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In Search of Structured Business Model for Renewable Energy Expansion in India

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Abstract

While overall power generation in India has been increasing over the years, the coverage of households in the energy access net (with 38% of total households or over 500 million people having no energy access) and availability of supply (at only 5-6 hours/day) are still prime concerns for the Government. In such a scenario, is renewable energy an alternative given the shortage of supply from conventional sources, with over 30,000 MW stranded power plants, commitment of the Government to set up 100 Smart Cities, High-speed/Semi-speed Rails, Industrial Corridors and more beyond that 'power to all' by 2022' Through this study, an attempt has been made to understand the socio-economic-environmental impact of renewable energy expansion and examined the factors that govern the feasibility and/or viability in meeting the ambitious clean energy target of 175 GW set out by the Government. The key determinants of renewable energy are found to be functionality variation, pattern of household's energy consumption, willingness-to-pay, behavioral change in tariff and cost, grid integration, energy efficiency and access to cheap green finance. Selective implementation of a combination of On-Grid, Off-Grid and localized Mini-Grids application and flexible revenue modality such as 'Pay as-you-go' in off-grid areas and 'Net-metering' or 'Feed-in-tariff' concept in grid-connected areas are best suited. Further, enforceable renewable purchase obligation, renewable generation obligation, faster and efficient implementation of renewable energy certificates as tradable commodity, carbon trading as a source of revenue, green marketing, mobilization of funds under corporate social responsibility and single procurement of all renewable energy by a centralized unit would go a long way in achieving the renewable targets.

Key words: renewable energy, energy access, finance, willingness-to-pay, green marketing, energy efficiency, renewable instruments, market failures

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I. Introduction

Energy is a primary input in the aggregate production function and a key source of economic growth, industrialization and urbanization. Availability of energy is pre-requisite to achieve a broad-based sustainable and inclusive growth. Rapid population growth and rising incomes have led to faster growth of energy demand. Compelling forces such as persistent energy deficit, economic and political uncertainty, energy security, climate change and greenhouse gas emissions, conventional resource constraints, urbanization and development etc. have made countries around the globe to look for alternate sources of energy. While overall power generation in India has been increasing over the years, the coverage of households in the energy access net (with 38% of total households or over 500 million people do not have energy access) and availability of supply (at only 5-6 hours/day) are still big concerns for the Government. *The key and central question* in such a scenario is whether 'renewable energy (RE) an alternative given the shortage of supply from conventional sources, with over 30,000 MW stranded power plants, commitment of the Government to set up 100 Smart Cities, High-speed/Semi-speed Rails, Industrial Corridors and more beyond that 'power to all' by 2022' ??? It is estimated that India's energy consumption as percentage of global energy will increase from current 6.65% to 18% by 2035 and India will become the second largest energy consumer in the world. Commercial energy consumption in India overtime has been growing at a compound annual growth rate (CAGR) of 6%, which is more than the CAGR of GDP during the last two decades. Since, India is a net energy importer, especially crude petroleum and coal, for which it has to pay a high import bill, no surprise then that India would usually be one of the biggest victims of any energy crisis in the future.

1.1 Objectives of the Study:

a) To assess the extent of energy deficit and growth of renewable energy in India;
b) To understand net aggregate socio-economic effects of renewable energy through employment, income generation, health improvement and other sectorial implications;
c) To identify the key determinants of renewable energy.
d) To assess the behavioral change in tariff of renewable energy and its implication on subsidy given the form of grant given to make it commercially viable;

e) To assess the substitution effects of subsidy on kerosene and diesel and carbon emissions caused by them;

f) Understanding the impact of renewable energy generation on the thermal electricity price in India.

g) To examine the existing policy framework and finding appropriate business model for renewable energy;

