Title: LED technologies, a way to create sustainability in Energy Sectoral System of Innovation of NICs: A case of India

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Abstract:

The energy sectoral system of innovation (ESSI) in India has multifarious challenges of sustainability for production, effective transmission, and efficient use of energy through application and adoption of innovative strategies, technologies, policies, and approaches. The paper focuses on a couple of the power saving technologies i.e. LEDs (Light Emitting Diodes). It identifies the key driving features of LED for sustainability of ESSI in India. Further, it explores the potential effects of adoption of LED technologies on saving of energy, lowering carbon foot prints, lessening of generated electrical waste, self life of lights, reducing the hazardous substances and economic effectiveness in ESSI. In the next section paper argues that how application and adoption of LED technologies can create sustainability in ESSI. Finally, it discusses the dynamism of ESSI in context of energy saving technologies.

The most important driving features for sustainability of LED technologies in India include product availability, increasing competitiveness, environmental friendliness, cost effectiveness, hazardousness, durability, low power consumption, and all weather usage. Further, the results shows that the use of light emitting diodes technologies in street lights, commercial lights, traffic light, signage and display boards has reduced the level of energy consumption by more than 50% and create an equal amount of power. It lowers the carbon footprint by half and significantly less quantity of electrical waste. In addition, they generate no mercury which is generated by many of the other lighting systems which are presently in use. The results support that the LED technologies create sustainability in the energy sectoral system of innovation by making replacement of presently applied technologies. This sustainability is proved in terms of ecological friendliness, power saving, long life, less uncertainties, long term financial viability and technological availability.

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1. Introduction

India is a relatively energy-scarce country, relying heavily on oil imports, and its power sector has not been able to meet the growing demand, resulting in poor reliability of grid power, significant supply shortages, and lack of access to electricity by about half of the rural population. The combination of exposures to power outages and oil price volatility might have affected the industry structure with respect to the use of energy and hence CO_2 intensity.

India has developed strategy for making available power to all by 2012 that includes promoting energy efficiency and its conservation on all the possible fronts, which is found to be the least cost option to constrict the gap between demand and supply. The Energy Saving Company (ESCo) projects in Newly Industrialising Countries, including India, have become part of strategies fulfil such gaps.

India energy sector is likely to add a capacity of 78,577 MW during the 11th Plan, whereas during the 12th Plan the tentative capacity addition is expected to be 82,200 MW. Further, it has also been estimated that in the long term the projections of electricity requirement are expected to grow, with the Installed Capacity requirement by 2031-32 being about 7.6 lakh MW and 9.6 lakh MW, with 7% and 8% growth rates respectively (CEA and CII, 2007).

Nearly 25,000 MW of capacity creation through energy efficiency in the electricity sector alone has been estimated in India. Energy conservation potential for the economy as a whole has been assessed as 23% with maximum potential in industrial and agricultural sectors (Ministry of Power, 2010). Government has turned this strategy in reality through enactment of the Energy Conservation Act, 2001 (52 of 2001). In fact, electricity is a concurrent subject in Seventh Schedule of the Indian Constitution. It means both Union and state can make law on this subject. Therefore, Parliament of India and the State Assemblies are equally empowered to make laws on the subject of *electricity*- Sl. No. 38 of List-III, Concurrent List (Government of India, 2010) . Hence, Federal structure of the constitution has established the principle of central government and state governments should be able to legislate on power. Consequently, the energy efficiency and conservation becomes common responsibility of center and state. Therefore, to attain efficiency and energy saving in India, there is need for innovations (radical, incremental, and Grass root). However, innovation in sectors has systemic features. The sectors differ along several dimensions related to technology, production, innovation and demand. And that they differ in the type and degree of change (Malerba, SECTORAL SYSTEMS OF INNOVATION AND PRODUCTION, 1999).

The sectoral system of innovation (SSI) (and production) is composed by the set of heterogeneous agents carrying out market and non-market interactions for the creation or generation, adoption and use of (new and established) technologies and for the creation, production and use of (new and established) products that pertain to a sector ("sectoral products"), (Malerba, Setoral System: Concept and Issues, 2004), here case may be of energy sector. SSI has three components viz. knowledge and technology, actors and networks, and institutions. It means every SSI has its own knowledge base, technologies, and (existing and potential) demand. The agents and actors are individuals and organisations at various levels of aggregation with specific learning processes, competencies, organisational structure, beliefs, objectives and behaviours (Malerba, 2005). Therefore, they create a network wherein they interact through a process of communication, cooperation, exchange, competition, and command. This kind of interaction is shaped by the institutions. Moreover, an SSI changes over time through co-evolutionary processes.

