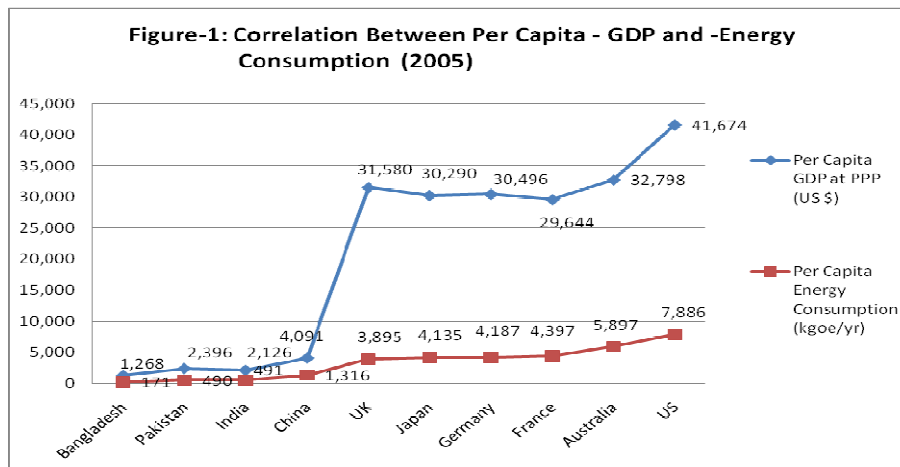


Investment Opportunities in Renewable Power Galore

Energy- A Growth Engine:

Energy, particularly electricity growth is closely linked to growth in economy. The World Bank report has defined per capita GDP-at-PPP (purchasing power parity) as a value of all final goods and services produced within a nation in a given year divided by the average (or mid-year) population for the same year. If the values of per capita GDP for different countries (World Bank ICP-2005) are plotted (**Figure-1**) along with total energy consumption (kgoe) per capita / year (World Resources Institute Report-2005), a strong correlation is observed. The countries having higher per capita GDP have also relatively higher energy consumption per capita. (All forms of energy converted into kgoe i.e. Kilogram Oil Equivalent. 1 kgoe = 11.63 kWh)



U.S.A. with 7% of world's population consumes 32%, whereas India, with 20% of world's population consumes only 1% of total energy consumed in the world.

Global Energy Demand- Ever Increasing:

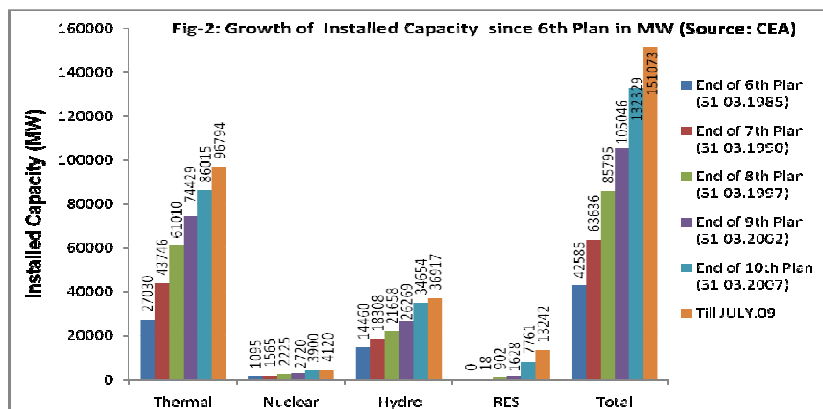
International Energy Outlook 2009 report envisages that world energy consumption will increase from 472 quadrillion Btu in 2006 to 552 quadrillion Btu in 2015 and 678 quadrillion Btu in 2030 i.e. a total increase of 44 percent over the projection period. China and India are the fastest-growing non-OECD economies, and they will be key world energy consumers in the future. Since 1990, energy consumption as a share of total world energy use has increased significantly in both countries. China and India together accounted for about 10 percent of the world's total energy consumption in 1990, but in 2006 their combined share was 19 percent. Strong economic growth in both countries are expected to continue over the projection period, with their combined energy use increasing nearly twofold and making up 28 percent of world energy consumption in 2030. This is due to rising standards of living, increased demand for home appliances and the expansion of commercial services, including hospitals, office buildings, and shopping malls.

