

India Transits to Clean Energy Economy: Where will the differentiated sustainable path lead to?

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Abstract

India is in the midst of a multi pronged transition on energy front. A country of 1.25 billion people is on the move with compelling aspiration for better life. There is quest for quality of life that is free from the shackles of the past. A young demography is looking for dignity and development, within democratic polity.

The process of development is constrained by two factors: a) energy and b) environment. Within these two boundaries, there are issues of: a) energy equity, b) energy security and c) environmental sustainability; the 'trilemma' monitored by World Energy Council.

India is heading towards centre stage in world energy landscape, by virtue of its growing size, complexity, diversity of energy basket, linkage with other countries by way of trade, technology transfer and destination for investment. India is poised to be a major market of solar energy, as it will play a significant role in world's commitment to reduce green house gas emission.

Amidst plethora of diplomatic pronouncements in COP21 on the backdrop of landscape of India's economy, energy and environment, a research scope remains: what is the most desirable and feasible energy transition path that can be drawn for India post 2015 and how can that be achieved?

This paper attempts to:

- Take stock of developments during last 5 years with respect to energy trilemma for India.
- Draw a transition path for India with respect to energy consumption, to meet its quest for inclusive development.
- The paper provides a layout of drive for clean and reliable energy to meet sustainable development goal launched in September 2015 by UNFCCC.

This paper is structured in the following parts:

1. Identify India's place in emerging global energy landscape
2. Challenges and transition of India's energy ecosystem
3. Long term shift in energy mix.
4. Measures to be taken with implications for business and provision for funding

Keywords: India, Energy, Renewable, Environment, Sustainable Development

1. INTRODUCTION

India will contribute to the single largest share of growth, around one-quarter, in global energy demand during 2013 to 2040, as estimated by International Energy Agency [1]. India's 1.25 billion people consume abysmally low level of energy. There are 237 million people, constituting 19% (26% in rural and 4% in urban), who live without electricity [1]. Indian cities will accommodate 315 million more people by 2040. As Government is focused to improve manufacturing activity, aiming at growth of income and employment, more energy will be consumed. Share of coal is likely to be 50% of energy mix. The largest source of increase in world's coal use will come from India by 2040. Oil consumption will be at 10 million barrels per day in 2040 and that will be the highest increase, comparing other countries. India is on move to decarbonize its energy system with urgency to meet its goal of having 40% share of non-fossil fuel capacity in the power sector by 2030.

Large capital investment and innovative technology, along with measures for energy security and environmental upkeep, are required for meeting India's growing energy need. Investment of \$2.8 trillion is required to ramp up energy supply up to 2040. Three-quarters of this investment will be required in power sector, which needs to almost quadruple in size. India will be the second-largest coal producer in the world by 2020, and also the world's largest coal importer, overtaking Japan, the EU and China. Indigenous oil production will be inadequate to meet the growing demand, and oil import dependence will be above 90% by 2040. [1]

Expanding energy sector is certain to exacerbate already serious challenges with climate change consequences, water stress and local air pollution. Integrated policies on land use and urbanization (the 'smart cities' initiative), pollution controls, technology development, and a relentless focus on energy efficiency can mitigate these risks.

India will strive to meet the 'Sustainable Energy for all' goal of United Nations, where it is envisaged that the following 3 goals will be achieved by 2030 on global space: [2]

- a) Universal access to electricity and clean cooking fuels;
- b) Doubling the share of the world's energy supplied by renewable sources from 18 to 36 percent;
- c) Doubling the rate of improvement in energy efficiency.

India will be on watch for its ambitious INDC (Intended Nationally Determined Contribution) committed to United Nations Framework Convention on Climate Change (UNFCCC). [3] The significant measurable commitments are:

- To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
- To achieve about 40 percent cumulative electricity installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
- To create an additional carbon sink of 2.5 to 3 billion tones of CO₂ equivalent through additional forest and tree cover by 2030.

Government of India announced in 2014 its intention to have cumulative renewable power generation capacity of 175 GW by 2022 (excluding large hydropower). Out of this, solar will be 100 GW, wind 60 GW, biomass 10 GW and small hydro projects will be 5 GW. India launched international solar alliance of 120 countries in 21st Conference of Parties (COP21) at Paris in December 2015, with commitment to contribute \$27 billion and headquarter in India.