A comprehensive understanding of energy sector can be developed through application of the SSI approach. The major benefits of SSI approach is in understanding the dynamics of actors, their interaction and institutional changes in energy (power) sector which helps in making the whole sector competitive and cost effective. The technology is considered as a key actor which shapes the innovation system and has potential to impart sustainability through its application and adoption. Therefore, a new innovative technology, like LED (Light Emitting Diode) potentially proclaims itself as an efficient lighting technology, need to be studied and understand for its claims to impart sustainability. In this context the present paper focuses on a couple of the power saving technologies i.e. LEDs (Light Emitting Diodes). It identifies the key driving features of LED technology for sustainability of ESSI in India. Further, it explores the potential effects of adoption of LED technologies on saving of energy, lowering carbon foot prints, lessening of generated electrical waste, self life of lights, reducing the hazardous substances and economic effectiveness in ESSI. In the next section paper argues that how application and adoption of LED technologies can create sustainability in ESSI. Finally, it delineates the dynamism of ESSI in India.

2. Driving features of energy saving technologies: LEDs

An LED (light-emitting diode) is a semiconductor light source that generates light at a precise wavelength when a current is applied. Each diode is about 1/4 inch in diameter and uses about ten milliamperes to operate at about one-tenth of a watt. Multiple LEDs are networked together in a single fixture to generate (in combination) the appropriate light output for each particular application. In recent years LEDs have begun to penetrate the street and area lighting market due to rapid improvement in the efficacy of white-light LEDs, innovations in fixture design, particularly optical efficiency and thermal management, and extended fixture warranties. Moreover, the key features of the energy saving technologies, like LED which create sustainability in Energy system of innovation, are:

2.1 Better photometric parameters and Visibility (on per watt power)

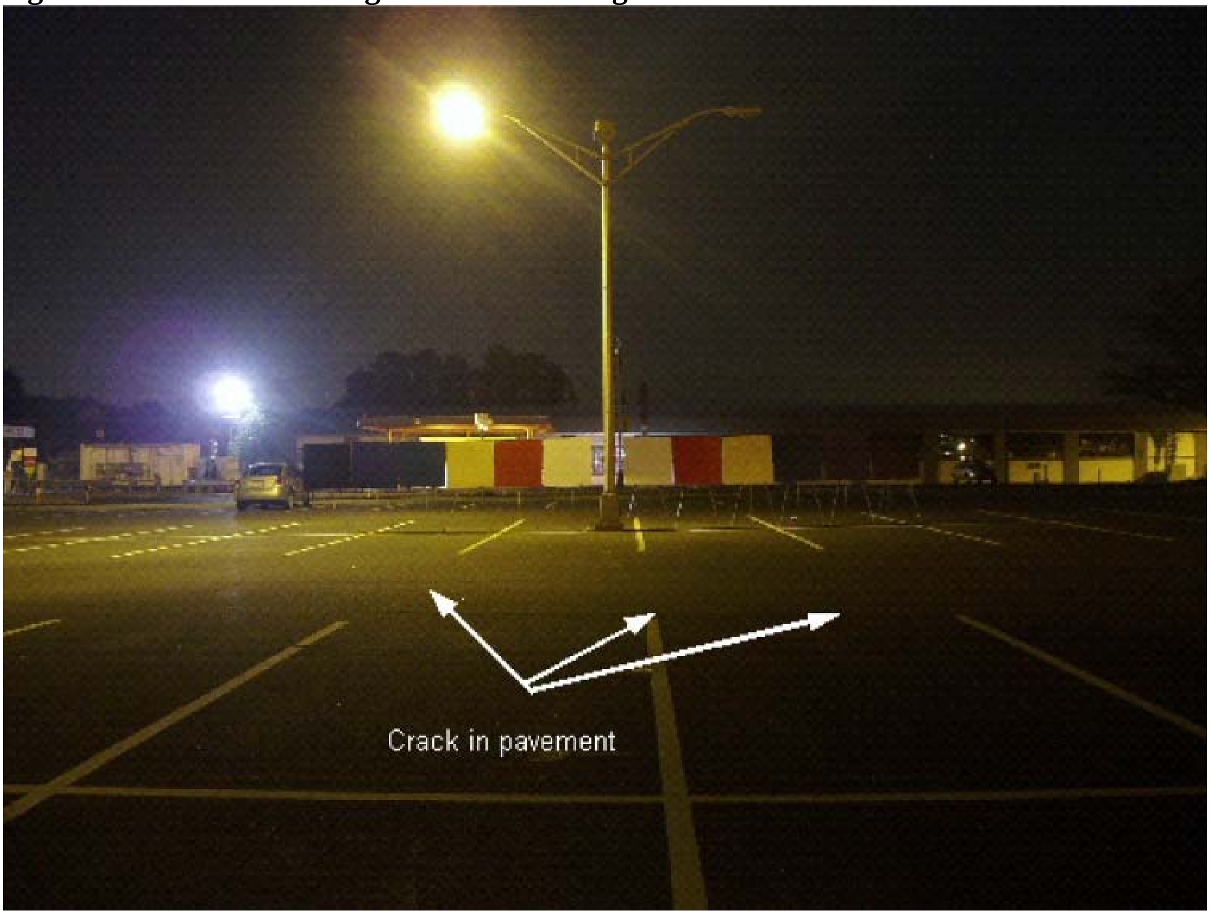
By comparison, it is believed that white light source is more efficient than sodium light source (Szary, 2005). The LED lights have better performance on parameters which determines the level of visibility and clarity in night. The main parameters include colour rendering index (CRI) which signifies ability to reflect the true colour of the surface by a lighting source. A light source with better CRI means better colouring rendering or less colour shifting. CRI between 75 and 100 is considered as excellent, as LED also falls in this range. Following figures 1 and 2 demonstrate the difference between the white light and HPS light CRI.