According to them, net electricity generation worldwide totals 31.8 trillion kilowatt hours in 2030 that is 77 percent higher than the 2006 total of 18.0 trillion kilowatt hours. Renewable energy sources are the fastest-growing energy source for world electricity generation, increasing by an average of 2.9 percent per year from 2006 to 2030. Much of the growth is in hydroelectric power and wind power. Government policies and incentives typically are the primary drivers for the construction of renewable generation facilities. With its vast and relatively inexpensive English-speaking labor force, India is well positioned to reap the benefits of globalization. "Above observations clearly show a great opportunity ahead for business in the power sector."

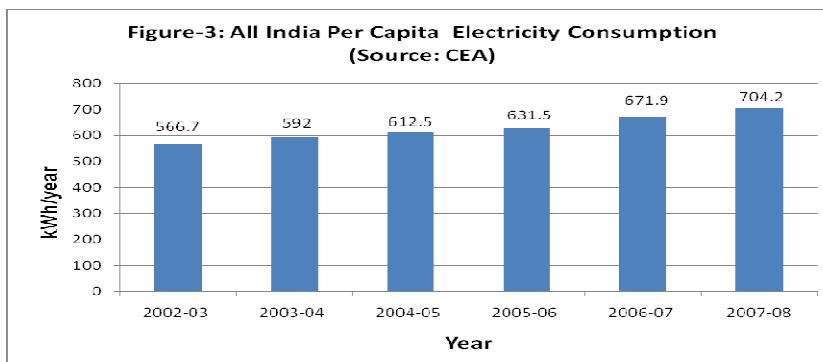
Electricity Growth in India- Well Poised:

Scope of this article is to present regional scenario of electricity in India especially in context with the renewable energy (RE) and investment opportunities in this sector. The growth rate of electricity in India has been substantially higher than other forms of energy, the reason being convenience of use and cleanliness at the user end. The document-10 "A Strategy for Growth of Electrical Energy in India" published by Department of Atomic Energy, Govt. of India has recorded that at the time of independence in the year 1947, total installed electricity generation capacity was 1,363 MW. It rose to 30,214 MW (1980-81), to 66,086 MW (1990-91) and to 1,38,730 MW (2002-03), the corresponding growth rates being 9.54%/yr, 8.14%/yr and 6.26%/yr. The average growth rate over the entire period, thus, has been an impressive 8.6%/yr. In spite of this impressive growth, per capita energy consumption is still very low as compared to the developed countries. Rapid economic growth in India is demanding higher growth rate in the electricity sector.

Sector-wise growth in power sector has been documented by Central Electricity Authority, Govt. of India. The graphical representation in **Figure-2** shows that there has been a healthy growth in the overall installed capacity of the power projects in the country. The thermal power plants (based on coal, gas and diesel) are dominant in the Indian power scenario followed by hydro power projects. Nuclear energy has a very minor share. As regards the renewable energy (RE) power projects, they were practically absent in the 6th and 7th plan periods. However, since the 8th plan, rate of growth was so rapid that RE has now taken over even nuclear power projects which were very enthusiastically started way back in the 6th plan. With many potential sites yet to be developed, the environment friendly Hydro Power projects are showing steady growth and are expected to play a greater role in the future power scenario.



India, the largest democracy with the population of more than 1.0 billion, is on a road to rapid growth in economy. During the period 1981-2000, it has witnessed an impressive GDP annual growth rate of around 6.0%. Even the year of global financial meltdown 2008-09 has shown the growth rate of 6.8%. Policy initiatives of the Government of India during the past decade have resulted in a faster growth of GDP. Forecasts by several agencies point towards continued growth of Indian economy. In the expected line, per capita electricity consumption also shows a steady growth (Figure-3).



