Regional Report on the Transition to Efficient Lighting in South Asia

Prepared for and Submitted to:
United Nations Environment Programme (UNEP)/
Global Environment Facility (GEF) ***en.lighten initiative***

UNEP gef en.lighten

The Energy and Resources Institute

...towards global sustainable development

T E R I. 2014

Regional Report on the Transition to Efficient Lighting in South Asia

New Delhi: The Energy and Resources Institute.

[Project Report No. 2013BS04]

For more information

Project Monitoring Cell
T E R I
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003, India
Tel.: +91 (0)11 2468 2100 or 2468 2111
E-mail: pmc@teri.res.in
Web: www.teriin.org

UNEP-GEF en.lighten initiative
Division of Technology Industry and Economics
15 rue de Milan
75441 Paris Cedex 09
France
Tel.: +33 44 37 42 54
E-mail: en.lighten@unep.org
Web: www.enlighten-initiative.org

Table of Contents

List of Tables

Executive Summary

The South Asian region includes Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka and occupies approximately 4.5 million sq. km of land. Over 1.5 billion people[1] live in the region, which is more than one-fifth of the global population and is increasing at an accelerated rate of 1.5 % to 1.8 % annually.

South Asia accounts for 6% to 7 % of global greenhouse gas (GHG) emissions however, these figures are on the rise. To successfully address environmental challenges at local, regional and global levels, each country has realized that in spite of rapid economic growth and increasing energy demand, preventive measures need to be taken to prevent an increase in the emissions. This compels South Asian countries to accelerate efforts to promote energy efficiency and to develop clean, renewable sources of energy.

In the region, 30% of the population still lives without electricity[2]. The percentage is highest in Bangladesh, which is around 59% followed by Nepal where it drops to 56%. Sri Lanka and India have the lowest percentages of population without electricity, around 23% and 25% respectively. In Pakistan and Bhutan, 37% and 40% of the population still do not have access to electricity.

Total electricity consumption in the South Asian region is approximately 875 TWh per year with India consuming the largest portion at 86%. Pakistan and Bangladesh constitute 8.5% and 4.6 % of total electricity consumption in the region. Sri Lanka, Nepal and Bhutan constitute 1%, 0.3% and 0.02% of total electricity consumption in the region, respectively.

Total electricity consumption in lighting in South Asia is approximately 132 TWh which is about 15% of the total electricity consumption. In Nepal, the lighting contribution to total electricity consumption is highest at around 21% and it is lowest in Bhutan, at approximately 11%. In India and Pakistan, lighting consumption accounts for 15% in each country, for total electricity consumption. The contribution of lighting to total electricity consumption is around 16% in Sri Lanka and 13% in Bangladesh, respectively.

There are approximately 2.6 billion light sockets in the South Asian region, out of which 39% still contain incandescent lamps. Therefore, the region offers a great opportunity to derive environmental and economic benefits from a transition from inefficient to energy-saving lighting. Compact fluorescent lamps (CFLs) account for 18% of the total light points. The phase-out of incandescent lamps would reduce 5.5% of the region's total electricity consumption and approximately 36% of total electricity consumed for lighting alone. This would lead to a reduction of approximately 43 Mt of CO_2 emissions per year in the region.

The investment required for this transition would be approximately USD 3.2 billion, with a simple payback of 0.75 years. The energy savings potential and reduction in CO_2 emissions varies from one country to another based on the pattern of energy demand, fuel mix for electricity generation, and energy efficiency levels.

[1],[2] Country Lighting Assessment, UNEP-GEF en.lighten initiative (2010)

Most of the countries in the region have already undertaken several initiatives for establishing a strong regulatory framework and developing control mechanisms to help facilitate a quick transition to efficient lighting. Countries like India, Pakistan and Sri Lanka have developed minimum energy performance standards (MEPS) for CFLs and have already launched energy efficient building codes. India and Sri Lanka have adopted voluntary labelling for linear fluorescent lamps and CFLs. All the countries of the region have enacted Energy Conservation Acts to streamline and accelerate energy efficiency efforts.

Countries like India, Pakistan and Sri Lanka have developed market based instruments such as low interest bank loans for energy efficient product procurement. Energy service companies (ESCOs) have been established in Bangladesh, India, and Sri Lanka to promote the energy efficiency market. In India, the bulk purchase organization, Directorate General of Supplies & Disposals, has revised product specifications to ensure the procurement and distribution of energy efficient lighting products. However, bulk distribution programmes are not sufficient to secure a sustainable transformation to efficient lighting. These programmes should be implemented within a broader and more integrated policy framework.

Several tax rebates, such as the import duty reduction on CFL imports in Pakistan[3] , and value added tax (VAT) reduction on the sale of LEDs in India[4], are already in place. Several international funding organizations, like the World Bank and the Asian Development Bank are currently supporting energy efficiency programme in most of the South Asian countries.

The environmental management of hazardous waste for example, mercury from CFLs and e-waste from LEDs, are in place in Sri Lanka and Pakistan. In India, the government has adopted e-waste management guidelines and is in the process of finalizing mercury disposal guidelines[5]. Countries like Bangladesh, Bhutan and Nepal have yet to come up with guidelines. The environmental management of hazardous waste, such as mercury disposal from CFL lamps and e- waste from LED lighting products, has been implemented in Pakistan[6] and Sri Lanka.

The countries in the region are engaged in conducting several public awareness and demonstration programmes, along with educational programme at schools/universities, and general campaigns for promoting energy efficient lighting technologies.

The authorities responsible for developing standards and testing procedures for lighting products have already developed standards and procedures for CFLs either by adhering to their national standards which are compliant with international standards, or have adopted international methods as per International Electrotechnical Commission (IEC) standards. In India, performance, safety and testing standards have already been developed for LEDs while the other countries in the region are currently in the process of developing standards and testing for these products.

India is manufacturing almost all incandescent and fluorescent lamps to meet its current requirements, along with 98% of CFLs and 60% of high intensity discharge (HID) lamps. Sri Lanka has full manufacturing capacity for incandescent lamps and is importing 40% of their CFL and fluorescent lamp requirements along with 90% of HIDs. Pakistan is importing 80% of CFLs,

[3] Interview conducted and information shared by National Energy Conservation Centre (ENERCON), Pakistan

[4],[6] Interview conducted and information shared by Electric Lamp and Component Manufacturer's Association of India (ELCOMA), India

[5] E-waste management guidelines, Central Pollution Control Board (CPCB)

30% of fluorescent lamps, 75% of HIDs and 10% of incandescent lamps. Bhutan and Nepal do not have the manufacturing capacity for CFLs, fluorescent or HID lamps and they are importing 80% and 95% of incandescent lamps, respectively. Bangladesh imports 20% of incandescent lamps, 80% of CFLs, 40% of fluorescent lamps and 90% of HIDs[7].

Worldwide, 1.6 billion people (almost a quarter of the world's population) live without access to electricity. Around 470 million people live without electricity in South Asia (around 30% of total South Asian population). Currently, off-grid households largely depend on conventional fuel, such as kerosene, for lighting and cooking. Kerosene is inefficient as it causes serious pollution and damages both health and the environment.

Replacing the millions of kerosene lamps, candles and flashlights with efficient solar LED lighting products can provide an increasingly low-cost solution to reduce carbon emissions, lower indoor air pollution and mitigate health risks.

A transition to efficient off-grid lighting in South Asia would have an equally significant benefit for the almost 500 million consumers in the region who are not connected to the grid. Replacing all the kerosene, candles and battery-powered torches with solar LED lanterns would save 5.6 to 7.6 billion USD in fuel costs and avoid 23.3 million tonnes of CO_2 emissions each year.

In order to ensure a sustainable transition to efficient lighting, an integrated policy approach is required. The main components of this integrated approach include:

- Establishment of minimum energy performance standards
- Policies and programme for the promotion of energy efficient lighting products
- Monitoring, verification and enforcement strategies
- Environmentally sound waste management

Bangladesh, India, Pakistan and Sri Lanka have already developed various policies and capabilities towards the effective and sustainable transition to efficient lighting following an integrated policy approach. However, Bhutan, Maldives, and Nepal have yet to take the necessary steps to adopt this approach. Therefore, both regional and national actions are required for South Asia in order to successfully phase-out inefficient lighting in the region.

The analysis of the existing policies and capabilities for the different countries in South Asia are provided below in Table 1.

[7] Guidelines for CFL disposal, National Energy Conservation Centre (ENERCON), Pakistan, June 2011

Table 1: Analysis of Existing Policies and Capabilities for Countries in South Asia

	Regulatory and Control Mechanisms	Economic and Market-Based Instruments	Fiscal Instruments and Incentives	Support Information and Voluntary Action	Sustainability and End-of-Life	MVE	Product Quality & Testing	Production and Manufacturing	Relative Readiness
India	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Strong**
Sri Lanka	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Strong**
Pakistan	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Strong**
Bangladesh	**Yes**	**No**	**Yes**	**Yes**	**No**	**No**	**Yes**	**Yes**	**Strong**
Bhutan	**No**	**No**	**No**	**Yes**	**No**	**No**	**No**	**No**	**Limited**
Nepal	**No**	**No**	**No**	**Yes**	**No**	**No**	**No**	**No**	**Limited**
South Asia	**Strong**	**Moderate**	**Strong**	**Strong**	**Moderate**	**Moderate**	**Strong**	**Strong**	**Strong**

As seen in the Table 1 above, South Asia has a very "strong" regional readiness for transition to efficient lighting.

In order to develop a regional roadmap towards phasing out inefficient lighting in the South Asian region, a two-day conference was held in New Delhi in September 2013 comprised of various stakeholders from within South Asia. The main objective of the conference was to discuss and identify the region's strengths, weaknesses and priorities for regional/bilateral cooperation, and to identify opportunities.

During the conference, discussions were held about developing a harmonized plan building on the experiences, expertise and infrastructure from amongst the countries of the region to achieve a transition to efficient lighting. It was identified that it is imperative for the South Asian region to:

- Promote energy efficient lighting in order to gradually phase out inefficient lighting technology by 2020 in South Asia;
- Develop a policy framework to phase out inefficient incandescent lighting by 2016;
- Examine the availability of technological options with regard to manufacturing capabilities in each country for efficient lighting products.

India, Sri Lanka and Pakistan, where already lot of work to achieve transition to efficient lighting has been done, should take the lead for achieving the transition to efficient lighting in the region.