Figure 1: Colour Rendering Index for White Light Source (LED)

Source: (Szary, 2005)

The above picture shows clearly the colours, more brightness, and clarity. Even cracks in the pavement are clearly visible. In contrast, HPS light does not show much clarity in terms of colours and cracks visibility in figure 2.

Figure 2: Colour Rendering Index for HPS light Source



Source: (Szary, 2005)

The colour appearance of a light source is measured in terms of temperature (Kelvin). The LED lights are available in a range of pure white (5,000~6,500K) and warm yellow (less than 3000K). LEDs have better colour refractions and luminous power than CFLs (Pandey, 2009). Therefore, LED lights provide freedom of choice to different segments of consumer market. Consequently, these features have already created a space for LED lights in India, including NICs.

2.2 Low power consumption

The low power consumption by new technologies in lighting sector is an important driving force for installation of energy efficient lighting system. The LED light luminous efficiency varies from 90 to 110 lm/w, which is significantly high as compare to other sources of light like HPS, MV, Fluorescent and incandescent lamps. In long term, when LED happened to be long life light, such a driving factor has already become a main factor for shifting to LED based street light system in NICs.

2.3 Ruggedness

LED Lights do not have any filament or sparking assembly which may be damaged by vibrations or during transportation. They are more rugged and damage-resistant than compact fluorescent bulbs, incandescent bulbs, mercury vapour lamps, metal halides lamps, and sodium lamps. This becomes driving character for LED lights over the other kind of lighting lamps. Consequently, they can sustain for long time without any damage.

2.4 Produce Less Heat

LED light do not generate light as result of electrical spark at very high temperature as in Metal Halide, HPS, and MV lamps. Therefore, LEDs produce very less heat as compare to other available lights. For instance, the incandescent lamp works by passing an electrical current through the filament, typically made of tungsten, which then glows white hot emitting light. This is not an efficient process as approximately 95% of the energy supplied to the lamp is emitted as heat. This feature is important for efficiency and production of more illumination per watt of power consumed by different lights. Therefore, this has become driving character in designing of energy efficient lighting system.

2.5 Product Availability

With globalisation and liberalisation of markets the LED light are available in all the NICs. Presently, China has become major producer of LEDs along with South Korea, Japan, and US. Consequently, there are a number of companies who make available a variety of LED lights and products in India in-spite of no LED production facilities in India. There are lots of LED fixture manufacturer who are making available a range of LED lights. Some of the important companies are Philips, Avani, Cree, and Nechia. Therefore, the availability of product is a crucial driver for adoption of this product in NICs.

2.6 Increasing Competitiveness

There is increasing competitiveness among technologies and firms which provide products in market for lighting industry. There are more investors in this area in India who are coming forward with more investment for creating competitive market due to recent steps taken by the Government of India. Therefore, the focus has started shifting from CFL to LED which visible from new tender notices for purchasing of LED Street lights by different government departments. Energy efficiency will be a goal that consumers are looking for, businesses are embracing and governments are actively promoting. The combination of demand and market potential is making high brightness (HB) LEDs one of the fastest growing sectors in lighting in the next few years (Itvior, 2010).

2.7 Cost Effectiveness

The cost of a technology is a key factor in decision making for adoption of any technology in NICs, specifically in India. In some circumstances cost can sabotage the whole process of technology selection. The cost of LEDs technologies is more than twice of the cost of other lights like metal halide, sodium and mercury vapour lamp. But the cost of LED lamps has always been a deterring factor. The average cost of a CFL is around Rs 100, while that of an LED lamp was around Rs 200. Now, with the cut in excise duty, an LED bulb will cost Rs 150-170, making it a more affordable option (Times of India, 2010). And homeowners will find that LEDs electric savings will pay off in the long run. By 2015, the cost of ‘warm’ LED lights is expected to slide to $4 per 1,000 lumens versus $2 for ‘cold’ lights, according to estimates from the US Department of Energy. With the support of government policies on taxation and subsidies this factor may become favourable to LED technologies in near future.

2.8 Hazardousness and Environmental Friendly

The light system produces a number of hazardous materials like mercury, sodium and glass. The LED lights do not contain mercury (Webster, 2009) which is dangerous to human and animal health. Further, the accumulation of mercury in the environment and the food chain is a serious environmental and health hazard. Therefore, level of hazardousness of a lighting system is important driving factor for LED technologies. The government policies and environmental activist are likely to support LED light for its green properties.

2.9 Durability or Life Span

The durability or life span is important factor as driving force for making selection out different kind of lights like low pressure sodium lamps, high pressure sodium lamps, mercury vapour, metal halide, incandescent bulb, and fluorescent lamps. None of among all these lighting technologies provides life span more than 20,000 hours. On the other hand LED lights have life span more than 12 years (50,000 hours) (Jamal, 2009), triple to other's life span. This feature is a potential trigger for the demand of the LED light in India, NICs.