2. TRANSITION IN INDIA’S ENERGY SYSTEMS: 2000 - 2014

India for best part of last quarter century (1991 – 2014) has been struggling to emerge as an economy on upward drive, at times bucking the trend of major economies of the world. Table 1 shows that India’s economy has been growing around 7% per annum during last quarter century; which is though slightly lower than that of China, much above the level of OECD and average of world.

Table 1 Long term Growth Trend of India, China and World (Average Annual GDP Growth in %)

	1990 – 2000	2000 - 2009	2009 – 2014
India	6.0	7.6	6.9
China	10.6	10.9	8.5
High Income Countries	2.6	2.1	1.8
World	2.9	2.9	2.7

Source: [4]

The energy system of India has evolved and supported the upward drive of the economy. There are of course symptoms of energy poverty, high disparity in energy consumption linked to differences in regions, income and education etc. Table 2 presents energy atlas for India, showing a complex energy system from the consumption side. The energy indices are of course much below the level compared

to other countries, yet presents a spectrum to exhibit that India's energy system is on a path of transition and showing upward trend.

Table 2 Select Energy Consumption Indices for India

		1990	2000	2006	2008	2009	2010	2011	2012	2013
Access to Electricity (% of population)	Urban	86.5	98.6	-	-	-	93.1	-	98.2	96
	Rural	38.7	48.4	-	-	-	66.9	-	69.7	74
Access to non-solid fuel (% of population)	Urban	-	-	-	-	-	87.4	-	86.8	
	Rural	-	-	-	-	-	11.9	-	12.5	
Fossil fuel energy consumption (% of total)		53.9	63.8	67.0	69.0	71.2	71.6	71.4	72.4	72.4
Energy Imports (net) (% of energy use)		8.2	20.4	23.4	25.9	27.5	28.4	29.6	31.8	32.5
GDP per unit of Energy used (ppp \$ per kg of oil equivalent)		3.2	4.8	6.8	7.3	7.2	7.7	8.1	8.3	8.7
Energy use – kg of oil equivalent per 1000 GDP (constant at 2011 ppp)		198.6	166.1	135.5	131.0	133.2	126.4	122.6	122.4	118.1
Energy use – kg of oil equivalent per capita										
	India	352.2	418.9	468.5	501.6	545.3	562.7	574.3	595.1	606.0
	China	767.0	919.3	1478.1	1576.2	1692.7	1845.7	1994.4	2079.1	2226.3
	United States	7671.8	8056.9	7697.6	7488.1	7056.8	7161.5	7029.2	6812.3	6914.3
	World	1661.2	1638.9	1784.2	1806.5	1774.8	1848.6	1859.2	1869.6	1894.4

Source: [5]

India's energy system as a whole revolves around four 'A's, namely: availability, accessibility, reliability and affordability. People in large part of India's rural track live at subsistence level and meet their energy requirement from natural and conventional sources. Transition to modern energy carrier for cooking and lighting and adoption to modern equipments and powered lifestyle will be creating demand for energy. Supply from indigenous sources has been a constraining factor. That partly explains the increasing percentage of energy getting imported from 20% level in 2000 to 32.8% in 2013. Increasing import dependence for energy requirement, coupled with volatility of crude oil prices in international market, presents the challenge of energy security and managing country's balance of payment.

3. CHALLENGES OF ENERGY SYSTEMS IN INDIA

Energy systems in India have evolved over last six decades along with country's economic development, supporting the aspiration of 1.25 billion people, within the framework of democratic polity, globally integrated economy and environmentally sensitive regime. India pursued a reformed

development agenda since 1991. Significant effort has gone into improving energy availability to support country’s development initiatives. May 2014, the time the current BJP led NDA government came to power, marks a watershed in India’s development agenda, as India tries to break from the slow growth symptom of previous decade (2004 – 2014).