II. Survey of Literature:

Sharma (2007) stated that energy is a driving force to foster economic, social and health condition. Energy effect all the dimensions and supporting pillars of sustainability. All the supporting pillars namely environment, social and economic should go hand in hand without compromising on its ability for the future generation to satisfy their own need. *De Young (1993), Mitchell and MacNulty (1981), and Carlson et al. (1980)* concluded that many analysts in academia and government suggested that the only way to solve the energy crisis back in the 1970s was to change social norms, practices, and expectations**.** *Prabhu, Narayanan and Mathew (2011)* estimated solar energy potential and stated that India receives nearly 3000 hours of sunshine every year, which is equivalent to 5000 trillion kWh of energy. India can generate over 1,900 billion units of solar power annually, which is enough to service the entire annual power demand even in 2030. *Buragohain (2012)* summarized that solar home-lighting system in the remote village can influence the life of people very significantly for their betterment. Substantial reduction in expenditure on kerosene has been found in the households of all income groups due to solar home-lighting system. This has mostly benefited women and children. Women find it easy to do household activities whereas children get enough light to study at night. Crime rate has also been declining due to availability of light in the village. Most of the beneficiaries of solar home-lighting system are very happy with the functionality of the system**.** *Muneer, Asif, and Munawwar (2005)* suggested that India should adopt a policy of developing solar power as a dominant component of the renewable energy mix, since being a densely populated region in the sunny tropical belt; the subcontinent has the ideal combination of both high solar insolation and therefore a big potential consumer base density. In one of the analyzed scenarios, India can

make renewable resources such as solar the backbone of its economy by 2050, reining in its long-term carbon emissions without compromising its economic growth potential. *Blazejczak et al., (2011)* stated that renewable energy expansion can be achieved without compromising growth or employment. The analysis reveals a positive net effect on economic growth in Germany. Net employment effects of renewable energy expansion are positive and strongly depend on prevailing labor market conditions i.e. more flexible labor market conditions lead to substantial job creation**.** *Bassi et al., (2009)* concluded that higher energy prices may work as a drain to energy users' budgets and hurt the competitiveness of energy-intensive industries which leads to a contraction of economic activity in terms of lower consumption and profit or investment. *Li, Wang, and Shi (2005)* analyzed the role of renewable energy in China and its contribution to the energy supply and generating capacities development dynamics. They mainly discuss wind, solar and biomass energy and concluded that renewable energy is developing very fast in China and have big potential for further expanding. There is still no nationwide feed-in tariff and complete solar power industry encouragement system. The technological sphere of solar power conversion in China needs more financial support and R&D, renewable energy policy making and implementing process in China still is not enough to provide good conditions for domestic solar power market development. There is also lack of attempts to assess the overall solar energy potential in China based on different geographical, recent technological and economical driven factors.

1.1 Scope of Study:

The current literature review presents the social, economic and environmental aspects of RE. *The examination of critical issues such as willingness to pay especially in the rural areas, pattern of household energy consumption, market failures for RE, energy efficiency and green marketing* etc. have not been deliberated in most of these studies. There is also lack of attempts to assess a market driven strategy or optimal policy-mix for RE given the constraints of conventional sources.

III. Research Method

The methodology is based on case analysis of existing empirical literature findings and recommendations of various reports published by different authorities and institutions.

These have been presented as supportive arguments against each suggested business model wherever suits.

IV. Analysis and Discussion

Any structured business model depends on demand and supply side management. While the demand side is driven through growth of economic activities, population base under the energy access net and a robust tariff policy to take care a minimum return on investment; the supply side is affected by the extent of electricity mix, grid synchronization and other requisite measures necessary to pull investments into the RE sector. It is also necessary to understand the paradox of energy deficit and extent of RE growth, net aggregate socio-economic effects of RE, determinants of RE, substitution effects, behavioural change in tariff, likely demand and willingness-to-pay for energy which are detailed in the section below.

a. Global Energy Deficit:

The 9th session of the Commission on Sustainable Development (*CSD-9, 2001*) concluded that "Energy is the central in achieving the goal of sustainable development'. About 1.6 billion of world populations have no access to electricity, of which about 80 per cent live in rural areas of developing countries in South Asia, Central America and South America. South Asia is home to 41% of the World's energy-poor, with over 400 million people having no access to electricity. Of these, 75 million rural households are not connected to the electrical power grid and another 80 million are underserved by electrical utilities in India. The *World Energy Outlook 2012* estimated that nearly $1 trillion in cumulative investment, around $49 billion per year is needed to achieve universal access by 2030. *Asian Development Bank Knowledge Showcases, August 2013, Issue 48* concluded that energy-poor households in India spend over US$2 billion annually on kerosene alone, of which US$1.8 billion is spent by rural households. At a monthly expenditure of US$9 for lighting and other energy needs, India's rural households spend half of their money to electrify their homes, the average monthly rural per capita consumer expenditure being US$19. It is

almost self-evident that lack of energy access is primarily a rural issue and energy poverty is worse than income poverty.

b. The Paradox of India's Power Sector Deficit:

The overall power generation in the country was 256 GW by end December 2014, with a registered growth rate of 6.04% over the 11th Plan period (2008-09 to 2012-13). However, the paradox while per capita electricity consumption in India is the lowest in the world (one third of global average consumption), it has been increasing persistently over last few years and is expected to reach 1900 kWh by 2032 from the current 914.41 kWh in 2012-13, is a real challenge. India is in a state of perennial energy shortage with a demand-supply gap of almost 12% of total energy demand and around 4% of total electricity/power demand. As the economy is expected to grow at a higher pace in coming years, to sustain this level of growth India needs to quickly add energy generation capacity. The electricity demand, therefore, will further rise as there is strong correlation between rise in energy consumption and economic growth. An empirical study by Ministry of Power reveals that to support Government's target of 8% annual GDP, electricity supply will have to increase by more than 10% annually whereas the current growth rate of generation is 6.04% in 2013-14 (the estimated growth rate for 2014-15 is 5.77%). In such a scenario, RE may play a crucial role in feeding India's energy hungry stomach.

1. Global RE Scenario: several studies have concluded that energy access based on renewable energy is plausible and cost-effective option to reach the masses. In recent years, the use of Renewable Energy Sources (RES) like wind, solar, biomass and hydro has increased substantially worldwide. *Renewable Energy Network (REN21, 2011)* assessed that global installed wind capacity increased from 6.1 GW in 1996 to 198 GW in 2010, whereas global solar photovoltaic's capacity grew from 0.7 GW to 40 GW. Total investment into renewable energy technologies rose from US$22 billion in 2004 to US$211 billion by 2010. According to *International Energy Agency (IEA, 2010)*, in coming decades, further large scale deployment of RES technologies is projected in most industrialized countries. The *European Union (EU, 2009)* aims to

increase the share of renewable energy in final energy consumption to 20% by 2020, which implies even larger shares in power generation. According to *German Government's Energy Concept (BMWi and BMU, 2010)*, renewable should supply 35% of gross electricity consumption by 2020, 50% by 2030 and 80% by 2050 and that the power sector could be mainly based on RES in the long run.

2. Indian RE Scenario: the Integrated Energy Policy of the Government suggested a number of policy interventions to provide energy security for the country including development of domestic resources both fossil fuels and renewable to maximize the domestic supply base to ensure any unprecedented supply shocks. With coastline of 7516 kilometers and located in the Tropic of Cancer, India has got surmountable potential for generation of renewable energy. The current contribution of RE to total power installation of the country is 13.6%, with share of wind energy at 8.79% and solar energy at 1.20%. With around 78% wind energy and 99.6% solar energy potential remains untapped, India has the potential to be amongst the top 3 countries globally in the next five years in terms of installed capacity of renewable energy, thereby creating millions of new jobs, reducing poverty and achieving sustained socio-economic development. While India is the 4th largest producer of wind energy globally, solar power has the potential to meet 7% of our power needs by 2022, mitigate 2.6% of carbon emissions and reduce coal imports by 71 million tones i.e. Rs. 33,000 crores per annum. The solar energy potential estimated by National Institute of Solar Energy is approx. 748 GW which is sufficient to meet total energy demand of the economy by 2030. Keeping in view its potential, past performance and its importance to long term energy security of the country, the Government has recently revised the cumulative targets of renewable energy to 175 GW [100 GW Solar, 60 GW Wind and 15 GW mini-hydel and biomass-based] by 2022 at an estimated investment of over US$ 300 billion. This will not only lighten over 500

million people who do not have electricity access but also provides 24X7 electricity supply to all- commercial, institutional and households.