In addition, LED lights are non flicker, shock resistant quick light up in micro-seconds, compact, ideal for use in applications that are subject to frequent on and off cycle, and maintenance free. (Jamal, 2009). Such feature make LED as part of better choice as efficient lighting system for all weather usage. If this technology is adopted by the NICs then what effects may result in ESSI.

3. Potential effects of adoption of LED technologies in ESSI

3.1.Saving of energy

LED lights are energy-efficient and are widely seen as the future of lighting technology (Economic Times, 2010) by the future studies experts. The most important finding is that LEDs can save upto six times energy in a year as compared to CFLs technology (Pandey, 2009), which is presently promoted by Govt of India policies, consumers preferences, and cheaper products availability. Generally speaking, the lamination flux of a LED lamp is 3 times that of the fluorescent lamp and 8 time that of the incandescent lamp. That is to say, a 30W LED lamp can replace the 90W fluorescent lamp and 240W incandescent lamp (Yangzhou Yalian Optoelectronic Technology Co., Ltd, 2010).

3.2.Less carbon intensive ESSI

The adoption of LED technology results in the saving of energy that mean less energy consumption for the providing lighting system at the same illumination. Consequently, less quantity of carbon is emitted by same system. A row of 24 brand new street lamps equipped with LEDs supplied by Avnet Electronics Marketing India is now saving 10th Main Street in Bangalore's Sadashivnagar neighbourhood up to 70 per cent of the energy and money burned by conventional lights. These are the first LED street lamps installed in Bangalore (Itvior, 2010). Cary Eskow, director, LightSpeed of Avnet Electronics Marketing Americas, believes that energy efficient LED lighting could help India to achieve the voluntary 20-25% carbon reduction commitment made by minister of state for environment and forests Jairam Ramesh in the run up to the United Nations Climate Change Conference Copenhagen 2009. (Itvior, 2010). The carbon emission rate is 1kg per kWh power production from coal in India which is imported from Australia. The carbon emission rate is more than 1 kg per kWh for lignite based power production. Therefore, with saving of 100,000 kwh power with use of LED can result in reducing 100 tonnes of carbon emission.

3.3.Lessening of generated electrical waste

The adoption of LED light leads to generation of less waste when the lamp expires. When a lamp breaks it generate lots of electric waste which is almost zero with LED lights because these are completely recyclable. Therefore, waste management problem can also be addressed by shifting to LED technologies in different Indian cities.

3.4.Long life of light system

They also have good vibration resistance and low starting temperatures, making them a good choice for rugged operating environments. LED lights have long life that varies between 50,000 -80,000Hrs. When LEDs lights are used for 10 hours a day, the life can be more than 13 years that is 5-10 times more than the working life of traditional sodium or mercury lamps.

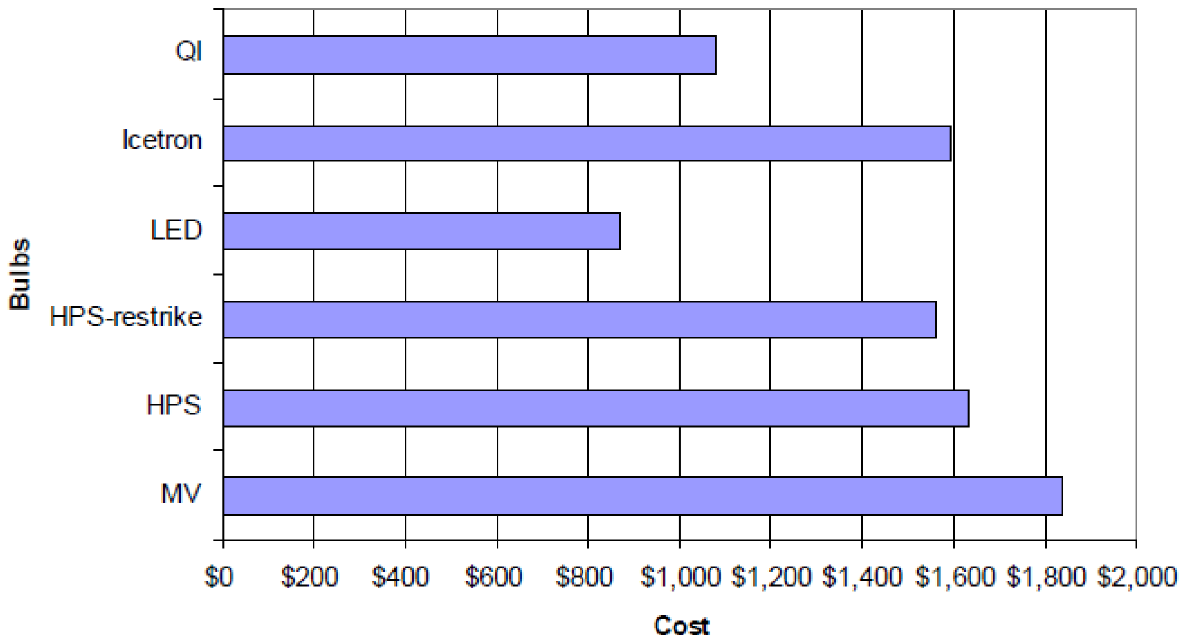
3.5.Reducing the hazardous substances

The new technology like LED application reduces the hazardous substance like mercury which is generated by other lighting technologies like sodium lamps, mercury vapour lamps, and metal halides lamps. Mercury is a toxic metal associated with contamination of water, fish, and food supplies, and can lead to adverse health effects. A CFL bulb generally contains an average of 5 mg of mercury. A power plant will emit 10mg of mercury to produce the electricity to run an incandescent bulb and 2.4mg of mercury to run a CFL to get equal illumination for the same time. In contrast, LEDs generate 0.0mg (NO) mercury because it is not used in manufacturing of LEDs.