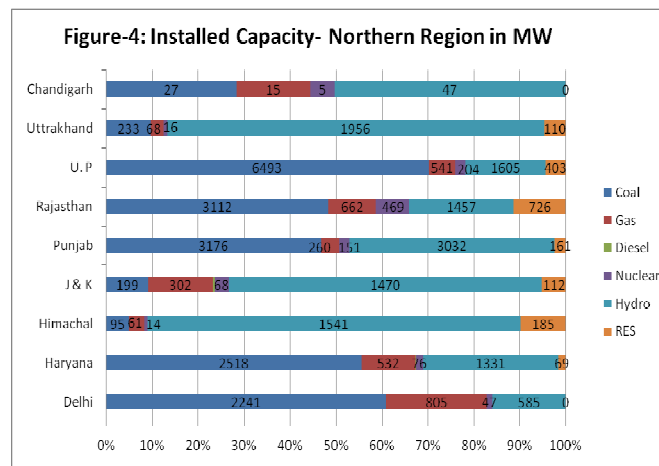
Regional Power Scenario:

India is the country of wide geographical diversity with large variation of seasonality, agricultural practices, forest cover and availability of energy resources/ raw materials. The eastern part is rich in coal reserves while the southern part has gas and oil underground stock. The Himalayan ranges have perennial rivers having large resources of water energy. Most parts of India have agro-waste as a bio-mass resource. Western India, Rajasthan in specific has abundant solar energy throughout the year. Majority of the areas are bestowed with around 300 sunny days. Due to specific geographical location of the Indian peninsula, westerly winds accompanied with monsoon are responsible for large wind resources in most of the parts. Coastal areas account for about 3/4th boundary of the country making a huge potential for sea-wave and tidal energy.

Needless to say that India needs specific energy planning with judicious choice of fuel-mix due to various important variables such as local availability, transportation cost, pollution cost concerns and social obligations. Energy security is the prime factor while formulating the realizable energy plan. The power map of India has been divided by Central Electricity Authority (CEA), Government of India into six regions namely Northern, Southern, Eastern, Western, North-Eastern regions and Islands. Each region is unique in itself so that it is necessary to study the power status and future strategy thereof for each region separately.

Region-wise analysis of power scenario based on renewable and non-renewable energy sources are explained ahead based on mainly the data published by CEA and Ministry of New and Renewable Energy (MILLIONRE), Government of India. It may be noted that central share unallocated to particular state is not considered since objective of the article is to compare state-wise status in context with RE power progress.

- **Northern region:** The graphical representation of power scenario of northern region is given in **Figure- 4:**



The northern region is dominated by Himalayan regions having perennial rivers with high heads. They are ideally suited for hydro power, which is why J & K, Uttarakhand, Himachal Pradesh and Chandigarh have the lion's share of hydro energy in the power basket. Remaining states i.e. Haryana, Delhi, U.P, Rajasthan, Punjab are predominantly planer areas with less potential of hydro energy and hence they depend mostly on the coal transported from eastern part of India. It is interesting to note that energy from gas based power projects also have a significant presence in this region. It may be noted that as per the government of India policy less than 25 MW capacities of hydro projects are considered under renewable energy category while large hydro projects beyond this capacity are considered separately under conventional hydro power category. The Himalayan region states are showing greater share of renewable energy due to presence of micro, mini and small hydro projects. Rajasthan renewable energy basket has the major share of wind energy. Punjab and Haryana also have predominantly some biomass projects. As expected, Himachal Pradesh and J&K have the lesser share of electricity through coal and gas power projects.

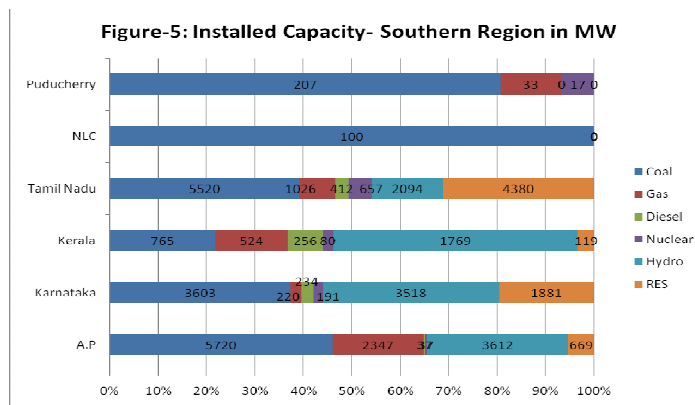
Potential and achievement in the states of northern region are given in **Table-1**:

TABLE-1

Sr. No.	State	Source	Total Potential	Achievement	Untapped Potential
1.	Rajasthan	Wind	4858	738	4120
		Biomass	1027	31	996
		Hydro	63	24	39
2.	U.P.	Biomass	1585	373	1212
		Hydro	292	25	267
3.	Himachal	Biomass	140	0	140
		Hydro	2268	231	2010
4.	Punjab	Biomass	3156	28	3128
		Hydro	390	124	247
5.	J & K	Biomass	41	0	41
		Hydro	1412	112	1295
6.	Uttrakhand	Biomass	20	0	20
		Hydro	1609	128	1441
7.	Haryana	Biomass	1330	6	1324
		Hydro	110	62	41
Total		Wind	4858	738	4120
		Biomass	7299	438	6861
		Hydro	6144	804	5340

Thus the northern region has a total untapped potential of 16,321 MW of power projects through renewable energy sources.

- **Southern Region:** The graphical representation of power scenario of southern region is given in **Figure-5**:



In the southern region, Andhra Pradesh and Tamil Nadu have the balanced proportion of power projects based practically on all sources of energy, except that of nuclear. Kerala and Karnataka have larger share of conventional hydro energy. Tamil

Nadu is leading in renewable power projects followed by Karnataka. Andhra Pradesh having good potential is awaiting the momentum to pick up for renewable power generation.

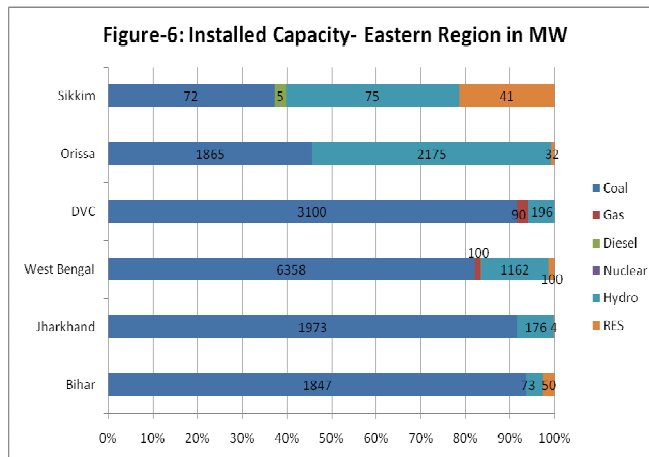
Potential and achievement in the states of southern region are given in **Table-2**:

TABLE-2

Sr. No.	State	Source	Total Potential	Achievement	Untapped Potential
1.	Andhra Pradesh	Wind	8968	123	8845
		Biomass	575	334	241
		Hydro	552	181	371
2.	Karnataka	Wind	11531	1327	10204
		Biomass	1125	274	851
		Hydro	643	563	80
3.	Kerala	Wind	1171	27	1144
		Biomass	1042	0	1042
		Hydro	708	134	574
4.	Tamil Nadu	Wind	5530	4305	1225
		Biomass	430	309	121
		Hydro	500	90	410
Total		Wind	27200	5782	21418
		Biomass	3172	917	2255
		Hydro	2403	968	1435

Thus the southern region has a total untapped potential of 25,108 MW of power projects through renewable energy sources.

- **Eastern Region:** The graphical representation of power scenario of eastern region is given **Figure-6** :



It is interesting to note that the eastern region has comparatively low potential for renewable power generation. Only Sikkim, Bihar, West Bengal have some contribution of renewable energy. As expected, due to proximity to the eastern coal fields, this region is dominated by coal based power projects. It may be noted that over all installed capacity is comparatively less in this region. Most probably, this may be due to the fact that proper potential assessment study in this region has not been done extensively.