Table 1: Capacity and expected growth in renewable energy in India (*MNRE, 2015*)

	Solar PV and CSP	Wind	Biomass	Small hydro
Total potential	5,000 trillion kWh per year	48,000 MW	23,700 MW	15,000 MW
Installed capacity (as on 31.12.2014)	3062 MW	22,465 MW	4730 MW	3,990 MW
Projected capacity in 2022	1,00,000 MW	60,000 MW	10,000 MW	5,000 MW in 2015

c. *Net-aggregate Socio-economic Effects of Energy Especially Renewable Energy:*

The extent of electricity consumption of a country is one of the indicators of socio-economic development. While overall power generation in the country has been increasing over the years, the coverage of households in the energy access net is still a concern for the Government. According to Census 2011, percentage of households using electricity as primary source of energy for lighting stands at 55.3% in rural areas, 92.7% in urban areas and 62.2% overall. This indicates that about 44.7% of the rural households do not have access to electricity. Even, the availability of supply (@ only 5-6 hours/day) and quality of power in the electrified households is a bid challenge. Energy access thus, crucial for inclusive and equitable growth as well as for reduction of poverty and improvement in the quality of life of people in rural India and providing opportunities for human development.

Renewable energy has net positive economic effects through employment and income generation, health improvement, reduction of subsidy on kerosene and diesel, reduction in carbon emission etc. The relationship between household energy consumption and poverty is bi-directional. Access to modern energy can contribute to poverty alleviation, but its lack is not only in itself a sign of poverty but also contribute to it. Access to modern energy services significantly improves the quality of life in many ways- lighting, health, education, communication, entertainment etc.

According to *Global Network on Energy for Sustainable Development (GNESD, 2007)*, without adequate supplies of affordable energy, it is impossible to improve health, education and reduction of poverty. It would also allow productive activities like water pumping, micro industry and agro-processing in the rural areas which would improve livelihoods and drive basic economic development.

According to *United Nation (2007)*, energy is crucial for sustainable development, poverty eradication and achieving the internationally agreed development goals, including the Millennium Development Goals. Access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services is crucial, particularly in developing countries. While fossil fuels will continue to play an important role in the energy supply in the decades to come, every effort must be made to diversify the energy mix. *World Bank's* campaign for 'Sustainable Energy for All Initiative'- includes achieving universal access, accelerating improvements in energy efficiency, and doubling the global share of renewable energy by 2030. It recognizes that each country's transition to sustainable energy sector involves a unique mix of resources opportunities and challenges, prompting a different emphasis on access, efficiency, and renewable energy.

The RE sector is a source of temporary and permanent employment generating substantial numbers of both unskilled and technical jobs. The employment is balanced and well distributed across the entire major RE sectors and the functional areas of employment (e.g. design, installation, fabrication, operations and maintenance, project development and marketing). As per the data available for year 2009, the distribution of the jobs across the individual RE sectors is displayed in following table.

Table 2: Distribution of Jobs across RE sectors (*IRENA, 2011*)

Type of Job	All RE	Wind	Solar PV	Solar Thermal	Hydropower	Biomass
Direct and Indirect	350,000	2,000	112000	41000	12500	142,500

Based on RE sectorial growth, it is estimated that employment opportunities would grow many folds in coming years. The table below shows estimated employment possibilities in moderate growth and high growth scenarios for the RE sector in the

country. Based on these estimates it can be predicted that the job market in the RE sector will witness a average annual growth, ranging from a low of 18.2% for moderate growth scenario to high of 27% for the high growth scenario for the period 2009-2020. Considering the fact that India needs to generate an average of 15 million jobs annually to address unemployment issue (Business Line, 2013), RE sector can play a very important role in supporting the social and economic growth in the country.