3.6.Economic effectiveness

The cost involved in life cycle of LED is significantly low as comparison to other kind of lights. Though, these products have initial cost quite higher than other lights. But the operating cost is too less for LED lights because they need less maintenance and zero replacement till 12 years. Therefore, it saves labour cost for maintenance and replacement. As figure 2 shows that the life cycle cost for different types of lights in US wherein LED light is most cost effective.

Figure 2: Total present value cost during 20 years LCCA (for one bulb)



Source: (Szary, 2005)

In India too LED light Life Cycle Cost is significantly low as it includes initial lamp or retrofit Cost, labour relamping cost, lamp relamping cost during life cycle and electricity cost. At the micro level, the use of LED lights can bring down an average citizens tariff by 45%. Mumbai’s power consumption on lighting, which includes residential, public and commercial usage, amounts to around 850 MW per day. According to Ashok Pendse, If LED lights replace the existing Compact Fluorescent Lamps (CFL) at commercial and residential establishments including civic lighting then the city can save up to 225 to 300 MW every day (Times of India, 2010). It means Mumbai can save more than up to Rs 20 million per day. If the same argument is extended to 50 largest cities of India then this saving can be upto Rs. 400 million per day. Therefore, annually it can be Rs. 146000 million per annum in India.

4. Can adoption or application of LED technologies lead to sustainability (in ESSI)?

In order to achieve sustainable development in NICs, environmental protection shall constitute an integral part of the development process in energy sectoral system of innovation (ESSI) and cannot be considered in isolation from it. The new and innovative technologies, which have abilities to deliver the same or more efficient light with less resources consumption, can generate huge benefits over the already installed technologies. Moreover, if new and innovative technology like LEDs is adopted in innovation systems in NICs, specifically India, then, can it lead to sustainability?

It is proved in previous section that application of LED technology can result in reducing significant quantity of carbon emission, lowering by more than half (60 to 70%) of consumption of electricity, very low annual maintenance and operational cost, Zero hazardous waste material generated in terms of mercury, no light pollution, enhanced life (more than 12 years), sturdiness and all weather uses, and easy to recycle. Therefore, it demonstrates that LED light technology can impart sustainability over the other available technologies for lighting usages in NICs. Additionally, the technological competitive cycle is always determining factor in the over all performance of the LED technology.

Although the LED, an innovative and new technology has the capability to impart sustainability, however, it is subject to kind, level, time, place, society, economy, firms, regulatory system, knowledge, institutions and network in an energy sectoral system of innovation. A competitive technology like induction light[1] can be a challenge to its

[1] Induction light is basically fluorescent lamp with electromagnets wrapped around a part of the glass tube (external induction lamp), or inserted inside (internal induction lamp). In external inductor lamps, high frequency energy, from the electronic ballast, is sent through wires, which are wrapped in a coil around the ferrite inductor, creating a powerful magnet.

Induction light are discharge lamps, where the idea is to get mercury or other atoms to elevate their energy level, then discharge a photon as they fall back to normal. Induction lamps differ from fluorescents-their closest relative in the lighting family-in the way they energize the mercury atoms. Instead of striking an arc between electrodes in a tube, an electromagnetic field is generated by a carefully shaped coil. The field created by the coil induces a current flow in the gas/mercury blend within the lamp. This current excites the mercury atoms and boundaries of sustainability among all available technologies for lighting applications. Moreover, adoption of LED lights also has strategic significance in India where boundaries of the country are so vast where lighting system is essential for nights. Defence ministry, Government of India has been installing lights along the sensitive borders to prevent infiltrations. It will be very difficult to put off LED lights as once they are installed across the sensitive borders the infiltrators would have to fire at least 21 times to destroy them," (Pandey, 2009). Therefore, they can stand against such adverse conditions.

The sustainability factor can also be attributed to lowering carbon emission due to transportation of fuels. The natural gas, oil, and coal that are used in thermal plants for the production of power, transported from distant within country or outside the country. The transportation may be carried out by Trucks, Trains, and Ships (oil tankers) which emit a good amount of carbon. Among NICs, India and China are major energy importing countries. Whereas India imports approximately 80% of its required energy in terms of fossil fuel and coal from west Asian countries, Australia, Russia, and African countries. Therefore, saving of energy for lighting application can impart sustainability in the ESSI of India.