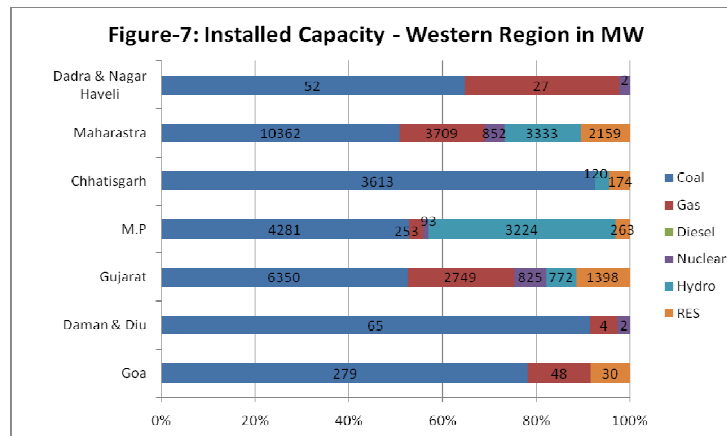
Potential and achievement in the states of eastern region are given in **Table-3**:

TABLE-3

Sr. No.	State	Source	Total Potential	Achievement	Untapped Potential
1.	Bihar	Biomass	604	0	604
		Hydro	214	55	159
2.	Jharkhand	Biomass	89	0	89
		Hydro	209	4	205
3.	W. B.	Biomass	391	0	391
		Hydro	394	98	296
4.	Orissa	Wind	255	0	255
		Biomass	241	0	241
		Hydro	295	44	251
5.	Sikkim	Biomass	2	0	2
		Hydro	266	47	219
Total		Wind	255	0	255
		Biomass	1327	0	1327
		Hydro	1378	248	1130

Thus the eastern region has a total untapped potential of 2,712 MW of power projects through renewable energy sources.

- **Western Region:** The graphical representation of power scenario of western region is given in **Figure-7**:



In the western region, the coal based power projects are again dominating. Maharashtra and M.P have a good share of conventional hydro projects. The easy access to oil and gas reserves is responsible for larger share of energy from gas based power projects in this region. Maharashtra along with Gujarat is leading in renewable energy power projects.

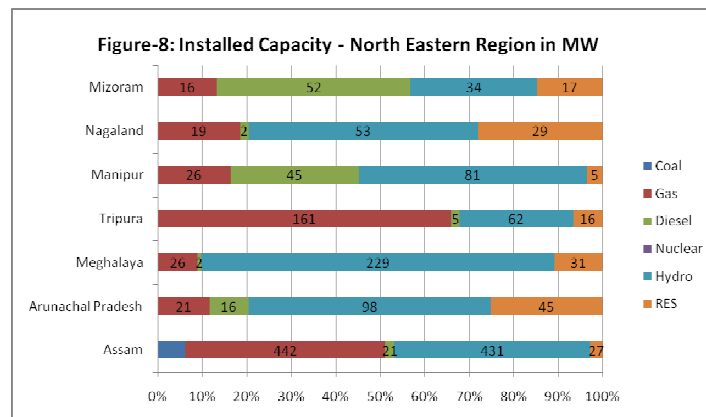
Potential and achievement in the states of western region are given in **Table-4**:

TABLE-4

Sr. No.	State	Source	Total Potential	Achievement	Untapped Potential
1.	Goa	Biomass	25	0	25
		Hydro	9	0.05	8.95
2.	Gujarat	Wind	10645	1567	9078
		Biomass	1205	0.5	1204.5
		Hydro	197	7	190
3.	Madhya Pradesh	Wind	1019	213	806
		Biomass	1718	1	1717
		Hydro	401	71	330
4.	Chhattisgarh	Biomass	234	156	78
		Hydro	706	18	688
5.	Maharashtra	Wind	4584	1939	2645
		Biomass	1878	155	1723
		Hydro	763	211	552
Total		Wind	16248	3719	12529
		Biomass	5060	313	4748
		Hydro	2076	307	1769

Thus the western region has a total untapped potential of 19,049 MW of power projects through renewable energy sources.

- **North-Eastern Region:** The graphical representation of power scenario of north-eastern region is given in **Figure-8**:



Due to difficult hilly terrains the transportation of coal is practically impossible in this region and hence there is hardly any share of energy from coal based power project. On the other hand the availability of oil and gas reserves, energy from gas-based power project has significant presence. Fortunately this area is blessed with many perennial rivers which contribute to the conventional hydro projects. The renewable energy scenario is mainly dominated by small hydro projects. The diesel based power projects have significant share in this region that needs to be replaced with other sources of energy.