Table 3: Estimated employment in the RE sector- Moderate and High Growth Scenarios (*MNRE & CII, 2010*)

Scenarios	Estimated Employment generated in 2009 (No.)	Estimated Employment by 2015 (No.)	Estimated Employment by 2020 (No.)
Moderate Growth Scenario	3,50,000	5,89,000	10,51,000
High Growth Scenario		6,99,000	13,95,000

The RE projects substitute fossil fuel, thus focus on such projects can help reduce the GHG emissions from the energy sector. Considering the life-cycle approach, the net CO2 emissions from RE projects is significantly lower than that of coal and natural gas based energy generation facilities as shown in table below.

Table 4: Life-cycle Emissions from Power Sources (*MNRE, 2015*)

LCA Emissions (g CO2 equivalent/kWh)	Wind	Solar	Nuclear	Coal CFB
Implementation	13.7	37.5	1.2	3.6
Operation	4.7	12.0	12.4	918.8
Decommissioning	0.6	0.5	0.4	52.2
Total	19.0	50.0	14.0	975.3

At the local level the environment and social impacts of the wind and solar farms are negligible if the projects are developed on wasteland. For projects coming up in environmentally fragile regions adequate regulatory safeguards do exist. Renewable projects don't have long term irreversible impact on the local environment due to zero emissions associated with operations. As established by life-cycle assessment, RE projects have comparatively low environmental externalities that too are limited to project development phase. The RE projects don't generate solid or liquid effluents during operations and thereby pollution of land, surface water or ground water resources is not anticipated from such projects. During the operations phase the impacts on the surrounding environment are negligible, and are reversible in nature and can be mitigated by proper Environmental Management plan.

d. Determinants of RE:

The key to success of RE expansion plan as proposed by the Government will be determined by the following factors:-

1. Mapping of functionality variation, households access to energy and pattern of household consumption (electricity, heat, fuel vis-à-vis total energy consumption).
2. Willingness-to-pay for renewable energy: a demand survey of primary and discretionary choices of India's rural households for solar power generated through mini/micro-grids. Willingness-to-pay for energy in the rural areas is very strong due to effects of modern consumerism. Studies over the years suggest that electricity consumption has high value for rural households, and where access exists, willingness to pay is high even amongst the poorer households *(ESMAP, World Bank, 2004)*. Several studies have concluded that if it ensures early access, the point of contention should not be the level of tariff but the proper supply of electricity *(Singh, J.and Neuhoff, K. 2007)*.
3. Understanding the market failures of renewable energy instruments such as renewable purchase obligation (RPO), renewable generation obligation (RGO), renewable energy certificate (REC) frameworks etc.

4. Create an enabling environment for investment in RE. Studies suggest that renewable energy boom in Germany was triggered by supportive policies. Renewable energy utilization for heating is encouraged by ordinances, investment grants, low interest loans and other market incentive programs *(Schimschar et al. 2011)*.
5. Exploring sustainable business strategies and/or commercialization of RE beyond need.

e. Behavioral Change in Renewable Tariff:

Bassi et al., (2009) advocated that higher energy prices may work as a drain to energy user's budgets and hurt the competitiveness of energy intensive industries which leads to a contraction of economic activity in terms of lower consumption and profit on investment. There has been a drastic reduction in the tariff rates of renewable energy (reduced from Rs.15 per unit over a decade ago to Rs. 4.5 per unit now which is almost equal to thermal) and its implication on subsidies in the form of grant given by the government to make it commercially viable. The tariff and per unit cost of generation have been reducing over the years due to improve technology, greater emphasis on R&D and energy efficiency. Reducing tarif accompanied by technological advancement, easy finance and increase in thermal tariff over time may make renewable a feasible commodity in future.

f. Substitution Effects:

Renewable energy as a substitute to kerosene and/or diesel may not only serve a large sunk of the un-served/under-served rural population but will also necessary to balance the demand-supply equation of energy to ensure energy security and independence, besides contribution to clean environment. At current subsidy of Rs. 35/litre of kerosene, and saving of 25 liters annually per household, the savings for 2 million households would be Rs. 175 crore (1.75 billion) in the first year. This will be the amount added additionally for each year. Over 15 years, subsidy of about Rs. 24,000 crore (240 million) alone would be saved at current prices apart from many other benefits replacing kerosene such carbon emission etc.