Abbreviations

ADB	Asian Development Bank
AIIMS	All India Institute of Medical Sciences
APLAC	Asia Pacific Laboratory Accreditation Cooperation
BEE	Bureau of Energy Efficiency
BELP	BESCOM Efficient Lighting Programme
BESCOM	Bangalore Electricity Supply Company
BIS	Bureau of Indian Standards
BLY	Bachat Lamp Yojana
BSTI	Bangladesh Standards and Testing Institution
CEB	Ceylon Electricity Board
CFL	Compact fluorescent lamp
CPCB	Central Pollution Control Board
CPRI	Central Power Research Institute
CPWD	Central Public Works Department
DGS&D	Directorate General of Supplies & Disposals
DoE	Department of Energy
DRE	Department of Renewable Energy
DSM	Demand side management
ECF	Energy conservation revolving loan fund
EESL	Energy Efficiency Services Limited
ELCOMA	Electric Lamp & Component Manufacturers Association of India
ENERCON	National Energy Conservation Centre
ESCOs	Energy services company organizations
ESIC	Employees' State Insurance Act
EU	European Union
FNCCI	Federation of Nepalese Chambers of Commerce and Industry
GDP	Gross domestic product
GEDA	Gujarat Energy Development Agency
GEF	Global Environment Facility
GHG	Greenhouse gas emissions
GIZ	German Development Corporation

GW	Gigawatt
GWh	Gigawatt hours
HID	High intensity discharge
HPSV	High pressure sodium vapour
HSBC	Hong Kong and Shanghai Banking Corporation
IEA	International Energy Agency
IEC	International Electrotechnical Commission
ILAC	International Laboratory Accreditation Cooperation
ISI	Indian Standards Institution
ISO	International Organization for Standardization
JNNSM	Jawaharlal Nehru National Solar Mission
kWh	Kilowatt hour
LED	Light emitting diode
Lm/W	Lumens per watt
MEDA	Maharashtra Energy Development Agency
MENR	Ministry of Environment and Natural Resources
MEPS	Minimum energy performance standard
MNRE	Ministry of New and Renewable Energy
MoEF	Ministry of Environment and Forest
MoP	Ministry of Power
MoU	Memorandum of understanding
Mt	Million tonnes
Mtoe	Million tonnes of oil equivalent
MVE	Monitoring, verification and enforcement
MW	Megawatt
NABARD	National Bank for Agriculture & Rural Development
NABL	National Accreditation Board for Testing & Calibration Laboratories
NAPCC	National Action Plan on Climate Change
NBC	National building code
NBSM	Nepal Bureau of Standards & Metrology
NCERT	National Council of Education, Research and Training
NCS	Nepal Council for Standards
NEA	Nepal Electricity Authority
NEDRC	National Engineering Research & Development Centre
NIS	Nepal Institute of Standards

NMEEE	National Mission for Enhanced Energy Efficiency
NOAA	National Oceanic and Atmospheric Administration
NPL	National Physical Laboratory
NSB	National Standards Body
NTPC	National Thermal Power Corporation
OECD	Organization for Economic Co-operation and Development
PCSIR	Pakistan Council of Scientific and Industrial Research
PFC	Power Finance Corporation
PSQCA	Pakistan Standards and Quality Control Authority
PSU	Public Sector Undertakings
R&D	Research and development
RE	Renewable energy
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
SARI	South Asia Regional Initiative
SDA	State Designated Agencies
SEEP	Super Energy Efficient Programme
SIDBI	Small Industrial Development Bank of India
SLCF	Sri Lanka Carbon Fund
SLSEA	Sri Lanka Sustainable Energy Authority
SLSI	Sri Lanka Standards Institution
SREDA	Sustainable & Renewable Energy Development Authority
TERI	The Energy and Resources Institute
TWh	Terawatt hours
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nation Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States dollar
WECS	Water and Energy Commission Secretariat

1.0 Introduction

Studies carried out to identify viable options to combat climate change have revealed that improving energy efficiency measures are more effective in preventing climate change than developing energy supply technologies. Improving lighting system efficiency by using efficient lighting products has been established as one of the most effective, economically viable and easy to implement options available to reduce energy consumption and CO_2 emissions in almost all of the countries in the world. The use of energy efficient technologies would ensure a reduction in energy consumption which would then lead to cost savings that could be used to meet other developmental goals in South Asian Countries.

The United Nations Environment Programme (UNEP) and the Global Environment Facility (GEF) in collaboration with the private sector launched the "en.lighten" initiative in 2009 with the main objective of accelerating the global transformation to efficient lighting through promoting high performance, energy efficient technologies and phasing out inefficient incandescent light sources. The UNEP/GEF en.lighten initiative assists developing and emerging countries by providing technical and policy support in their transition to energy efficient lighting.

This report has been prepared for the UNEP/GEF en.lighten initiative by The Energy and Resources Institute (TERI), New Delhi, India with the support and the technical cooperation of the Electric Lamp and Component Manufacturers Association of India (ELCOMA) and Bureau of Energy Efficiency (BEE), India. The South Asian countries included in this report are Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

The report provides detailed information concerning the current status of efficient lighting in the region and makes an assessment of region's readiness for each component of the en.lighten integrated policy approach that includes: minimum energy performance standards; supporting policies; monitoring, verification and enforcement; and environmentally sound management of lighting products. An estimate of a transition in terms of the environmental and economic benefits for each country has also been produced and highlighted in the report. Finally, the most effective transition strategies for countries to follow have been recommended. The report encompasses both on-grid and off-grid lighting.

The report focuses primarily on the phase-out of inefficient incandescent lamps in the region, based on the significant environmental, energy and financial savings that could be realized by this transition.

The transition to efficient lighting will be challenging in the region, as per capita income is much less than even the liveable standard, which leads to cost barriers for more energy efficient products such as compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs). These technologies are primarily found in metropolitan areas of the region. Therefore, a realistic national efficient lighting strategy is necessary for each country to be able to address the way a transition could occur successfully, taking into account the initial costs and the ability of those in rural areas to afford energy efficient products.

The main findings of this document were presented to participants at the "Transition to Energy Efficient Lighting in South Asia" workshop held from 26 - 27 September, 2013 in Delhi, India. Delegates included relevant stakeholders in the region such as: governments, private sector organizations, civil society and international agencies who came together to share information concerning the status of the transition towards efficient lighting in South Asian countries.

The concise recommendations made in this report are based on many of the success stories of different countries, keeping in mind the constraints that these countries face for the implementation of a complete phase-out of inefficient incandescent lamps.

The information used to develop this report originates from various official sources, articles, publications and contacts within several departments in relevant ministries and pertinent agencies in the

countries of South Asia. Efforts have been made to include the latest information wherever available. It is also possible that this report may include potential gaps concerning the status of activities in the countries or other information. Every effort has been made to present accurate information, but any error or misinformation discovered after the report has been published, is regretted.

2.0 Climate Change and Lighting

Climate change is no longer an issue of the future. It is already taking place, and the people of South Asian countries, particularly the poorest ones, are most at risk. The impact of higher temperatures, more variable precipitation, extreme weather events, and the rise in sea level are being felt around the world and will continue to intensify. These changes are already having a major impact on the economic performance of South Asian countries and on the lives and livelihoods of millions of impoverished people. The effects are not only from the gradual changes in temperature and the sea level but specifically from increased climate variability and extremes, including more intense floods, droughts and storms.

The Intergovernmental Panel on Climate Change's (IPCC) fifth Assessment report[8] highlights the impact of climate change into the future including:

- Further warming will continue if emissions of greenhouse gases continue.
- The global surface temperature increase by the end of the 21st century is likely to exceed 1.5°C relative to the 1850 to 1900 period for most scenarios, and is likely to exceed 2.0 °C for many scenarios
- The global water cycle will change, with increases in disparity between wet and dry regions, as well as wet and dry seasons, with some regional exceptions.
- The oceans will continue to warm, with heat extending to the deep ocean, affecting circulation patterns.
- Decreases are very likely in Arctic sea ice cover, Northern Hemisphere spring snow cover, and global glacier volume
- Global mean sea level will continue to rise at a rate very likely to exceed the rate of the past four decades
- Changes in climate will cause an increase in the rate of CO_2 production. Increased uptake by the oceans will increase the acidification of the oceans.
- Future surface temperatures will be largely determined by cumulative CO_2, which means climate change will continue even if CO_2 emissions are stopped.

Due to the nature of these impacts, climate change could hamper the achievement of many of the Millennium Development Goals (MDGs), including those on poverty eradication, child mortality, malaria, and other diseases, and environmental sustainability. Much of the damage would be felt through severe economic shocks. In addition, the impact of climate change will exacerbate existing social and environmental problems and lead to migration within and across national borders.

Due to new technology development, industrialization and the extensive use of fossil fuels, climate change is one of the key challenges now confronted by humankind. The increase in the concentration of carbon dioxide, methane, nitrate oxides and chlorofluorocarbons in the atmosphere as a result of human activities, has led to the progressive warming of the earth through the greenhouse effect. The exponential growth of these pollutants led to global warming and underlies the main cause of climate change. The problems due to global warming became apparent and identified as a serious concern for the international community during the 1980s. The United Nations Earth Summit meeting held in Rio de Janeiro, Brazil, in 1992, emphasized on the issue of climate change and a UN Framework Convention on Climate Change (UNFCCC) was signed, committing governments to reduce greenhouse gas

[8] Intergovernmental Panel on Climate Change's (IPCC) fifth Assessment report

emissions to 1990 levels by the year 2020. This received decisive support from developed countries, the main actors responsible for the increase of the emissions. These countries also agreed to transfer technologies to developing and emerging countries in order to tackle climate change globally.

According to scientists at the US National Oceanic and Atmospheric Administration (NOAA), all twelve years of the 21st century (2001-2012) rank among the 14 warmest in their 133- year period of record. Most areas of the world experienced higher-than-average annual temperatures, including most of North and South America, most of Europe and Africa, and western, southern and far north eastern Asia. Most of Alaska, western Canada, central Asia, parts of the eastern and equatorial Pacific, southern Atlantic and parts of the Southern Ocean were notably cooler than average.

Against this backdrop, in COP 16 held in 2010 in Cancun, Mexico, resolved to limit the increase of global temperature to a maximum of 2 degrees Celsius. Therefore, the need to reduce CO_2 emissions by 25% to 40% was established, in order to prevent emissions from surpassing 32,000 million tons by the year 2020.

By the end of 2010, global CO_2 emissions reached their highest level in history, surpassing the previous record from 2008 by 5%, reaching 30,600 million tons, a value not distant from the 2020 threshold of 32,000 million tons. To mitigate climate change, it is imperative to undertake energetic, decisive and urgent actions. It is precisely with regard to these actions that energy efficiency in the lighting sector is presented as one of the key potential solutions.