There is going to be high order of increase in demand for all kinds of energy; commercial and conventional, renewable and non renewable, fossil fuel and green fuel in future. The demand for energy will be caused by factors like: i) changing lifestyle of 1.25 billion population, climbing energy ladder, ii) economic growth aiming at poverty elimination and structural transformation of the economy. Technological refinement in manufacturing and increasing share of services in the composition of GDP will create high energy efficiency, leading to low energy intensity in production. There will be more and more compulsions for green energy with a view to reduce environmental degradation and greenhouse gas emission.

3.1. Energy Trilemma Index by World Energy Council

Challenges on energy front in India are best captured by the energy trilemma index formulated by World Energy Council. [6]

Table 3 Energy Trilemma index Ranking and Balance Score of India

	2013	2014	2015	Score (2015)
Energy Security	76	76	53	B
Energy Equity	110	105	104	D
Environmental Sustainability	121	123	122	D
Overall Rank and Balance Score	115	122	107	BDD

Source: [7]

Table 3 brings out that during 3 years, India’s rank has improved on two indicators and also on overall, from 115 to 107. Impressive improvement is noted on energy security front and marginal fall is noted on environmental sustainability front. Overall score BDD, however, leaves much room for improvement.

3.2. Energy Architecture Performance Index by World Economic Forum

World Economic Forum has devised a composite index, Energy Architecture Performance Index (EAPI), as a measure of 3 key indicators of a country’s energy system, which are again split into 18 sub indicators. EAPI index ranks 125 countries in descending order and gives score to the 3 key indicators on a scale of 0 – 1. [8, 9, 10]

3 Broad Index	What the Sub-indices indicate
Economic Growth and Development	This sub-index measures the extent to which a country’s energy architecture adds or detracts from economic growth
Environmental Sustainability	This sub-index measures the environmental impact of energy supply and consumption
Energy Access and Security	This sub-index measures the extent to which an energy supply is secure, accessible and diversified

Table 4 Energy Architecture Performance Index for India (score on the scale of 0 – 1)

	Rank out of 125 Countries	Composite Score	Economic Growth & Development	Environmental Sustainability	Energy Access & Security
2016	90	0.53	0.51	0.49	0.61
2015	95	0.51	0.50	0.42	0.61
2014	69	0.48	0.49	0.41	0.54

Source: [8] [9] [10]

Table 4 brings out the fact that India has improved score on all fronts, during last 3 years, particularly with respect to energy access and security. There is marginal improvement in composite score over the years, though the rank scrolled down in 2015 and went up in 2016.

4. SHIFT IN ENERGY TRAJECTORY

Energy scene in India is undergoing a radical transformation. The issues of significance from the point of view of management are: a) size and volume of energy use, b) diversity of energy sources, c) energy efficient technology at the application end, d) new technology for production of clean and green energy, e) affordability of people, f) providing energy accessibility to people and g) investment required to shift to renewable. Everything put together poses challenges in terms of policy and management, within the country in a democratic polity and outside the country in dynamic geopolitical forces.

4.1. Projected Changes in Energy Basket in India 2030

India's demand for energy is contingent upon the following factors: a) growing population, b) growth in GDP, c) shift of economic activity from service to manufacturing, d) increasing use of energy intensive appliances, e) households switching from conventional bio-energy to modern energy carriers, climbing the energy ladder, f) preference for personalized automobiles and g) increasing urbanization.

Each of the above factors has bearing on pattern of energy consumption, preference for energy carrier type, dictated by substitution possibilities, primarily arising out of policies, prices and concerns of energy efficiency. The actual use of energy, volume, type and regional spread, is dictated by macro issues like state of economy, government policies, regulation and environmental concern, together influencing business activities and consumers' preference. India, today and more in future, is going to be a free market and open economy having wide linkage with external world.

Today's political system in India carries vision to eradicate poverty in this generation, to have inclusive growth, to use world class technology, harness natural resources in environment friendly and sustainable ways. Everything put together to take the country to a new height, unconstrained by the baggage of the past and making use of dividends from 3 Ds: demand, democracy and demography. There is focus on innovation, digital technology, entrepreneurship, and smart clean habitation.