g. Sustainable Business Strategy:

Considering that large number of people are outside the energy access net, geographical variations and socio-economic development status among different regions, there is a need to commercialize renewable energy beyond need with a combination of the following strategies:-

1) Pay as-you-go in rural areas as willingness to pay of rural people have been changed due to modern consumerism, net-metering in urban/semi-urban areas and feed-in-tariff concept wherever there is a possibility of loading renewable energy into the grids. This requires ensuring required payback to investors. Cost recovery to private investors will be possible only if appropriate tariff is charged to the beneficiaries or the state decides to subsidies the tariff in a programmatic way.
2) Supply side management and integration of renewable into electric grid: Synchronization of optimal electricity mix through grids, transmission and smart grid facilities are essential to sustain RE business. Where the load is largely day time, solar could be tried. Where longer, biomass gasifiers could be an option for augmentation, but rest must come from the normal grid.
3) Manufacturing of RE equipments along with generation of energy may be designed under the Make in India programme. This will make RE generation cost effective as most of these equipments are imported.
4) Corporate social responsibility (CSR) and green marketing: as part of CSR while companies may be given the option to choose an un-electrified village for development as 'model solar village', they may be allowed for green marketing initiatives such as creating awareness campaign about scarce resources and to save energy through use of energy efficiency appliances including LED lights.
5) Commercial enterprises may be encouraged to develop least electricity consumption appliances such as solar based electric cooking stoves as there is huge untapped potential demand in the rural areas. For example, as per 2011 Census, almost 85% of rural households were dependent on traditional biomass fuels for their cooking energy requirements. NSSO (2009-10) data shows that

76.3% households in rural areas depend on firewood for cooking. A study has calculated that if a programme of 150 million stoves is implemented, 196 MT of solid fuels would be saved annually, of which 95 MT would be wood and 6 MT would be coal, both caused emission of GHG. The study further estimates that this will reduce 4% of India's total estimated GHG emissions and 0.15 MT of annual reduction of Indian black carbon emissions. Similarly, automobile companies may be incentivized to produce electric vehicles on a large scale and provisioning of solar electric charging pumps/stations in line with the concept of petrol pumps to ensure fuel supply continuity. However, such schemes could be made successful through provisioning of structured incentives such as grant, tax holidays, easy financing etc. to the commercial enterprises by ensuring that part of the benefit is being transferred to the end consumers.

h. Policy Interventions:

While constant reduction in generation cost and renewable tariff, and bringing energy efficiency will make solar energy expansion plan a success, government's intervention requires in the form of-

1) Technical: selective implementation of a combination of On-Grid, Off-Grid and localized Mini-Grids application wherever suits. Also creation of green-energy-corridors and large solar parks for scale and economy operation.
2) Procedural: strict enforcement of RPO and/or RGO through necessary amendments in the Electricity Act; faster and efficient implementation of MAT and Accelerated Depreciation; making Renewable Energy Certificates (RECs) as tradable commodity and/or carbon trading as a source of revenue; procurement of all renewable by a centralized Unit, etc.
3) Fiscal and financial: tax free solar bonds; roof top solar as part of housing loan by banks and Financial Institutions; RE for priority sector lending; setting up of 'Green Energy Funds' by banks/FIs; raising the kitty of National Clean Energy Funds (NCEF), raising ECB limits for RE, international long term loans from multi-lateral/bi-lateral/international donors, launch of solar park financing vehicles (SPFV) to issue solar bonds etc.

V. Conclusion:

RE deployment becomes an obvious choice for ensuring country wide energy security and access, particularly in remote areas where off-grid applications are the preferred solution. Promoting RE, therefore, will lead to both economic growth and social development in the country. However, challenges such as last mile connectivity, bringing down transmission losses into a desired level, financial bankruptcy of state utilities, domestic manufacturing of solar equipments, adequate emphasis on R&D, mobilizing easy finance, making available skilled and semi-skilled rural labour force and increasing consumer awareness etc. will remain as concerns for the power sector in general and renewable energy in particular.

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