For lighting alone, electricity consumption is expected to increase by 60 – 70 per cent by 2030. Today, lighting is responsible for approximately 15 per cent of global electricity consumption and 5 % of global greenhouse gas emissions (GHGs). Globally, lighting accounts for more than 1,400 million tonnes of CO_2 annually. Around 40 % of future global energy demand for lighting could be avoided by switching to efficient lamps. Shifting to efficient lighting technologies would reduce world lighting energy demand significantly, saving countries, businesses and end users considerable sums in reduced electricity bills.

More than 1.6 billion people around the world do not have access to grid-based technology and use over 77 billion litters of kerosene each year for lighting, emitting more than 190 million tonnes of CO_2 per year in the process. Medical experts warn that kerosene smoke is unhealthy and the open flame lanterns are dangerous. Rural electrification using efficient lighting has the tremendous potential to reduce CO_2 emissions and improve health conditions in rural areas that still rely on traditional fuel-based lighting, such as kerosene.

At the UNFCCC meeting held at Bonn in June 2013, relevant issues were reiterated to ensure continuous follow-up of the agreement that had been reached at the UNFCCC Rio +20 Summit. Here, governments identified the way in which climate finance can shift investment patterns faster toward a low carbon economy. Key elements required for such a shift were examined including: reducing investment risk for investors; public-private partnerships; a long-term legally binding agreement; and strong domestic institutions in recipient countries.

At the same time, the International Energy Agency (IEA) report "Redrawing the Energy Climate Map" identifies four fundamental and achievable policies including: improving energy efficiency in buildings (lighting and transportation); decreasing construction costs and the use of inefficient coal plants; minimizing methane emissions from oil and natural gas production; and accelerating the phase-out of some fossil-fuel consumption subsidies.

3.0 Global Initiatives for the Promotion of Efficient Lighting

Initiatives in Other Emerging Countries

Many initiatives for the promotion of efficient lighting have already been occurring in the BRICS countries (Brazil, Russia, India, China and South Africa) around the world. For example, CFLs have been distributed either at a lower cost or free of cost. Minimum energy performance standards (MEPS) for CFLs have already been established and efficiency labelling is underway. Several international funding organizations, such as the Asian Develop Bank, World Bank and Global Environment Facility have funded many of the energy efficient lighting programmes. Although several initiatives are underway, most of the countries still do not have any outright ban on incandescent lamps. The main reasons for not taking such action are affordability, quality and availability of the lamps, as well as awareness amongst various users.

Table 2: BRICS Countries with Efficient Lighting Policies in Place[9]

BRICS Country	Initiatives
Brazil	• Awareness raising among the population conducted by ANEEL and Procel (2008) • Lamp distribution to low-income households programme are being implemented, such as the AES Eletropaulo Energy Efficiency Programme (2004-2012) • BRESL Project
Russia	• Transforming the market for efficient lighting in Russia- Four-year collaboration (2010-2014) project between the GEF, UNDP and Russia, with the GEF contributing USD 7 million to the total project cost of over USD 28 million. The goal is to reduce Russia's GHG emissions by transforming the Russian lighting market towards more energy efficient lighting technologies. [10] • In 2011, Russia Government adopted Decree No.602 "On approval of requirements to lighting devices and electric lamps" which specifies mercury level lower than 2.5 mg, 2.5 mg, 5.0 mg and 15 mg for 30W, 30W to 50 W, 50 W to 150 W and more than 150 W CFL. Maximum quantity of lead should be lower than 0.2% of weight of CFL.[11]
India	• Bulk procurement and distribution of 26 million CFLs under the Bachat Lamp Yogna (BLY) scheme started in 2009 • Awareness raising and educational programme conducted by Bureau of Energy Efficiency (BEE), The Energy and Resources Institute (TERI) and Electric Lamp & Component Manufacturers Association of India (ELCOMA)

9 Regional Report on Efficient Lighting in Southeast Asia, UNEP/GEF en.lighten initiative, , November 2011

[10] http://www.undp-light.ru/en/

[11] Energovopros Russia. (2012). Decree No. 602 "On Approval of the Requirements to Lighting Devices and Electric Lamps Used in Alternating Current Circuit for Illumination. Retrieved March 27, 2012, from: http://www.energovopros.ru/zakonodatelstvo/svet/20478/

	• Establishment of MEPS for CFLs
China	• Minimum energy performance standard (MEPS) for CFLs in the year 2009
South Africa	• More than 54 million CFLs from 2004 to 2012 and 1.5 million in 2011 were distributed free of charge through the Eskom National Efficient Lighting Programme. • To replace the inefficient lamps, bulk purchases and the issuing of free efficient lamps to households (door-to-door) or at exchange points has been implemented by Eskom • Voluntary certification and labelling developed by the Energy Efficient Initiative (ELI) programme, implemented by the International Finance Corporation (IFC)

Initiatives Undertaken in the Organization for Economic Co-operation and Development (OECD) Countries

In most of the OECD countries, the labelling of CFLs has occurred and is still at a voluntary stage. Various grants and subsidies have been provided for the promotion of efficient lighting. Large-scale awareness and demonstration programmes have also been carried out in most of the countries.

Table 3: OECD Countries with Efficient Lighting Policies in Place[12]

OECD	Efficient Lighting Policies in Place
Australia	
	• Low Income Energy Efficiency Grant Programme • The Community Energy Efficiency Programme supports local councils and community organizations to undertake energy efficiency upgrades to council and community-use buildings, facilities and lighting • Education and promotional materials such as point of sale information, advertisements and retailer training programme • Industry awards programme "The Australian Lighting Energy Efficiency Design Award" • Training Guide: The Basics of Efficient Lighting
Argentina	
	• Distribution of 25 million CFLs from 2008-2010 • ELI (Efficient Lighting Initiative) voluntary labelling • Large-scale education campaign • Public demonstration campaigns

[12] Regional Report on Efficient Lighting in Southeast Asia , UNEP/GEF en.lighten initiative, , November 2011

OECD	Efficient Lighting Policies in Place
Canada	
	• Energy Star voluntary specification requirements for CFLs • The Eco-Energy Efficiency programme • Rebates and bulk distribution • Grants to homeowners • Educational and awareness raising campaigns
Colombia	
	• Bulk procurement and distribution of 1,170,000 CFLs under the "Illuminate con Buena energía" programme in 2009
Turkey	
	• Replacement of incandescent lamps with CFLs in all public institutions and municipalities. Public awareness campaigns. • Distribution and awareness-raising activities at primary schools under the "Hand-in-Hand ENVER (Energy Efficiency) Movement" • Distribution of 4.8 million CFLs in 43 provinces during 2008-2009 • Subsidies and investment support for energy efficiency projects
United States of America	
	• Energy Star voluntary specification requirements • Energy Star voluntary endorsement labelling • SSL Quality Advocates, a voluntary pledge programme jointly developed by DOE and NGLIA, works to assure that LED lighting, as it reaches the market, is represented accurately • Rebates and coupons • Consumer education campaigns • Retailer incentives and training • Giveaway programmes • Federal purchases of lighting products must meet Federal requirements for high efficiency
United Kingdom	
	• European Voluntary CFL and LED Quality Charter • Promotional campaigns: distribution, subsidies, awareness-raising, rebates, on-bill financing • The European EcoLabel Voluntary scheme for light sources

OECD	Efficient Lighting Policies in Place
	• The EU Green Public Procurement Criteria for Indoor Lighting • The European Commission Green Paper "Lighting the Future: Accelerating the Deployment of Innovative Lighting Technologies" (COM(2011) 889 final)

4.0 Obstacles for the Promotion of Efficient Lighting in South Asia

Lighting has played a central role in energy efficiency programmes for decades, as it is one of the easiest and most cost-effective ways to save energy and combat climate change. To ensure the penetration of energy saving lighting technologies into the market, the economic viability of these products needs to be assessed. There are several obstacles hindering the widespread adoption of energy efficient lighting technologies which are examined below.

Need to Implement Product Quality Control

Many low quality CFL and LED lamps have flooded the market which leads to confusion and disappointment among end users who wish to use energy efficient products. Consumers need to be satisfied with the performance and perceived value of the product purchased. Ensuring quality and convincing end users about product performance are key challenges in promoting the use of efficient lighting. This requires an integrated approach that includes: minimum energy performance standards (MEPS); performance testing; procurement planning; monitoring, verification and enforcement (MVE) activities; and awareness-raising programmes. Labelling and applying star ratings for products is one of the ways in which to ensure the quality improvement of products.

Information Concerning the "Real Cost" of Efficient Lighting

Many South Asian consumers lack awareness about the total life cycle cost of products, which includes both the initial cost, as well as operating and replacement costs. The high initial cost is a key deterrent to the penetration of these products. Although incandescent lamps initially cost much less than CFLs, the total cost of operating incandescent lighting is much more than the total cost of operating CFLs because of the inefficiency of incandescent lamps and their short life.

As end users usually use the initial cost as the decisive parameter for buying the lamps, the transition towards efficient lighting is relatively slow. The total life cycle cost for the different efficient technologies needs to be communicated well through public awareness programmes and energy conservation projects.

Divided (Split) Incentives

In cases where a building owner pays the energy bills, the benefits derived from an energy efficient lighting promotional programme would be directed to the this target group. However, in cases where energy bills are paid by building tenants, the building owner or manager may attempt to minimize lighting costs by compromising the efficiency of the product which is not in the interest of the resident who wishes to reduce electricity costs. Unfortunately, it is difficult to benefit both parties in this case, which may be the reason that efficient lighting is not prevalent in rental residential and commercial properties. The problem may be addressed either through energy efficiency financial incentives which could take care of first costs, or through government regulations that mandate the installation of energy efficient lamps.

Risk Perception of New Lighting Technologies

CFLs contain mercury as compared to incandescent, which do not. Many manufacturers have already reduced the mercury content in CFLs and almost all governments are developing mercury disposal guidelines for spent CFLs, in order to reduce or eliminate the negative environmental and health impact of mercury.

LEDs do not contain any mercury however, there is a perception that they may cause irreparable harm to the retina of the human eye due to blue light hazard. There is no evidence for this claim and that should be addressed and clarified.