In this scenario of optimism and activism, it is hard to project demand for energy in future. However, taking everything into account, two international agencies have projected long term demand for energy in India. Though each projection varies from the other, depending upon their inputs and assumptions, it is worthwhile to see the aggregate value to get a sense of volume that the projections make. (Table 5) We will however work for disaggregated analysis on the projection prepared by IEA (2015). [1] 'World Energy Outlook 2015' by IEA, factors latest initiatives of Government of India including the announcements made on the eve of COP21. Two specific initiatives having significant bearing on energy systems have been accounted, namely: a) 'make in India' campaign to promote manufacturing and b) universal and reliable electricity supply.

Table 5 Multiple Projections of Demand for India's Energy (MTOE)

Agency	Edition / Year	2013	2020	2030
BP	February 2015	595	807	1160
BP	February 2016	637.8 (year 2014)	841.0	1505.3
IEA	Mid 2015	770	940	1182
IEA	November 2015	775	1018	1440

Source: [1] [11] [12] [13]

India will experience significant shift in production and consumption of power from renewable sources. Projection made by International Energy Agency (IEA) in World Energy Outlook (WEO) 2015, taking into account the India's commitment to UNFCCC, suggests that there would not be dramatic shift in energy mix in terms of percentage, though significant power will be made by deploying modern renewable technologies, led by solar and wind, as presented in table 6.

Table 6 Primary Energy Demand by Fuel - Projection till 2040 (MTOE)

	2013	2040	Shares (%)		2013-2040	
			2013	2040	Change	CAGR (%)
Oil	176	458	23	24	282	3.6
Natural Gas	45	149	6	8	104	4.6
Coal	341	934	44	49	592	3.8
Nuclear	9	70	1	4	61	7.9
Renewable	204	297	26	16	93	1.4
Total	775	1908	100	100	1133	3.4

Source: [1]

Two significant developments merit attention. Coal by virtue of indigenous resource endowment will continue to play significant role as fuel in industries and in power production. However, efforts are on to set up clean power plants, called supercritical power plants. [14] Super critical power plants offer higher efficiency and lower carbon emission because it generates lesser carbon for the same amount of coal burnt. Currently, share of clean coal is about 10%, which is planned to rise up to 24% by 2022. Secondly, gas will replace oil (in transport) and coal (in power generation) and will add volume. Thirdly, renewable will take a leapfrog use, particularly solar and wind. However, there are many supporting developments which are seriously being worked on to make renewable power a big break through. The Electricity Act of 2003 mandates State Electricity Regulatory Commissions to develop renewable energy projects and include the fixation of minimum quotas for the sourcing of renewable energy power, under renewable purchase obligations and determination of preferential feed-in-tariff. India has moved up to 3rd position (score 71.6) in 'Renewable Energy Country Attractiveness Index' (RECAI) in 2016 from its previous year position of 5th, formulated by Earnest & Young. RECAI

represents a country's macro fundamentals, energy imperative, policy enablement, project delivery and technology potential. [15]

Significant developments are taking place on technical, commercial and institutional front to generate solar power at grid parity price. [16, 17, 18] The current installed solar power generation capacity is 4,878 MW. India launched the Jawaharlal Nehru Solar Mission in 2010, with the aim of adding 20,000 MW of grid connected solar power to the country's energy mix by 2022. The current BJP led NDA government has revised the target of 20,000 MW capacity to 100,000 MW. (Solar parks will generate 20,000 MW; roof-top 40,000 MW and distributed generation projects 40,000 MW.) The solar space has witnessed significant decline in tariffs. Government is hopeful to provide green power at less than Rs 4.50 per unit.

A perennial problem on power sector is pricing of power by State Governments and financial sickness of State government owned power distribution companies (DISCOMs). Government of India has come out with an innovative scheme in November 2015 with the objective to improve the operational and financial efficiency of State DISCOMs. [19] Till date (14.03.2016), 8 States have joined the scheme UDAY (Ujwal Discom Assurance Yojana), which aims to restructure the debt of State Discoms with federal funding.