5. Dynamism in Energy Sectoral System of Innovation

The dynamism in energy sectoral system of innovation in India is created by a number of changes, innovations and initiatives, one of them is the ‘Mission 2012: Power for All’, a goal of the Ministry of Power, Government of India. It is a comprehensive Blueprint for Power Sector development which encompasses integrated Power Generation, Transmission, Distribution, Regulation, Conservation, and Communication strategies. The mission is under implementation with objectives to develop energy sector with sufficient, reliable, and quality power for all by 2012 at optimum cost with commercial viability for power industry to achieve GDP growth rate of 8% in the country. Currently, the power sector is poised for long term capacity addition wherein more than 50,000 MW capacity power generation projects are under execution (CEA and CII, 2007) which provide adequate confidence to the industry for taking up investment decision for capacity augmentation. Additionally, dynamism in ESSI

starts the flow of photons. Mercury atoms emit UV photons; phosphors lining the lamp wall absorb the UV photons and in turn emit visible photons.

can also be explored and understand in terms of regulatory, financial, institutional, legal, technological, and policies progression and new firms entry and investments.

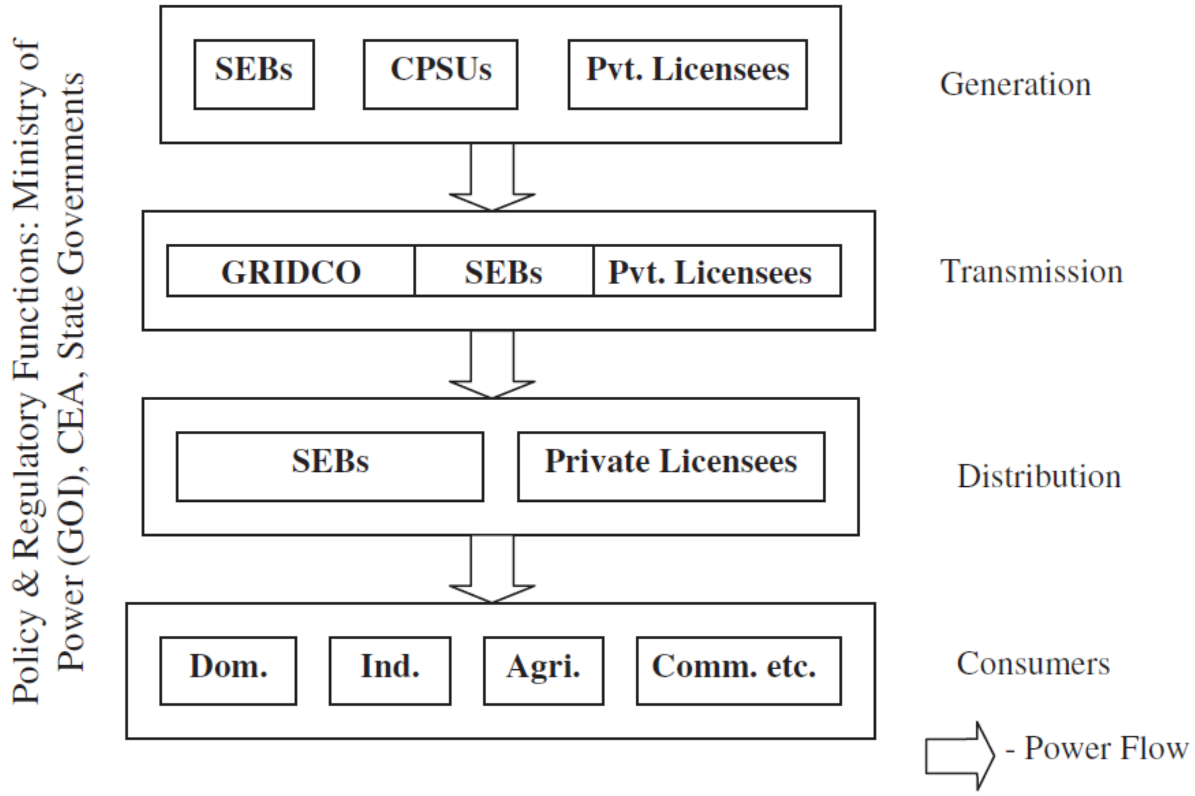
5.1.Evolving Regulatory system

The energy sector in India has been suffering problems of inefficiency, transparency, financial loses, accountability, demand-supply mismatch and insufficient regulatory teeth. Moreover, environment got enough consideration in Indian constitution under Article 21 as fundamental right of the citizen and a duty as a part fundamental duties chapter. Therefore, Indian judiciary has assumed it responsibility to see the enactment of constitution through its decisions while examining and determining various aspect and facets of the problems and the permissible remedies. Hence, applicability of the precautionary principle and polluter pays principle, which are part of the concept of sustainable development, is to be ensured in all decision making processes. This whole scenario led to a number of advancements on front of regulatory part of the ESSI.

A scenario, wherein state electricity boards (SEBs) with adverse financial situation during 1990s, led to make changes from piece meal approach to paradigm shift. Therefore, power sector reform and introduction of a regulatory framework was proposed as one possible solution to improve the SEBs' finances (Carstairs, 1995). The Indian government has enacted Electricity Act 2003by replacing the three existing legislations governing the power sector, namely Indian Electricity Act, 1910, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998.