Studies have revealed that for different light sources, optical safety of lamps requires additional evaluation for infants or adults. Sensory interaction is an essential part of human perception, and too much radiant energy can damage human tissue. Shorter wavelengths (UV) can cause sunburn, or may even have effects at cellular/DNA level. Longer wavelengths (IR) are perceived as heat and too much can lead to discomfort or injury. LEDs used for lighting do not emit UV or IR radiation therefore, they are safer for eyes and skin as compared to other light sources[13].

[13] Solid State Lighting Technology Factsheet, U.S Department of Energy

5.0 Benefits of the Transition to Efficient Lamps for Countries in the Region

On-Grid Lighting

All South Asian countries are importing oil and have power deficits - both peak and supply - except for Bhutan. Providing energy security against the growing demand and with limited supply expansion has been a key country policy issue in this region. Some areas face blackouts from 10 to 15 hours per day, due to power shortages. In rural areas, shortages are even more severe, compared to semi-urban or urban areas. Additionally, the rate of access to electricity in South Asia is among the lowest in the world. India and Pakistan have the highest access rates, around 66 %. For Bangladesh and Nepal however, it is closer to 40 %. Frequent power cuts and shortages in energy supplies have inhibited economic growth in this region.

South Asian countries vary in size, population, rate of urbanization, economic development, power production and access to energy. Each of these countries has made efforts towards a shift to efficient lighting and the phase-out of inefficient light sources. The individual benefits from a phase-out of inefficient lamps will vary from country to country. A transition to efficient lighting would lead to significant energy consumption reductions with payback periods on all the investment of less than two years for different countries as seen below in Table 4.

Total annual electricity consumption of the six countries examined is 874 TWh, producing about 2174 million tons of CO_2 per year. The phase-out of inefficient lighting in the region would save nearly 48 TWh of electricity and reduce 43 Mt of CO_2 emissions.

The cost for the region to transition to efficient lighting would be approximately USD 300 million, with a simple payback of 0.75 years. Regional annual financial savings after a transition would exceed USD 3.2 billion. India, Pakistan and Sri Lanka are the largest consumers of electricity in the region, with India alone consuming about 86%.

According to World Energy Outlook, around 1.6 billion people without access to electricity, about 470 million live in South Asia region. Thus, when the region reaches 100% electrification, then the impact of the phase-out of inefficient lamps would be even more substantial.

Table 4: Estimated Benefits of Transition to Efficient On-Grid Lighting South Asia[14]

Country	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka	Total
Total population (millions)	148.7	0.7	1200.0	30.0	173.6	20.9	1573.9
Total annual energy consumption-2010 (TWh)	40.0	0.2	749.0	2.7	74.0	8.4	874.3

[14] Country Lighting Assessment, UNEP/GEF en.lighten initiative (2010)

Total estimated annual electricity consumption for lighting-2010 (TWh)	5.2	0.0	113.8	0.6	11.5	1.3	132.4
Total annual electricity savings with efficient lamps (TWh)	1.9	0.0	41.3	0.2	4.1	0.6	48.1
Total annual CO_2 emissions (before transition) (Mt)	53.0	0.8	1921.0	4.0	183.0	12.0	2173.7
Total annual CO_2 emissions avoided with efficient lamps (Mt)	1.1	0.0	39.9	0.0	2.0	0.2	43.2
Total annual CO_2 emissions avoided (%)	2.1	0.0	2.1	0.0	1.1	2.0	7.3
Total annual financial savings (million USD)	105.2	0.3	2600.0	20.5	408.1	114.0	3248.1
Total estimated cost of transition to efficient lighting (million USD)	16.7	0.1	242.0	1.8	37.0	2.8	300.4
Amortized time of transition cost (yr.)	0.8	1.9	0.8	0.4	0.4	0.3	

Off-Grid Lighting

Nearly 500 million people in South Asia live in a state of near darkness, coping with unreliable or non-existent access to electricity on a daily basis. The effects on these vulnerable communities are severe. Medical and educational opportunities and services are severely constrained; health risks are heightened by unsafe lighting alternatives; and opportunities for income generating activities are reduced. Many people also pay a great deal over time for the limited lighting service provided by most fuel based lighting.

There is a great need for clean, sustainable and affordable products to bring light to these households. Modern off- grid lighting has emerged with the introduction of solar energy and LED technology has been experiencing a rapidly growing demand from those living off-grid. The savings potential in terms of energy and costs, CO_2 mitigation and economic benefits have been estimated by the UNEP en.lighten initiative, as shown in Table 5. The transition to efficient off-grid lighting would also result in social and health benefits in terms of providing better quality light. It would save approximately USD 110 per household per year, and reduce or eliminate fuel-related health issues, fire hazards and toxic fumes.

A full transition to energy efficient off-grid lighting would result in energy savings of 61.1 million barrels of crude oil energy equivalent; USD 6.2 billion of cost savings; and 33 million tonnes of CO_2 reduction. The total estimated expenditure required would be approximately USD 6.9 billion with a payback period of just 1.2 years[15].

[15] Country Lighting Assessment, UNEP/GEF en.lighten initiative (2010)

Table 5: Estimated Benefits of a Transition to Efficient Off-Grid Lighting in South Asia[16]

No	Parameters	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka	Total
1	Total population (millions)	148.7	0.7	1170.9	30.0	173.6	20.9	1544.8
2	Off-grid population (millions)	87.7	0.3	292.7	16.9	65.3	4.9	467.8
3	% population off-grid	59.0	40.0	25.0	56.0	37.0	23.0	30.3
4	Off-grid households (millions)	19.5	0.1	54.2	3.1	9.6	1.3	87.8
5	Installed stock							
	Kerosene lamp {glass cover} (million)	2.9	0.1	113.9	4.9	2.0	1.9	125.7
	Kerosene lamp {simple wick} (millions)	3.9	0.1	51.0	2.4	2.7	0.9	61.0
	Torch (millions)	1.5	0.0	17.0	0.7	1.0	0.3	20.5
	Candles {light points} (millions)	38.8	0.0	8.5	1.5	27.0	0.1	75.9
6	Economic and energy benefits							
	Kerosene savings (billion litres)	0.3	0.0	6.7	0.3	0.2	0.1	7.6
	Candle savings (billions)	14.6	0.0	3.7	0.6	9.4	0.1	28.3
	Battery savings (millions)	111.0	1.0	896.0	36.0	74.0	16.0	1134.0
	Cost savings (billion USD)	1.8	0.0	2.8	0.4	1.1	0.1	6.2
	Payback period (months)	6.0	7.0	22.0	8.0	6.0	11.0	

[16] Country Lighting Assessment, UNEP/GEF en.lighten initiative (2010)

	Energy savings (million barrels of crude oil energy equivalent)	5.1	0.1	49.3	2.4	3.3	0.9	61.1
7	Climate change mitigation benefits							
	CO_2 reduction (million tonnes)	2.4	0.0	18.1	0.9	1.6	0.3	23.3
	Equivalent to no of cars off the road (millions)	0.6	0.0	4.5	0.2	0.4	0.1	5.8
8	Environmental, health and social benefits							
	Annual savings per household per year (USD)	84.2	138.6	47.0	102.5	110.1	61.8	544.2
	Better quality light households (millions)	19.5	0.1	54.2	3.1	9.6	1.3	87.8

6.0 Efficient Lighting Initiatives in South Asia

6.1 Bangladesh

Electricity is the major source of power for most of the Bangladesh's economic activities. From 2011 to 2012, almost 75% of the power generated was from natural gas, 11.5% furnace oil, 8.2% diesel, 2.9% hydro and 2% from coal. The installed generation capacity was 8525 MW in 2012-2013, an increase of 16% from the previous year. The average growth in electricity consumption is around 7% and only 50% of the population has access to electricity, with a per capita availability of 252 kWh per annum (includes captive generation also).

The Ministry of Power, Energy and Mineral Resources provides access to affordable and reliable electricity and its vision is that electricity should be made available to all by the year 2021. The major functions of the ministry include: power transmission, generation, distribution; the promotion of renewable energy; and energy efficiency through regulations, incentives and research and development.

Apart from energy efficiency, a focus on clean energy sources, like renewable energy, became apparent when a new policy was adopted by the government in the year 2008-2009. The Sustainable and Renewable Energy Development Authority (SREDA) has been established as a focal point for the promotion and development of sustainable energy which includes renewable energy, energy efficiency and energy conservation.

6.1.1 Regulatory and Control Mechanisms

In 1985, the Bangladesh Standards and Testing Institution (BSTI) was created with the merger of the Bangladesh Standards Institution and the Central Testing Laboratories. BSTI is the National Standards Body (NSB) of Bangladesh, entrusted to standards development for various products and services, and to ensure compliance by testing in its own laboratories. BSTI issues quality assurance product certificates, as well as management system certificates, which are accredited by the Norwegian Accreditation Board. BSTI is the member-body of International Standardization Organization (ISO) and country member of International Electro technical Commission (IEC)[17].

6.1.1.1 Energy Performance Standards

BSTI is the lead agency for the development of MEPS and for establishing processes and institutions for energy performance testing. BTSI is also responsible for formulating energy efficiency standards. The standard BDS IEC 60969, "Specification for energy efficiency labelling requirements for CFLs" describes MEPS for CFLs. Currently there are no standards for LED lamps[18].

[17], [16] Bangladesh standards and testing institutions http://www.bsti.gov.bd/

6.1.1.2 Energy Labelling[19]

Under the Barrier Removal to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling (BRESL) project, a joint international project sponsored by the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF)), Bangladesh has adopted a Policy to standardize and label six energy efficient electrical appliances and equipment. Two lighting products, CFLs and electronic ballasts for fluorescent tubes, are included in this programme. BSTI has already started issuing Energy Star Labelling certification for CFLs on a voluntary basis in Bangladesh.

The parameter which is being used for rating of CFLs is performance grading. Performance grading takes into account not only the efficacy of the lamp, but also the power factor. CFLs having a performance grading above 70 will be 5-star certified and CFLs having a PG lower than 50 would not qualify for a rating.[20]

6.1.1.3 Bangladesh Building Code

The Bangladesh National Building Code was published in 1993, but only adopted under the Building Construction Act in 2006. It was developed by the Public Works Department under the Ministry of Housing and Public Works. The Code specifies minimum standards for the design, construction, quality of materials, use and occupancy, location and maintenance of buildings. Currently, no environmental sustainability elements are addressed in the building code. There are also no recommendations mentioned in the code for the installation of energy efficient lighting.

6.1.2 Economic and Market-Based Instruments

6.1.2.1 Efficient Lighting Initiative of Bangladesh (ELIB)[21]

The Government of Bangladesh, with support from the World Bank, has launched a large- scale lighting energy efficiency programme to reduce electricity peak loads. The programme is funded by Bangladesh Rural Electrification and Renewable Energy Development (RERED) project and supported by a carbon finance intervention from the World Bank. The main objective of programme is to replace approximately 30 million incandescent lamps with CFLs.