5. MEASURES FOR INDIA'S COMMITMENT TO UNFCCC

Sustainable energy path is unique for each country. Increasing demand for energy in India reflects aspiration of 1.25 billion people to have a decent living condition. For 237 million people, who are currently living without electricity and for 841 million households using solid bio mass for cooking, energy accessibility means coming out of energy poverty. 'Make in India' initiative of Government of India with the objective of providing employment to 47 million youths aged between 15 to 24 years would rebalance the economy towards manufacturing and that would necessitate higher energy consumption.

5.1. India's Action plan on Energy Point no. 7 of SDG of UN

United Nations adopted Sustainable Development Goal (SDG) in September 2015. Goal no. 7 is to 'ensure access to affordable, reliable, sustainable and modern energy for all'. [1] India upholds the principle of "common but differentiated responsibilities" in climate change matters, but is committed

to de-carbonize its energy system in its own interest. These include: a) energy efficiency measures particularly in incentivizing use of LED lights; b) benchmarking appliances for energy efficiency, c) encouraging Indian industry to move to more sustainable production patterns and waste recycling. Government is making efforts in generating renewable energy by focusing on solar, wind, geothermal and small hydroelectric plants including through quintupling the target under National Solar Mission to 100 GW by 2022. However, as coal will remain a dominant source of energy in future years, adoption of advanced technologies such as carbon capture and storage (CCS) would be imperative. Private sector’s support towards sustainability efforts, particularly by undertaking investments for clean energy deployment, assumes a critical priority. [20, 21]

5.2. India’s Action Plan to Realize the INDC Commitment made at UNFCCC

Global carbon intensity fell by 2.7% in 2014, the steepest decline on record, while world GDP grew by 3.3%. During 2000 to 2014, carbon intensity declined by 1.3% per annum, against 3.7% growth in GDP per annum. (Table 7)

India witnessed the highest rate of emission growth over 2013 at 8.2% and contributed the most to the increase in global emission in 2014. India’s de-carbonization rate has averaged 1.4% since 2000. Carbon intensity followed a mostly downward trend in the early 2000s, but since the 2008 recession it has fluctuated. (Table 7)

Table 7 Low Carbon Economy Index

	2013 – 2014			Trend this century		
	Change in carbon intensity 2013-2014	Carbon intensity (tCO2/\$mGDP) 2014	Change in energy related emissions 2013-2014	Real GDP growth (PPP) 2013-2014	Annual average change in carbon intensity 2000 – 2014	Annual average change in GDP 2000-2014
India	0.7%	268	8.2%	7.4%	-1.4%	7.2%
World	-2.7%	306	0.5%	3.3%	-1.3%	3.7%

Source: [22]

5.3. India’s Action plan to Mitigate Carbon Emission

- All coal-fired power stations are required to have stringent emissions standards and efficiency targets.

- Renewable power of 175 GW is to be produced by 2022, including 100GW of solar PV and 60GW of wind. Non-fossil fuel sources will constitute 40% of electric power installed capacity by 2030.
- Energy conservation program will attempt to save 10% of today's energy consumption by 2019. Over the longer term, industry, transportation, buildings and appliances will be required to achieve energy efficiency savings.
- The carbon tax has been increased four-fold to approximately \$6 per tonne of CO₂ and applies to coal, lignite and peat. Carbon tax revenue is redistributed through the National Clean Energy Fund and contributes up to 40% of project costs.
- Perform Achieve Trade (PAT) will have its second phase of energy intensity targets (which has achieved a 4-5% decline in between 2012 and 2015 for eight sectors, iron and steel, cement, fertilizers, textiles, aluminum, pulp and paper, and chlor-alkali).
- 100 'smart cities' with smart energy system have been identified for grant support.
- Additional areas will be covered with forest and tree, saving 2.5 to 3 billion tonnes of CO₂ equivalent by 2030

5.4. Carbon Pricing

Major companies operating across the globe say that they can take faster climate change action, if governments provide stronger carbon pricing and global system puts a proper price on economic cost of emission. Economic reasoning shows that the least expensive ways for each country to implement its INDC is to put a price on carbon emission. To really get the investments to flow into energy infrastructure, we need to put a dollar value on carbon dioxide to create a pool of potential money. A meaningful carbon price would send a clear market signal to investors and, by leveling the playing field redirect investments to low carbon projects. The most common mechanisms to price carbon are emissions trading schemes (ETS), carbon taxes, and emissions standards. There are 18 ETSs, including sub-national jurisdictions in the US and China, and 12 carbon taxation schemes implemented worldwide to meet ambitious goals to reduce GHG emissions. [23] About 40 national and 20 sub-national governments have adopted some form of carbon pricing. These schemes cover about 12% global emissions and typically with modest price (around \$10 per ton or less). [24] As per IMF, average carbon tax of \$ 57.5 per ton of CO₂ across top 20 emitters is justified by national interests. [25]