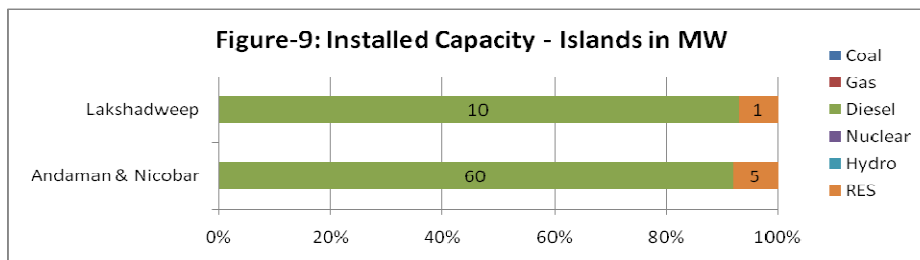
The potential and achievements in the states of the north-eastern region are given in **Table-5**:

TABLE-5

Sr. No.	State	Source	Total potential	Achievement	Untapped potential
1.	Assam	Biomass	203	0	203
		Hydro	214	27	187
2.	A. P.	Biomass	5	0	5
		Hydro	1333	61	1272
3.	Meghalaya	Biomass	9	0	9
		Hydro	230	31	199
4.	Tripura	Biomass	3	0	3
		Hydro	47	16	31
5.	Manipur	Biomass	12	0	12
		Hydro	109	6	103
6.	Nagaland	Biomass	8	0	8
		Hydro	197	29	168
7.	Mizoram	Biomass	0.04	0	0.04
		Hydro	167	25	142
Total		Biomass	240	0	240
		Hydro	2297	195	2102

Thus the north-eastern region has a total untapped potential of 2,342 MW of power projects through renewable energy sources.

- **Islands:** The graphical representation of power scenario of islands is given in **Figure-9**:



Diesel is the main source of power on the islands. Andaman and Nicobar islands have potential of hydro 8 MW out of which 5 MW are achieved. The Lakshadweep islands' renewable energy potential is not reported, however, 1 MW plant is installed. Major source of power is diesel which is a costly affair that invites looking for alternatives.

Investment Opportunities:

The corporate sector, as potential investor in India, needs to have a separate strategy for each region. Empowered with the Electricity Act, 2003 for liberalization of power sector, regulatory reforms and investor friendly policies of State and Central Governments, the vibrant Indian corporate sector has shown keen interest in enthusiastically participating in Independent Power Plants (IPP) and public-private ventures. It's heartening to note that more and more private players in power sector are turning green. Sudden spurt in renewable energy power plant growth in 9th and 10th plan period has been possible only due to huge private investment in this sector. Preferential tariffs announced by many states combined with fiscal and financial incentives have given fillip to this sector. No wonder, the renewable energy sector in the country has got private investment to the tune of approximately Rs. 600,000 million (assuming average Rs. 50 million/ MW). This definitely indicates a good beginning with a bright future ahead.

The above energy scenario clearly indicates that there is a large potential of private investment in the renewable energy sector. The CERC, in its "RE Tariff Regulations, 2009" has identified the benchmark cost of installed capacities of power projects based on wind, hydro and biomass as Rs. 51.50 million, Rs. 63 million and Rs. 45 million per MW respectively. Considering the average cost of Rs.50 million / MW (2009 Price) for renewable power projects in general, the region-wise investment potentials are given in **Table-6**:

TABLE-6

Sr. No.	Region	Total Untapped Potential (MW)	Total Investment Potential (Rs. in million)
1.	Northern	16321	816050
2.	Southern	25108	1255400
3.	Eastern	2712	135600
4.	Western	19049	952450
5.	North-Eastern	2342	117100
6.	Islands	3	150
Total		65,535	3,276,750

It would be worth to note here that 100% of the untapped potential will not be practically achievable due to limited grid availability, site constraints and other unavoidable reasons. Even if 60% of the untapped potential is achievable, there is still a huge

investment potential of Rs. 2,000,000 million in this sector excluding the solar power projects. As regards the solar power projects, the National Solar Mission mooted by the Govt. of India has projected the installations of 20,000 MW in the country by 2020 involving the investment potential of another Rs. 2,000,000 million.