Under the first phase of ELIB (January - December 2010), around 10 million energy efficient CFLs were distributed in exchange for incandescent lamps among the residential consumers of Bangladesh. This operation was nationally coordinated through over 1400 urban and rural distribution centres. The load reduction was almost 300 MW.

Under the second phase of the programme which will run until 2014, around 7.25 million CFLs will be distributed in rural areas.

6.1.3 Fiscal Instruments and Incentives

6.1.3.1 Tax Incentives

Currently, there are no tax incentives or import duty concessions for energy efficient equipment or services.

---

[19] BRESL 2013, Feasibility study report on regional ES&L harmonization for CFL

[20] Lites Asia Workshop 2012, New Delhi, National Standard, regulations and labelling requirements for lighting products in Bangladesh

[21] http://www.powerdivision.gov.bd/user/brec/52/94

6.1.3.2 Funds for Energy Efficiency

Currently there are no financial mechanisms or incentives that specifically target energy efficiency initiatives.

6.1.4 Support, Information and Voluntary Action

6.1.4.1 Course Curriculum in Schools and Universities

Initiatives have been undertaken in order to build awareness among students by incorporating a course on Energy Efficiency and Solar Energy Issues into the curriculum of schools, madrasas and colleges.

6.1.4.2 City Region Development Project

The government of Bangladesh has initiated the "City Region Development Project" with funding from the Asian Development Bank, to support the development of urban infrastructure, essential for economic growth and improvement of the urban environment. This includes installing solar powered street lighting in urban areas.

6.1.4.3 Pilot Project in Dhaka Metropolitan Area[22]

The main objective of this project was to install 23,000 CFLs by 2009 which would increase the awareness amongst the users and also would result in energy savings.

6.1.5 Sustainability and End-of-Life Treatment

The government has yet to implement any guidelines for safe disposal and recycling of CFLs which contain hazardous mercury.

6.1.6 Monitoring, Verification and Enforcement[23]

BSTI issues quality assurance product certificates as well as management system certificates, which are accredited by Norwegian Accreditation Board.

Bangladesh has more than four laboratories which are capable of testing of CFLs, but none of the laboratories are accredited with BSTI.

[22] UNEP/GEF en.lighten –Best practices for achieving transition to efficient lighting, 26 Sep 2013

[23] Bangladesh standards and testing institutions http://www.bsti.gov.bd/

6.1.6.1 Product Quality Testing Laboratories

BSTI began an initiative to provide certification, as well as an energy efficiency labelling format, to CFL manufacturers. The steps taken to date by BSTI include:

1) Performance level conformity testing
2) Sample collection and testing for conformity
3) Energy efficiency standards have been recently approved in addition to the performance standard that already exists
4) Three companies have already received certification and another nine companies are in the process of receiving it

6.1.6.2 Strengthening Testing Capacity[24]

BSTI formulated more than 3500 national standards for various products and services. Among these, around 1550 international and regional standards have been adopted as national standards. Among the 53 standards for electric lamps and accessories, the following lighting items have been identified for the compulsory certification mark scheme:

BDS 17:2006 Tungsten filament lamps (equivalent to IEC 60064)

BDS 1734:2003 Self-ballasted lamps (equivalent to IEC 60969)

BDS IEC 60081:2006 Double capped fluorescent lamps.

BDS 1606 Lamps for railway stocks

BDS IEC 60188 Mercury lamps

BDS IEC 60192 Sodium lamps

BDS IEC 60810 Lamps for road vehicles

BDS IEC 60901 Single capped fluorescent lamps

BDS IEC 60983 Miniature lamps

Bangladesh has adopted the IEC 60969 for CFL testing purposes.

6.1.7 Lamp Production and Manufacturing[25]

6.1.7.1 Lighting Products Industry in Bangladesh

Currently, there are only 15 BSTI certified tungsten filament lamp producers in Bangladesh. There are around 15 certified CFL lamp manufacturers and some certified linear fluorescent lamp producers. Today, a significant amount of CFLs and fluorescent lamps are imported from China and India.

There is one sole LED lamp manufacturing industry situated in Chittagong that exports LED products to foreign countries.

[24] Bangladesh standards and testing institutions http://www.bsti.gov.bd/

[25] Interview conducted and information shared by officials from Electric Lamp and Component Manufacturer's Association of India

Bangladesh is importing 20% of incandescent lamps, 80% of CFLs, 40% of fluorescent lamps and 90% of HIDs. Details of manufacturing capacity is provided below in Table 6.

Table 6 : Manufacturing Capacity of Bangladesh

	Incandescent Lamps	Compact Fluorescent Lamps	Linear Fluorescent Lamps	High Intensity Discharge Lamps
Bangladesh	80%	20%	60%	10%

The total number of sockets available in Bangladesh is approximately 220 million. The total number of lamps consumed every year is around 152 million. The number of incandescent lamps consumed constitutes 54% of total lamp consumption at approximately 82 million pieces every year. The numbers of CFLs consumed is around 38 million annually and constitute 25% of total lamp consumption. Linear fluorescent and HIDs constitute 18% and 3% respectively, of total lamp consumption.

6.1.8 Off-Grid Lighting[26]

6.1.8.1 Off-Grid Lighting Overview

The population of Bangladesh is around 163 million (29 million households) and the electrification rate is 41% with 17 million households off-grid. Of the off- grid population, a vast majority (89% or 15 million households) is concentrated in rural Bangladesh where the electrification rate dips to as low as 28%. Bangladesh households spend 1-2% of their monthly incomes on kerosene. Almost 94% of kerosene is being consumed for lighting which results in an expenditure of approximately USD 0.36 billion.

The transition towards solar LED lighting systems from fuel based lighting systems would results in an annual savings of 303 million litres of kerosene, 14.6 billion candles and 111 million batteries. Also, there is a potential to save of 2.4 million tonnes of CO_2 emissions annually. The annual monetary savings is around USD 1.8 billion with a payback period of less than 6 months[27].

6.1.8.2 Solar Off-Grid Lighting Market

The Infrastructure Development Company Limited's (IDCOL) solar programme was launched in 2003 as part of the Rural Electrification and Renewable Energy programme. Currently, it is operational only in those areas recognized as off-grid by the government of Bangladesh, which covers approximately 17 million off-grid households. Only solar home systems are supported through this programme, as the government only considers these households as being electrified.

The programme works with donor agencies, solar home system suppliers, technical experts, and partner organizations that have experience in microcredit financing. To reduce the costs to the end user, the programme subsidizes the upfront cost of the solar system through a grant and provides soft loans to partner

[26] *L*ighting Asia: Solar Off-Grid Lighting, International Finance Corporation, February 2012
[27] UNEP/GEF en.lighten Initiative, Country Lighting Assessment reports, 2010

organizations to allow consumers access to credit at low interest rates. About 680,000 solar home systems have been installed to date under the IDCOL solar lighting programme.

Although the programme is successful, there is still room for further growth, as there is only a market penetration rate of y 4% of the 17 million off-grid households. The programme aims to reach a scale of 4 million installations by 2014, implying an annual growth rate of over 115% and a market penetration of approximately 25%. The number of partner organizations has risen from five in 2002 to 30 in 2011. Of all the partners, Grameen Shakti (GS) is the most prominent, accounting for 64% of the installations so far.

Over 80% of the overall sales of solar home systems are in the range of 20-85 Watt peak (Wp) with 50 Wp systems accounting for an estimated 35% of all sales.

Larger systems (>20 Wp) primarily use linear fluorescent lamps however, there is a shift to CFLs for 20 Wp systems. There is no noticeable penetration of LEDs as of yet. Once systems with a Wp of lower than 20 Wp are introduced, these should be LED based.

6.3.8.3 Regulatory Environment

Financial Support

Solar LED lighting products have been made more affordable from the financing available through IDCOL's soft-loan programme. The programme makes it easier for end users to afford the systems and has attained much success in reaching off-grid households. Solar lanterns however, are not included in the programme.

Subsidies

The retail price of kerosene is approximately USD 1.1 per litre compared to a subsidized price of around USD 0.8 per litre. The subsidy on kerosene is not as high as to negatively impact the adoption of solar lanterns thus; the IDCOL programme has put solar systems on a level playing field with kerosene lamps.

Import Tariff and Duties

There is no import duty on solar photovoltaic cells, modules/panels and LEDs. There is however, a high import duty on solar lanterns which discourages the importation of good quality products. There is also a 40% on charge controllers, 7.5% on batteries, 26% on CFLs and 25% on solar lanterns.

Taxation Policies

Renewable energy equipment and related raw materials to produce such equipment is exempted from the 15% VAT. Public and private renewable energy investors are offered tax exemptions subject to extensions, based on impact assessments of the exemption on renewable energy.

6.2 Bhutan

During the last couple of years, Bhutan has experienced accelerated economic activities which put pressure on their natural resources such as land, air, and water. Development activities, increased urbanization, industrialization, mining and quarrying, agriculture, and solid waste management projects have led to enormous environmental challenges such as: land degradation; biodiversity and habitat loss, high fuel-wood consumption; and human-wildlife conflicts. Notwithstanding these issues, Bhutan overall remains carbon-neutral, and a net sink for greenhouse gases. Any minor decrease in electricity generation due to seasonal variances has a much more pronounced impact on electricity exports and thereby, the revenue generated from export to the Bhutanese economy.

With increased electrical connectivity and growing urbanization, electricity consumption has been increasing rapidly in Bhutan. The compounded annual growth rate was 15.5% between 2004 and 2011, with electricity consumption at 1620 GWh by the end of 2011. At the same time, electricity generation was 7046 GWh, with about 5273 GWh used by the industrial sector at 33.9% of the total electricity consumption. The commercial sector accounts for approximately 6.6%, with buildings consuming more than 250 GWh of electricity in 2011. Urban residential properties consume the most energy in the buildings segment accounting for 95 GWh of the 250 GWh of electricity consumed in 2011. Rural households are lower at 65 GWh of electricity however, domestic residences combined accounted for close to two-thirds of the electricity consumption in the buildings segment. The institutional buildings with about 46 GWh of electricity consumption, along with the commercial establishments, with about 43 GWh of electricity consumption, accounted for the rest of the consumption in the buildings segment in 2011.