The Electricity Act 2003 is aimed to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity. Additionally, It aspire for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas. Further, it is aimed at rationalization of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies. It has some important provision for constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal for matters connected therewith or incidental thereto. Moreover, the Act extends to the whole of India except the state of Jammu & Kashmir (Appellate Tribunal for Electricity, 2010). The figure 4 show the scenario of the power sector in India which is less open and flexible (Singh, 2006).

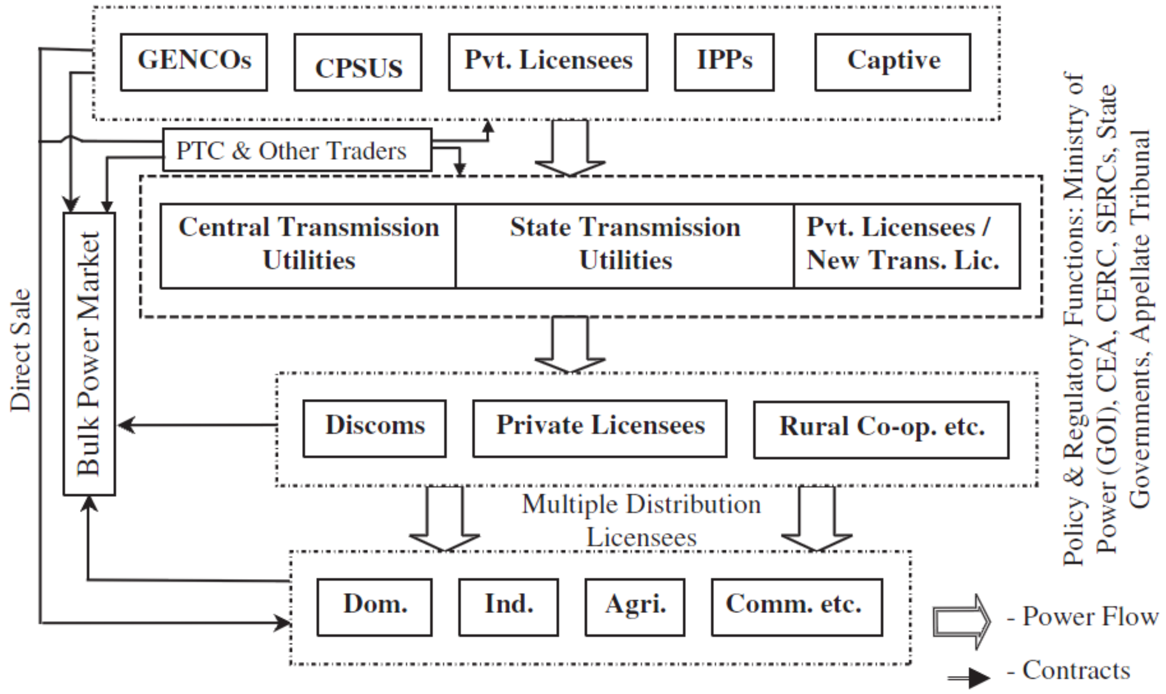
Figure 3: Indian Electricity (power) Sector (Pre Electricity Act 2003)



Source: (Singh, 2006)

Further, the figure 5 shows that a paradigm shifts in structure and actors of sectoral system of innovation in India during post Electricity Act 2003.

Figure 4: Indian Electricity (power) Sector (Post Electricity Act 2003)



Source: (Singh, 2006)

Pre-reform sectoral structure and network is vertically and linearly interlinked which proved to be less oriented to the needs of contemporary situations in India. On the other hand, post reform shape of the sector is adapted to the needs and on the process of orienting and evolving for the future requirement of the industrialising and rapidly growing Indian economy. This is proved through instances of new regulatory policies under implementation on all fronts, including energy conservation and efficiency.

The Bureau of Energy Efficiency (BEE), Government of India has made it mandatory for manufacturers to show atleast one star rating on electricity equipment (like Air Conditioners, Frost Free Refrigerators, Tubular Fluorescent Lamps, and Distributer Transformers) with effect form 7 January, 2010 (BEE, 2010). Therefore, this mandatory condition has the potential to trigger the demand of innovation technologies like LEDs, which consume less electricity to provide same or better illumination and visibility.

5.2.New Policies and Schemes

Under the energy conservation policies the Bureau of Energy Efficiency has implemented important schemes during XI five year plan which are aimed at saving of power in different subsectors of the energy sector. Four schemes, *Bachat Lamp Yojan, Standards & Labelling (S&L) Scheme, Energy Conservation Building Code (ECBC), and Operationalising EC Act by Strengthening Institutional Capacity of State Designated Agencies (SDAs)* are already implemented and resulted in saving a substantial units of the power. The S&L Programme has resulted in electricity saving of 1425.87 Million units, equivalent to avoided capacity generation of 260.4 MW (NPC, 2008). Energy Saving Companies (ESCo) are also promoted by government of India under energy conservation policies. A typical energy service company identifies and evaluates energy-saving opportunities in industrial units, commercial complexes, hospitals, municipalities and utilities, among others, by using energy audit tools and recommends a package of improvements that can pay for itself through the resultant savings. Therefore, the ESCo projects are emerging important factor for ESSI in India.