Since 2014-15, ever since crude oil prices declined substantially, India has moved from a carbon subsidization regime to one of significant carbon taxation regimes, particularly for petroleum products. Since October 2014, Government of India increased the carbon tax by nearly \$60 per ton of carbon dioxide for petrol and nearly \$42 per ton for diesel. Green energy cess on coal was twice doubled from Rs 50 per ton to Rs 100 per ton in 2014 and again to Rs 200 in 2015 towards National Clean Energy Fund.

5.5. Implications of Policy on Business

- India requires a cumulative investment of \$2.8 trillion, an average of \$110 billion per year, to make the energy available as per requirement. 75% of this will be in power sector and an additional \$0.8 trillion to improve energy efficiency [1]
- Tax-free infrastructure bonds of \$794mn will be floated for financing renewable energy projects during 2015-16.
- Grants of \$8bn, or \$15m per smart city per year for the next five years, has been earmarked for 100 smart cities. Private sector investment is expected to play significant role in this funding.
- India has relaxed FDI provisions as part of its 'Make in India' schemes with a view to encourage private funding for indigenous manufacturing.
- Efficiency measures are to be taken by business to reduce their PAT exposure. Certificates bought to make up for missed targets in phase 1 are estimated to cost business \$5.4bn.
- In July 2014, BJP led NDA Government formulated a \$12.5 million demand side incentive plan under National Electric Mobility Mission Plan. Since April 2015, these incentives are being provided in the form of discounts on electric vehicles under a scheme 'FAME India' (Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India).
- Funding of clean energy technologies may exceed \$2bn which was provided in 2014 as a result of recycled revenues from the doubled carbon tax.
- \$6.2 billion a year for forest conservation has been allocated in the Union Budget 2015-16. The lower House of Parliament has passed Compensatory Aforestation Fund Bill 2015, which aims to augment country's forest cover from 21.34% of land to 33%.

5.6. Funding of Green Projects

India's energy transformation needs investment. India has sought technology transfer and funding support from developed countries, particularly waiving intellectual property costs for technologies that can help India improve its energy production and efficiency.

Multilateral Development Banks have pledged to support developing countries. [20] Special funds have been created for this purpose. Some funds where India can benefit from are:

- The UK Department for Energy and Climate has formed a joint venture with the Green Investment Bank to channel \$304 million into clean energy and energy efficiency projects in India, South Africa, Kenya, Rwanda and Tanzania through the UK Climate Investment Fund.
- Asian Development Bank will double climate financing up to \$6 billion annually by 2020.
- International Solar Alliance, an Indian initiative, aims at providing off-grid affordable solar power. India will provide \$62 million over 5 years to 2020/21, including making collateral provisions such as land and \$27 million of funding for maintenance cost. The Alliance is hopeful to mobilize more than \$1,000 billion investment by 2030, required for the large scale deployment of affordable solar energy. [26]
- A group of 28 investors including Microsoft's Bill Gates, Facebook's Mark Zuckerberg and Amazon's Jeff Bezos have founded the Breakthrough Energy Coalition which pledges to support early stage clean energy technology.

5.7. Mission Renewable Energy

Presently, renewable energy accounts for approximately 12% of India's total installed power generation capacity, and 5% of the total generation. India aims to reach a renewable energy capacity of 175 GW by 2022. 100 GW of this is planned through solar energy, 60 GW through wind energy, 10 GW through small hydro power, and 5 GW through biomass-based power projects. Of the 100 GW target for solar, 40 GW is expected to be achieved through deployment of decentralized rooftop projects, 40 GW through utility-scale solar plants, and 20 GW through ultra-mega solar parks. Considering these targets, renewables (solar, wind and hydro) will account for about 10% of the total energy mix, by 2022. [27]

Solar Mission – 100 GW

India has set an ambitious goal of providing uninterrupted power for all homes, industrial and commercial establishments and adequate power for farmers by 2022 through its “24X7 Power for All program”. India aims to achieve a “solar revolution” by installing 100GW of solar power by 2022 - a thirty fold increase from 3.4 GW in early 2015.