There has been substantial growth in the electrical connectivity of households in Bhutan. While the number of rural electricity consumers increased from 34,225 in 2006 to 63,477 in 2011, the increase in urban consumers has been more moderate from 20,794 to 32,138. The on-going Rural Electrification (RE) programme aims at achieving near to 100% by the end of 2013.

Bhutan is developing a policy and framework to focus on the optimization and utilization of energy resources through demand side management (DSM) programmes in order to reduce the adverse effects of climate change, especially on its hydropower generation. An energy efficiency baseline study has already been carried out to facilitate the government in formulating a national energy efficiency policy.

6.2.1 Regulatory and Control Mechanisms

The Department of Renewable Energy, under the umbrella of Ministry of Economic affairs, is responsible for overall renewable energy and energy efficiency planning and regulations. The department has three divisions - Alternate Energy division, Planning and Coordination division and Research and Development division.

The Alternate Energy division is primarily responsible for implementation of alternative energy programmes, focusing on supply-side diversification. It has four sections dealing with solar, wind, bio-energy and small hydropower programme

The Planning and Coordination division oversees planning and coordination activities and has three sections that deal with rural electrification and CDM programmes.

The Research and Development division is responsible for applied research and development programmes, including energy efficiency and conservation measures.

The Electricity Act of 2001, which is currently still in practice, governs the regulations of the power sector. The Energy Development Strategy focuses on increasing the potential of hydropower, increased electrification and the promotion of private sector participation and investment.

The Sustainable Hydro Power Development Policy 2008 and the Economic development Policy of 2010 emphasize the need to have a renewable energy policy to promote renewable energy sources in order to ensure national energy security.

Currently, there are no other specific regulations adopted for energy efficiency or renewable energy actions.

6.2.1.1 Renewable Energy Policy

The Royal Government of Bhutan adopted the Alternate Renewable Energy Policy in April 2013. This legislation focuses on energy security through the promotion and development of renewable energy to meet current, as well as future, energy requirements. Under this policy, the goal is to achieve 20 MW of power by 2025 utilizing solar, wind and biomass technologies with other renewable accounting for 5 MW each.

6.2.1.2 Energy Efficiency Policy

To date, there are no specific policies to promote energy efficiency and conservation. A national level energy efficiency policy is currently being considered by the Ministry of Economic Affairs.

6.2.1.3 Energy Performance Standards

Minimum energy efficiency standards and labelling for appliances are yet to be established. A study conducted under the South Asia Regional Initiative for Energy (SARI) however, revealed the huge energy savings potential at a low cost by implementing standards and labelling for domestic appliances for Bhutan.

6.2.1.4 Energy Codes

Building codes and standards are currently being developed in Bhutan.

6.2.2 Economic and Market-Based Instruments

6.2.2.1 Energy Service Companies (ESCOs)

ESCOs have yet to be established in Bhutan.

6.2.2.2 CFL Distribution Programme[28]

In 2004, in the Trongsa & Bumthang districts, around 8000 CFLs were distributed to consumers at the subsidized price of USD 0.5 per piece. The demand was high which lead to an additional procurement of 11,000 CFLs, leading to a reduction of peak energy demand by 641 KW. Additionally, these two districts did not experience load shedding which resulted in savings of approximately USD 112 million.

6.2.2.3 CFL and LED Distribution

During the 11th Five Year Plan, a fund of around USD 2.4 million has been proposed by Royal Government of Bhutan for the distribution of CFLs and white LEDs nationwide, based on cost sharing principles.

6.2.3 Fiscal Instruments and Incentives

6.2.3.1 Tax Incentives

Currently, there are no tax incentives or import duty concessions for energy efficient equipment or services.

[28] Sourced through open competitive bidding at the cost of USD 2 per CFL while the market price was USD 6 per CFL.

6.2.3.3 Funds

Two sources of funding have been identified for the renewable energy policy through the Royal Government of Bhutan and Renewable Energy Development Fund (REDF) stipulated under Sustainable Hydropower Development Policy of 2008.

6.2.4 Support, Information and Voluntary Action

6.2.4.1 United States Agency for International Development (USAID) Programme

This partnership programme involves assistance from the SARI energy programme aimed at promoting energy efficiency standards and labelling for end-use domestic appliances.

6.2.4.2 The Energy & Research Institute (TERI) Programme

Local programme assistance has been provided by the Government of India under the 9th Five Year Plan (2002-08) aimed at developing an integrated energy management master plan for Bhutan. This programme was carried out in two phases. In the first phase, the Bhutan Energy Data Directory was developed and published in 2005 and in the second phase, a wide range of issues related to the energy sector was analysed.

6.2.4.3 South-South Cooperation

A partnership programme was established in 2002 between Bhutan, Benin and Costa Rica aimed at creating and increasing awareness among the public on all aspects of energy use in households and transportation. Under this initiative, an energy efficiency awareness programme which includes lighting was implemented by the Department of Renewable energy throughout 2008-09 in the local media and through the distribution of pamphlets and brochures.

6.2.4.4 Energy Managers and Auditors

An accreditation system for energy managers and auditors has been planned, but is yet to be established.

6.2.4.5 Department of Energy CFL Programme

A local programme aimed at providing CFLs at a subsidized rate was launched. CFLs were provided by the Bhutan Power Corporation to customers covered under micro hydro power plants in the Wangdue-phodrang, Trongsa, Zhemgang, Bumthang, Tsirang and Dagana regions.

6.2.5 Sustainability and End-of-Life Treatment

Many urban areas lacks designated landfills and effective waste disposal systems, prompting residents to burn or dump garbage.

Although passed in 2009, the Waste Prevention and Management Act was only finalized in 2011. The regulations covered refuse segregation, including industrial, chemical, radioactive, and electronic waste, which were not to be mixed with general refuse. The 2011 regulation also prohibited landfills and dumping within national parks, protected areas, biological corridors, and human settlements.

There are no specific guidelines or program to deal with used CFL lamps in Bhutan.

6.2.6 Monitoring, Verification and Enforcement

To date, no infrastructure is in place for monitoring the quality of lamps. However, in the 11th Five Year Plan, testing labs for the implementation of minimum energy standards and labelling programme will be established.

6.2.7 Lamp Production and Manufacturing[29]

The total number of light points in Bhutan is approximately 1.75 million with an annual consumption of lamps at around approximately 0.7 million. The number of incandescent lamps consumed is 57% of total lamp consumption which stands at around 0.4 million annually. The numbers of CFLs consumed is around 0.2 million annually and constitutes 28% of total lamp consumption. Linear fluorescent and HID lamps account for 11% and 3% respectively, of the total lamp consumption.

Bhutan does not have the manufacturing capacity for CFLs, fluorescent lamps and HIDs and they are importing 95% of incandescent lamps as seen below in Table 7.

Table 7: Manufacturing Capacity of Bhutan

	Incandescent Lamps	Compact Fluorescent Lamps	Linear Fluorescent Lamps	High Intensity Discharge Lamps
Bhutan	5%	0	0	0

6.2.8 Off-Grid Lighting[30]

Due to its geographical location, there is huge difference in electrification between urban and rural households. While 96.4% of the urban households are electrified, the figure is only 40% in case of rural areas (DoE 2010).

The low level of rural electrification can be attributed to the mountainous terrain, scattered patterns of settlement, huge capital investment required to extend the grid lines to such remote areas, and low tariff and demand in the villages. Since a substantial part of the country's revenue comes from electricity export, the Royal Government of Bhutan recently began providing impetus to intensify the rate of rural electrification and targets 100% per cent electrification by the end of the country's tenth Five Year P (2014). This is envisaged to be done through grid extension, development of mini hydro plants and individual solar home systems. Another key objective of rural electrification is to reduce fuel wood consumption in rural areas used for cooking.

Bhutan experimented with off-grid solutions for remote rural areas in the early 1980s. However, the off grid route was not mainstreamed and the schemes remained at pilot stages only, resulting in very slow progress. Currently, there are about 16 off-grid micro hydro plants with aggregate capacity of 1318 kW (DoE 2007). Most of these plants were commissioned in 1986/87. In addition to these, BPC (Bhutan Power

[29] Interview conducted and information shared by officials from Electric Lamp and Component Manufacturer's Association of India

[30] Off-grid electrification experience in South Asia: Status and best practices, May 2010, The Energy and Resources Institute

Corporation) also operates some off-grid diesel generation in the central and eastern Dzongkhags. In the solar photo voltaic (PV) sector, there were 4341 solar home systems installed in the country (DoE 2007) by the end of 2006. In addition, about 4.5 MWp of SPV power plans for telecom operations also exists, the majority of which were installed with support from JICA. However, the actual numbers of systems functioning currently are unknown.

In 2003, a solar energy project was initiated in Bhutan by the Solar Electric Light Fund (SELF) with support from the Royal Government of Bhutan, the Bhutanese Royal Society for the Protection of Nature, the Tshungmed Solar Inc., the Bhutan Development Finance Corporation, and the Bhutan Trust Fund (SELF 2003). The project aimed to bring small solar home systems to about 200 families in the Phobjikha Valley. This project had two critical components for ensuring long term success. Firstly, solar home systems were not donated free of charge to the families instead, SELF provided seed capital and a mechanism for families to secure micro loans for purchase of the systems. Secondly, SELF also trained local men and women in solar technology, installation, and maintenance, thereby ensuring that the project could be maintained over the long term after the project implementation period.

In Bhutan, the transition towards LED based solar lighting systems from fuel based lighting system would result in annual savings of 8 million litres of kerosene, 4 million candles and 1 million batteries. Also, there is a potential to save of 20.6 thousand tonnes of CO_2 emissions annually. The yearly monetary savings would be approximately USD 9.3 million with a payback period of less than 7 months.

6.3 India

India is one of the fastest growing economies in the world which increases the demand for energy to drive industrial progress and modern economic activity, as well as for meeting the needs of the poor. Access to affordable energy has been a main objective of various government policies and programmes. To achieve this, efforts must be made for improved energy efficiency and the use of cleaner forms of energy in all sectors of the economy.

The total installed power generating capacity in India has increased from 173 GW to 199 GW from March 2011 to March 2012, representing an increase of 15.1%. The installed capacity is comprised of 56% from coal, 20% from hydropower, 12% from renewable energy sources, and 9% from gas. From 2011-2012, major power generation came from thermal sources, contributing nearly 81% (709 billion units or BU) of the total power generated.

Hydropower (130 BU) and nuclear power (32 BU) contributed the remaining share of electricity generation the same year.

The demand is growing in term of both energy and peak demand. Although there has been an improvement in the energy and peak deficit situation since 2008/09, it remained constant from 2011 to 2012 at 8.5%.