At present southern region especially Andhra Pradesh and Karnataka appear to be most promising for private investment due recent investor friendly policies announced. Next is the northern region especially Rajasthan offering probably the highest wind power tariff in the country. Large investment potential in small hydro is available in Himachal Pradesh, Uttarakhand and J&K on favorable site conditions. Gujarat is inviting private investment with much of the wind potential still untapped followed by Maharashtra. Investment in power projects on biomass and small hydro are expected to be at slower rate as compared to that on wind. Recent developments have shown a great interest of corporate sector in solar power projects, especially in Gujarat, Maharashtra and Rajasthan. With the final policy on National Solar Mission expected to be announced any time, sky is the limit in the field of solar thermal and photovoltaic large power projects.

It makes a good business sense to invest in green energy with a twin objective of saving the environment and earning a reasonably good profit. With the international pressure group demanding India to share carbon mitigation liability along with the western countries, lots of positive activities have started at the central government level and many revolutionary steps have been recently taken to attract the private investments. Some of them are outlined below:

- The National Solar Mission is one the 8 missions under National Action Plan on Climate Change (NAPCC) announced by the office of Prime Minister of India. Under this mission incentives worth around Rs. 1,00,00 Crores are envisaged.
- Forum of regulators comprising the Chairmen of all the SERCs has announced the unique report 'Policies on Renewables' in November, 2008 which proposes many investor friendly steps.
- The Central Electricity Regulatory Authority (CERC) has come out with RE Tariff Regulations, 2009 incorporating many useful points that will give fillip to the RE sector beyond imagination.
- MILLIONRE sponsored study report on "Development of Conceptual Framework for Renewable Energy Certificate Mechanism for India" has been recently published on website which proposes the methodology for trading of green attribute of renewable energy units.
- Department of Information Technology, Govt. of India is implementing Special Incentive Package (SIP) scheme for polycrystalline and thin film silicon materials for solar cells only large scale manufacturing unit involving minimum Rs. 1000 Crores initial investment. Under this scheme, Lol has been already issued to many private companies.
- Generation based incentives have been announced by the Central Govt. for RE power projects.

- Fiscal incentives are already in place such as Income tax benefits/accelerated depreciation, tax holiday, reduced custom duty/ excise duty, octroi exemption etc.
- 100% FDI is allowed in RE sector like any other infrastructure project.
- Preferential tariffs for RE power generation are announced by many state electricity regulatory commissions.
- Some states are providing infrastructure subsidies to RE power projects for approach roads and electrical evacuation systems.
- Large amount of finances are conveniently available from Banking and Non-Banking financial institutions.
- A nationwide, automated and online electricity trading platform IEX (Indian Energy Exchange) is created to catalyze the modernization of electricity trade in country by ushering in a transparent and neutral market through a technology-enabled electronic trading platform.
- Electricity Regulatory Commissions in most of the states in India have announced the order of Renewable Purchase Specification/Obligation making it mandatory for utilities, captive users and open access users to purchase certain percentage of electricity generated from renewable energy.

It appears that an unprecedented era of the renewable energy sector growth has arrived and many good things are happening concurrently. Needless to say that corporate sector has now the appropriate and profitable business opportunities to invest in RE sector and to have a green tag also. This is called having the cake and eating too.



Dr. Sudhir Kumar

Dr. Sudhir Kumar and Ms. Sneha Shweta

The first author was until recently the General Manager in Maharashtra Energy Development Agency, a Govt. of Maharashtra Undertaking. He is presently advising many organizations as an expert of renewable energy and energy conservation through his company M/s. Green Energy Solutions, Pune. He is being actively supported by the co-author Ms. Sneha Shweta, an engineering graduate with distinction from D. Y. Patil Institute of Engineering & Technology, Pune. E-mail: drsk22@gmail.com



Ms. Sneha Shweta