The above includes an official target of installing 40GW of grid connected rooftop solar PV (GRPV) by 2022. Further, 33 solar parks have been approved in 21 States with aggregate capacity of 19,900 MW. Solar Energy Corporation of India has released Rs 54.93 crores to respective States from the sanctioned amount of Rs 374 crores.

Going by the drive of the Government at centre and States and the projects underway, it provides confidence that the things will materialize. As part of 100 GW solar plan, as on 31.01.2016, 5248 MW of projects (under schemes of Central and State Governments and also under private initiatives) have been commissioned, out of which 1504 MW was commissioned during 2015-16 (by end January 2016). It is expected that by end March 2016, 3790 MW projects are likely to be commissioned. [28] Solar tariff trend seen from bidding by various State Governments for solar parks done during December 2010 to January 2016 points towards tariff of Rs 5 per KW, which is lower than Rs 5, the generation cost of a new coal based power plant.

In order to expand the use of solar energy in the country, Government of India has launched several schemes and released Rs 1,930.94 crore in the current fiscal till January 31, 2016. Government had released Rs 568.64 crore in 2012-13, Rs 636.20 crore in 2013-14 and Rs 1,111.28 crore in 2014-15 under the solar energy program.

Domestic Content Requirement of Solar PV Cells & Modules

Government is stepping up production of solar equipment under the ‘Make in India’ initiative. The solar cell and module manufacturing capacity in the country stand at around 1,300 mw and 4,000 mw, respectively. Government is providing concessional Customs and excise duty exemption on raw material required for manufacturing solar energy equipment. This however has attracted adverse pronouncement from WTO panel. It is alleged that the viability gap funding scheme of Jawaharlal Nehru National Solar Mission violated WTO Agreement on Trade Related Investment Measures (TRIMS) and Agreement on Subsidies and Countervailing Measures (ASCM). India has been contesting this.

Wind Power

India has the fourth largest installed wind power capacity, which is 27 GW, in the world, after China USA and Germany. Wind power accounts nearly 8.5% of India's total installed power generation capacity and generated 28 GW power in 2014-15 which is nearly 2.6% of total electricity generation. Government of India has announced a revised estimation of the potential wind power resource (excluding off shore wind power potential) from 49 GW assessed at 50m Hub heights to 102 GW assessed at 80m Hub height at 15% capacity factor.

5.8. Regional Cooperation in Energy

Differing resource endowments, development needs, and demand patterns among the countries in Asia create significant opportunities for cooperation and trade in energy sector. Energy surplus countries (Nepal, Bhutan, Central Asian countries, Iran and Myanmar) are likely to benefit from energy export-led growth and implementation of large scale regional projects. Countries with significant energy import needs (India, Pakistan, Sri Lanka, and Afghanistan) will secure enhanced energy availability. Bangladesh will improve mix in energy basket. SAARC platform is expected to play significant role in building mutual trust, develop regional institutions and physical infrastructure, and partner with other multilateral development organizations.

6. CONCLUSION

The issues analyzed and scenarios presented in this paper together portray a plethora of possibilities, conditioned on multiple favorable complementarities. Things have to turn positives at both macro and micro level and also at socio political and behavioral level. We are dealing with civilization, science and technology and nature at atmospheric level. One sixth of humanity, together with the balance, existing at heterogeneous level of development, have to carry a common mission, that is to grow the economy, produce and consume energy and sustain the environment.

The path outlined in this paper is just an opening in the subject for scholars and policy makers to view the issues in totality. Nothing in the realm of economy, energy and environment can be predicted. But every development has to be dealt with clarity, confidence and collaboration.

The paper concludes that India has made an ambitious beginning in 2015. The path ahead is both challenging and rewarding.

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