About 68% of India's population still lives in rural areas and depends largely on non- commercial sources of energy such as fuel wood, biomass, and agricultural residue for their energy requirements for cooking and lighting. Approximately 33.54% of rural households used kerosene as primary lighting source in 2009/10.

India is facing the challenge of sustaining its rapid economic growth while dealing with the global threat of climate change. It is imperative to identify measures that promote India's development objectives, while

also yielding co-benefits for addressing climate change effects. Thus, cost-effective energy efficiency and energy conservation measures are of particular importance.

India, having recognized that climate change is a global challenge, has been actively involved in international efforts relating to environmental protection with 94 multilaterals environmental agreements, such as the Ramsar Convention on Wetlands, the Convention on International Trade in Endangered Species of Fauna and Flora and the Convention on Biological Diversity, among many others.

India has also signed the United Nations Framework Convention on Climate Change (UNFCCC), and has consented to the Kyoto Protocol in 2002. Despite not having binding mitigation commitments as per the UNFCCC, India has communicated its voluntary mitigation goal of reducing the emissions intensity of its Gross Domestic Product (GDP) by 20–25 per cent, over 2005 levels, by 2020. The Indian Government is committed to the UNFCCC principle of Common but Differentiated Responsibility (CBDR). The Government has also formulated the National Action Plan on Climate Change that provides for eight missions to help the country adapt to the effects of climate variability and change.

Energy Conservation Act

Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001. The Act provides for the legal framework, institutional arrangements and a regulatory mechanism at the central and state level to embark upon energy efficiency efforts in the country. Five major provisions of Energy Conservation Act are: identification of designated consumers; standards and labelling of appliances; energy conservation building codes; creation of an institutional set up – the Bureau of Energy Efficiency (BEE); and the establishment of Energy Conservation Fund.

The Energy Conservation Act became effective as of March 1, 2002 with BEE beginning operation on the same day. Energy efficiency institutional practices and programmes in India are now mainly being guided through various voluntary and mandatory provisions of the Energy Conservation Act. The Act was amended in 2010 and facilitates energy efficiency in lighting, air conditioning and various other energy consuming utilities.

The Bureau of Energy Efficiency

The Bureau of Energy Efficiency (BEE) is an agency of the Government of India, under the Ministry of Power created in March 2002 under the provisions of the Energy Conservation Act, 2001. The agency's function is to develop programmes to increase the conservation and efficient use of energy in India. BEE coordinates with government, industries, manufacturers and consumers to facilitate measures to be taken for conserving energy. The mission of BEE is to "institutionalize" energy efficiency services; enable delivery mechanisms in the country; and provide leadership to energy efficiency in all sectors of the country.

The objectives of BEE include:

- To exert leadership and provide policy recommendations and direction to national energy conservation programmes
- To coordinate energy efficiency and conservation policies and programmes for stakeholders
- To establish systems and procedures to measure, monitor and verify energy efficiency results in individual sectors as well as at a macro level

- To leverage multi-lateral and bi-lateral and private sector support in implementation of the Energy Conservation Act and the efficient use of energy and its conservation
- To demonstrate delivery of energy efficiency services as mandated in the EC bill through private-public partnerships
- To interpret, plan and manage energy conservation programmes as envisaged in the Energy Conservation Act
- To provide policy recommendations and direction to national energy conservation activities
- To coordinate policies and programmes on efficient use of energy with shareholders
- To establish systems and procedures to verify, measure and monitor energy efficiency improvements
- To leverage multilateral, bilateral and private sector support to implement the Energy Conservation Act 2001
- To demonstrate energy efficiency delivery systems through public-private partnerships

National Action Plan on Climate Change[31]

The National Action Plan on Climate Change (NAPCC) was prepared under the guidance and direction of the Prime Minister's Council on Climate Change and released in 2008 to achieve "a sustainable development path that simultaneously advances economic and environmental objectives". The NAPCC was formed to address India's requirements for comprehensive and urgent initiatives to address climate change and environmental issues at the national level. It also reflected the country's intention to behave as a responsible member of the international community, as well as its rejection of the burden of emission reductions on par with developed countries. The NAPCC argues that its success would be enhanced if "developed countries affirm their responsibility for accumulated greenhouse gas emissions and fulfil their commitments under the UNFCCC, to transfer new and additional financial resources and climate friendly technologies to support both adaptation and mitigation in developing countries".

The NAPCC has eight missions to achieve the above principles, two of which are directly energy related: the Jawaharlal Nehru National Solar Mission (JNNSM) and the National Mission for Enhanced Energy Efficiency (NMEEE). The JNNSM, implemented by the Ministry of Renewable Energy (MNRE), is a supply-side effort aimed at significantly increasing the share of solar energy in the total energy mix. The NMEEE, implemented by the BEE, is based on demand-side management.

Other missions also have indirect implications on energy sector, for instance, the National Mission on Sustainable Habitat aims to improve energy efficiency in the building sector.

National Mission for Enhanced Energy Efficiency

The National Mission for Enhanced Energy Efficiency (NMEEE) will enable energy efficiency programmes and transactions which would result in a savings of 10 GW by the end of 11th five year plan. The NMEEE will enhance energy efficiency through market-based mechanisms, energy efficient appliances and financial mechanisms to support demand-side management programmes.

[31] National Action Plan on Climate Change (NAPCC), Prime minister Council on climate change, Government of India

The total commercial energy consumed by industry, including small and medium enterprises, accounts for about 40–50 per cent of the total commercial energy consumption in the country. Hence, energy efficiency measures would yield substantial benefits in this sector. The introduction of innovative, energy efficient lighting would lower the growth of electricity demand while enhancing services to households.

Specific initiatives envisaged by the NMEEE include the Perform Achieve and Trade (PAT), a programme based on market mechanisms to enhance energy efficiency. The scheme expects to achieve energy savings of 3.5 million tons of oil equivalent (Mtoe) in seven selective industrial sectors and 3.1 million tons of oil equivalents in thermal power stations by 2014/15.The scheme covers the following:

- The first cycle of PAT is to achieve the set target of 6.6 mtoe by 2014/15. The second cycle envisages the inclusion of other energy-intensive sectors such as refineries, chemical production, etc.
- Fiscal instruments like the Partial Risk Guarantee Fund and Venture Capital Fund for Energy Efficiency, which have been proposed in NMEEE for successful implementation of PAT, would enable financial institutions and equity investors to invest in energy efficiency products and companies
- Widely used electrical appliances, such as fans and lights in homes and offices, would rapidly reduce energy consumption

Rajiv Gandhi Grameen Vidyutikaran Yojana

The Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme was launched by the Government of India in April 2005 to provide access to electricity to all rural households. The scheme involved electrification of all un-electrified villages plus a free connection for below poverty level households, by providing a subsidy of 90 per cent of the total project cost, where the remaining 10 per cent was to be borne by the Rural Electrification Corporation (REC) as loans. As of the end of March 2012, out of the total of 112795 villages under RGGVY, 104496 villages had been completed. Studies indicate that electrification alters the household energy mix by substituting traditional kerosene-based lighting, thus resulting in energy and financial savings.

Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy (MNRE) has signed a memorandum of understanding (MoU) with the National Bank for Agriculture and Rural Development (NABARD) to promote "Solar Home Lighting Systems" to rural areas. This programme is to be implemented under the Jawaharlal Nehru National Solar Mission by the MNRE. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 and is aimed at reducing the cost of solar power generation in the country through (is) long term policy; (ii) large scale deployment goals; (iii) aggressive research and development; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022.

6.3.1. Regulatory and Control Mechanisms

The Indian Standards Institution (ISI) was established in 1947 (now the Bureau of Indian Standards) for the harmonious development of standardization activities related to any article, process or product in India. The Indian standards are developed under the Bureau of Indian Standards (BIS) Act, 1986. Over 350 new and revised standards are being formulated each year by BIS.

India is a full member of IEC, with Bureau of Indian Standards operating as the National Committee. India is also participating member of TC34 and SC34A. In most cases, India uses IEC standards as guides and adapts them to Indian requirements.

There are 60 standards which deals with lamps, control gear and lamp holders. Of these 60 standards, there are about 29 standards for lamps. 52 standards of the existing 60 Indian standards are in harmony with IEC standards. The standards developed includes different categories of lamps such as incandescent, linear fluorescent, halogen lamps, CFLs, LEDs and high intensity discharge (HID) lamps. The standards which are currently under development include LED street lighting luminaries and double capped retrofit LED lamps.

6.3.1.1 Energy Performance Standards[32]

India currently has mandatory minimum energy performance standards (MEPS) for CFLs under the standard IS-15111. The standard covers the range of capacities and efficacy of CFLs. CFLs from 8 to 10 watts need to have 50 lm/W*, CFLs from 11 to 15 watts need to have 55 lm/W, 16 to 23 watt lamps need to have 60 lm/W* and 24 to 26 watt types need to have 60 lm/W.

India has voluntary MEPS for fluorescent lamps and has adopted IEC performance standards for LEDs.

6.3.1.2 Energy Labelling[33]

A standards and labelling programme has been identified as one of the key activities for energy efficiency improvements. A primary objective of this scheme is to allow the consumer to make an informed choice about energy saving lamps and the cost savings potential of the relevant marketed product. Standards and labelling programmes for various equipment and appliances have been developed under the Energy Conservation Act 2001. BEE is the organisation responsible for this programme in India.

The scheme was launched on May 18, May 2006 and currently covers 12 pieces of equipment and appliances including: air conditioners, fluorescent lamps, refrigerators, distribution transformers, induction motors, geysers, ceiling fans, colour TVs, agricultural pump sets, stoves and washing machines. The first four items, mentioned above, have had labelling as of January 7, 2010. The other appliances are presently in the voluntary labelling phase. The star rating ranges from 1 to 5, in increasing order of energy efficiency. This programme leads to huge energy savings and thereby, cost savings; reduces capital investment in energy supply infrastructure; enhances product quality; strengthens the competitive market; allows domestic industries to compete in markets where norms for energy efficiency are mandatory; removes indirect barriers to trade; reduces carbon emissions; and helps meet climate change goals.

India currently has mandatory labelling for tubular fluorescent lamps. The labelling programme for these products was launched in 2006 and became mandatory in 2010. To date, 46 fluorescent lamp types have been approved for star rating. The labelling system uses comparative labelling which varies from one star to five stars, depending upon the hours of usage and luminous efficacy (lm/W).

