promise a convincing ROI. Due to this, the banks would be hesitant in providing financial help and project financing is nowadays the most crucial issue in getting projects moving.

Another possible solution to develop the Indian PV market is to set up, or stimulate, new solar funds to guarantee project financing. Banks are a bit hesitant nowadays, and solar is not the first thing on their minds. Initial investments are too high in almost all Indian PV applications and projects. On the other hand, the returns are good and secured, and people are willing to pay interest of 10% or even more. So, a win-win scenario seems possible, with market development and good financial returns in return. This is the great thing about the Indian PV market. No investment subsidies are needed, so no government handout is required. Just the provision of financing will suffice. This could be either private or from the government (micro and macro financing). The benefits: saving its growing solar industry, bringing down power shortages, and all for an attractive return on investment. And the energy sector holds the key in accelerating economic growth in India. With the targeted GDP growth rate of 8%, energy requirements in India are expected to grow at around 6% per annum over the next few years, which is a four-fold increase over the next 25 years. It seems only a matter of time before the Indian PV market flourishes.

Policy Recommendations:

At a time when governments around the world are in the process of liberalizing their electricity markets, the increasing competitiveness of renewable energy should lead to higher demand. Without political support, however, renewable energy remains at a disadvantage, marginalized by distortions in the world's electricity markets created by decades of massive financial, political and structural support to conventional technologies and the failure to internalize environmental and social costs in price of energy.

Developing renewable energy sources will, therefore, require strong political and economic support, especially through laws that guarantee stable tariffs over a period of up to 20 years. At present new renewable energy generators have to compete with old nuclear and fossil fuelled power stations which produce electricity at marginal costs because consumers and taxpayers have already paid the interest and depreciation on the original investments. Political action is needed to overcome these distortions and create a level playing field. In the process, it would also contribute to sustainable economic growth, high quality jobs, technology development, global competitiveness and industrial and research leadership.

Actions on the following grounds could be undertaken:

- Enacting a renewable energy Law with time bound legal targets for Renewable energy uptake, both at the grid, and at stand alone level, in every state as well as nationally.
- The law should provide incentives for investment in RE technologies, such as offering potential tariffs, open transmission, as well as incentives for buying green energy.
- A shift from subsidiaries from fossil fuel to renewable energy.
- National feed-in-tariffs for renewable energy without a cap.
- A national program where in states are encouraged to promote generation of renewable energy.

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