5.3.Financial actors and factors

Under the sectoral reform process Power Finance Corporation (PFC) declared as public Financial Institution under companies act in 1990 and registered as a nonbanking financial company by Reserve Bank of India (RBI) in 2007 to finance new power projects, transmission, distribution and renovation works, energy conservation and efficiency related schemes, and consultancies and studies. PFC has been providing financial assistance so far for State Power Utilities and Municipal run Utilities, besides playing a catalytic role in bringing about overall improvement in the power sector performance (Ministry of Power, 2010). As a significant stride PFC has expanded its lending portfolio to cover the joint, central and private sector projects. As result, based on its contribution, it has been conferred with the status of Nav-Ratna PSU by Govt. of India in2007 (Ministry of Power, 2010).

The government financial and taxation policies are made investment, import and power production and distribution friendly in India. The excise duty on LED bulbs has now come down to four from eight per cent which is a significant step to popularise this technology and facilitates its adoption in the market.

5.4.Rising investment and Interest of Entrepreneurs

The Rural Electrification Corporation Limited (REC) has been incorporated as a Company, later notified as a public financing institution, with the main objective of financing rural electrification Schemes in the Country, including financing of all project including transmission and generation without any restriction on population, geographically location or size. Cumulative sanctions & disbursements by REC stand at Rs. 8, 00,000 million & 4, 50,000 million respectively (Ministry of Power, 2010). In addition, the large Indian companies and groups like Reliance, TATA, Birala, JP industries, and Suzlon, are coming with aggressive plans for making large investment in generation and distribution of power.

Lucifer Lights is a pioneer of LED-based lights in India. The Rs 10,000-million Ajanta Group is now focusing on the future of lighting technology—LED (Light Emitting Diodes) lights. The group is now planning to set up a Rs 10,000-million plant in Kutch to manufacture LED lights and is scouting for a joint venture partner. Oreva is currently in talks with LED manufacturers in Taiwan, China and South Korea to further develop partnership. Therefore, such kinds of initiatives and interests have helped ESSI to become more responsive and dynamic to fulfil the needs of the consumers in rural as well as urban areas.

5.5.Rising consciousness and knowledge

To make people and industry more aware about energy saving strategies Ministry of Power has launched the National Awareness Campaign in order to promote energy conservation in the country. Painting competition for students at the School, State and at National level has been included as one of the activities of the campaign, which would not only make aware the children about the need of conserving energy but at the same time would educate and involve their parents as well in the above cause. The identified activity is one of the measures, which can help in creating awareness in the domestic sector (BEE, 2010).

5.6.Rising adoption of LED technology by Govt

Indian Railways (Ministry of Railways) has decided to install special types of eco-friendly LED (Light Emitting Diode) based lights in the coaches of trains. Presently, small bulbs, CFLs (Compact Fluorescent Lights) are used for lighting purpose in the coaches of trains. Though these lights provide efficient lighting but they consume comparatively more energy than the LED lights. Further, they are also burden on the alternator and the batteries of the coaches. There will be reduction of power consumption by 30-35 per cent on account of implementation of LED based coach lighting scheme. It would also reduce the burden on alternator and batteries of the coach which are being fitted in the lower part of the coach.

Govt department and public undertaking are now among leading adopters of LED technologies in India. Many big cities in India like Bangalore, Delhi, Gandhinagar, Ahmadabad, Mumbai, Gurgaon, Chennai and Hyderabad, have already started adoption of LED light for street lights, on institutional campuses, and in stadiums. Such kind of developments helps the innovation system to become dynamic for acclimatisation to new changes and challenges. Consequently, it becomes conducive to cater the needs of the people at right time, at right cost and at right place.

6. Conclusion

The technology is a key actor which shapes the innovation system and has potential to impart sustainability through its application and adoption. Therefore, LED technologies has potential to impart sustainability due to it important features such as low power consumption, environmental friendliness, product availability, increasing competitiveness, cost effectiveness, hazardousness, durability, and all weather usage. The adoption of energy saving technologies like LEDs , in street lights, commercial lights, traffic light, signage and display boards has reduced the level of energy consumption by more than 50% and create an equal amount of power. These technologies are highly economic in long term period along with zero mercury waste generation. They create highly environmental friendly conditions due to decreasing of carbon emission by half.

The sustainability of LED technology adoption is proved in terms of ecological friendliness, power saving, long life, less uncertainties, long term financial viability and technological availability.

The ESSI of India has evolved as a dynamic innovation system among the NICs. The sector has witness regulatory system development, enactment of Energy Conservation Act and Electricity Act 2003, setting up of new institutions, opening of sector for private investment, emerging new firms, rural electrification schemes, power conservation scheme, reforming state electricity boards, adoption of new technologies and awareness programs. These developments have enhanced the communication, coordination and better network in ESSI of India over the last two one decade. The sector has better knowledge and technology transfer and diffusion due to enhance activities in the sector.

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