[32] Collaborative Labelling and Appliance Standard Program (CLASP) and en.lighten initiative, June 2011
[33] Report of the working group on power for 12th plan (2012-17), Ministry of Power, Government of India

6.3.1.3 Energy Codes for Buildings[34]

The Energy Conservation Building Code (ECBC) was launched by the Government of India in 2007. The ECBC sets minimum energy standards for new commercial buildings having a connected load of 100kW and above. The code limits the lighting power density for different spaces which compels energy efficient lighting system design and installation. The Central Public Works Department (CPWD) is responsible for the construction and maintenance of all central governments building in India. They have already made the ECBC mandatory for their buildings and many Indian states are in the process of mandating the use of ECBC.

Harmonization of ECBC with the National Building Code (NBC) is also in progress with the inclusion of a chapter on "Approach to Sustainability" in NBC-2005. BEE has developed an ECO-Nirman conformance check tool with the objective of helping architects and design professionals to assess the conformance of their designs with code requirements.

6.3.1.4 Star Rating of Buildings

In order to further accelerate energy efficiency activities in the commercial building sector, BEE has developed a star rating programme for office buildings, shopping malls and Business Process Outsourcing (BPO) buildings s based on the actual performance of a building in terms of its specific energy usage in kWh/sqm/year. The programme rates buildings on a 1-5 star scale, with a 5 star rated building being the most efficient. The star rating programme provides public recognition to energy efficient buildings and creates a 'demand side' pull for such buildings. Buildings with a connected load of 100 KW and above are being considered under the BEE Star rating scheme. It will be subsequently extended to other building types and different climatic zones.

6.3.2 Economic and Market-Based Instruments

6.3.2.1 Market Transformation for Energy Efficiency (MTEE)

The main objectives of MTEE are to:

- Accelerate the shift to energy efficient appliances in designated sectors through innovative measures
- Make the products more affordable by leveraging international financial instruments, including the Clean Development Mechanism (CDM)
- Make energy efficient appliances affordable and increase their levels of penetration

In order to reduce the transaction cost of CDM projects, an aggregation of a large number of projects is required. The public sector holds the key and in order to ensure the adoption of CDM in the public sector, barriers need to be removed by adopting following action plan:

- Make it mandatory for all public investment and over time, all public operations, to be assessed for their potential to attract carbon finance
- Promote programmatic CDM to reduce transaction costs and the aggregation of small energy efficiency projects

[34] Report of the working group on power for 12th plan (2012-17), Ministry of Power, Government of India

- Develop and implement a national CDM strategy for energy efficiency
- Promote market access of small industries to energy efficiency projects
- Promote transparency in pricing
- Ensure that the legal status of Certified Emission Reductions (CERs) is clear to avoid disputes related to taxation
- Enhance capacity-building and training

Under this initiative of NMEEE, BEE has developed the umbrella framework BLY- Programme of Activities (PoA) which has been registered under UNFCCC-EB on April 29, 2010.

Another programme under this initiative is the development of Super-Efficient Equipment Programme (SEEP). This goal of the programme is to develop super- efficient appliances with an aim to reduce consumption and enable demand side management. The aim is not only to reduce the cost of energy efficient equipment to stimulate accelerated market transformation, but also to encourage domestic manufacturing to sustain the market.

6.3.2.2 Bachat Lamp Yojana (BLY) for CFLs

The Bachat Lamp Yojana (BLY) project promotes energy efficient and high quality CFLs in households for the same cost as an incandescent lamp (i.e. Rs 15). This removes the barrier of high initial cost of a CFL, which is currently Rs 80 - Rs 100, and constrains their penetration into households. The programme targets replacement of about 400 million incandescent bulbs in the country, leading to a possible reduction of 4,000 MW of electricity demand, and a reduction of about 24 million tonnes of CO2 emissions every year. The price differential would be made up by project implementers through carbon credits earned which could be traded in the international market under Clean Development Mechanism (CDM) under the UNFCCC Kyoto protocol.

BEE has developed the umbrella framework BLY-Programme of Activities (PoA) which was registered under UNFCCC- EB on April 29, 2010. The PoA defined key CDM requirements, including the project baseline, as well as the methodology and monitoring protocols through which CO2 emission reductions would be assessed. The PoA approach reduced the time and transaction costs for registering the projects since the key CDM requirements will not need to be addressed by area-specific projects within the PoA.

BEE plays a role of a "coordinating and managing entity" in the BLY. Kerala State has distributed the CFLs throughout the entire state. Karnataka State has also launched the scheme and CFL distribution has started. BLY is at different stages of implementation in many other states like Punjab, Haryana, Andhra Pradesh, Orissa, Chattisgarh, Madhya Pradesh, Uttar Pradesh, Uttarakhand , Rajasthan, Goa, West Bengal, Tamil Nadu and Delhi. These projects can be added to the registered umbrella framework, as and when they are developed during the lifetime of the PoA.

6.3.2.3 Bachat Lamp Yojana (BLY) for LEDs

The second phase of BLY (which has started in 12th Five Year Plan (2012-2017)) aims to distribute around 20 million LEDs by facilitating provision of one LED bulb per below poverty line (BPL) consumer.

6.3.2.4 Super-Efficient Equipment Programme (SEEP)[35]

SEEP aims to catalyse successful market transformation for energy efficient appliances in India, starting with ceiling fans, and push the efficiency level of appliances far beyond what the BEE's standards and labelling initiative could be expected to achieve. To achieve this, the project will provide incentives to incentivize manufacturers to reduce the final price of five million super energy efficient ceiling fans in the first/pilot phase of this programme.

In the next phase of SEEP, which will begin in 12th five year plan, around 25 million LEDs will be distributed to grid connected consumers at subsidized prices which would result in overcoming the high initial cost of LEDs and would help the mass penetration of LEDs.

6.3.2.4 Cooperative Procurement (Bulk Purchasing)

The Directorate General of Supplies & Disposals (DGS&D) is a central purchasing organization under the Ministry of Commerce and Industry. Its role is to finalize the rate contracts to be used by government departments to procure items of general use. DGS&D contract rates allow the state, central and government-owned entities to buy required goods at the DGS&D specified prices.

DGS&D in general have laid special emphasis for sustainable procurement by buying products which are green, energy efficient, recyclable and environment friendly. Energy efficiency and 'Eco-mark' models have been introduced since 2008 for 11 items which include solar lanterns, solar home lighting systems, solar street lighting, CFLs and linear fluorescent lamps.

6.3.2.5 Energy Service Companies (ESCOs)

The overall size of the energy efficiency market is estimated to be Rs. 74,000 crores or USD 12 billion. To date, only 5% of this market has been tapped, primarily in the areas of lighting and some industrial applications. The large-scale implementation of energy efficiency is constrained by a number of important regulatory, institutional and financing barriers. The concept of performance contracting implemented by Energy Service Companies (ESCOs) is being increasingly considered as a mechanism to overcome some of the barriers hindering and discouraging the large-scale implementation of energy efficiency projects. However, despite the fact that the potential for application of performance contracting in both the public and private sectors in developing nations is enormous, the growth of the ESCO industry has been particularly slow in the country.

In order to develop a viable ESCO industry, the Ministry of Power has set up Energy Efficiency Services Limited (EESL), a joint venture of NTPC Limited, PFC, REC and Power Grid to facilitate implementation of energy efficiency projects. EESL will work as ESCO, as a consultancy organization for CDM, and as a resource centre for the capacity building of State Designated Agencies (SDAs), utilities, and financial institutions. EESL also leads the market-related actions of the NMEEE.

India has currently 37 companies registered as ESCOs with BEE.

6.3.2.6 Energy Efficiency Financing Platform

The Energy Efficiency Financing Platform (EEFP) was established to stimulate the necessary funding for Energy Service Companies (ESCOs) based on delivery mechanisms for energy efficiency. The costs will

[35] Transition to Efficient Lighting in South Asia 2013, Policy and programs supporting energy efficient lighting in India

be recovered from the energy savings, which will also reduce the subsidy bill of the state government. The scheme has the potential to be replicated across the country.

BEE has undertaken the following measures, in addition to those related to implementing demonstration projects in government buildings, in order to stimulate the market:

- Establishing a government supported standard methodology that covers the entire project chain, from audit to performance, measurement and verification
- Designing a standard performance contract
- Designing appropriate financial mechanisms to fund projects
- Implementing projects and evaluating their impact
- Building capacity in ESCOs and project owners

In an effort to provide EEFP, MoUs have been signed by the BEE with M/s. PTC India Ltd, M/s. SIDBI and HSBC Bank. PTC India Ltd. has commenced the financing of several building energy efficiency projects in Rashtrapati Bhavan Estate, ESIC Hospitals at Rohini and East Delhi, AIIMS, Safdarjung Hospital.

6.3.2.7 "Buy One Get 1 Free" CFL Scheme

In partnership with the Delhi government, BSES launched a 'Buy One Get One Free' scheme in October 2006. The programme was intended to run until 31 December 2006 but was extended until the end of June 2007. Under the scheme, a customer buying a CFL of 11, 15 or 20 watts, received another lamp of the same wattage absolutely free. All lamps were backed by a one year replacement warranty.

6.3.2.8 Demand Supply Management Based Efficient Lighting Programme

Under the Demand Supply Management Based Efficient Lighting Programme, four 60 watt incandescent lamps would be exchanged for four 10 watt LEDs in 0.25 million residential households at established distribution and collection points. The reduction in connected load as a result of the replacement would 50 watts per lamp, which is significant. The main objective is to overcome the first cost barrier to promote LEDs by using the basic architecture of the Bachat Lamp Yojana (BLY) project. The DELP will be implemented by electricity distribution companies with the help of EESL and resulting energy and cost savings will be linked with initial capital investment. DELP has already been introduced in Pondicherry.

6.3.3 Fiscal Instruments and Incentives

6.3.3.1 Funds for Energy Efficiency

State Energy Conservation Fund (SECF)

SECF is a statutory requirement under section 16 of the Energy Conservation Act 2001 and is one of the key elements of the Act. The Ministry of Power has approved the scheme "Contribution to SECF by the BEE" for which USD 11.2 million was sanctioned and was disbursed across SDAs during the last three financial years of the 11th five year plan (2009-2012).The funds were disbursed to those states that have constituted their state energy conservation funds and finalized the rules and regulations.

Partial Risk Guarantee Fund (PRGF)

A PRGF is a risk sharing mechanism that lowers the risk to the lender by guaranteeing repayment of part of the loan should a default occurs. The guarantee can directly support financing of energy efficiency projects by:

- Addressing credit risk and barriers to structuring the transactions involved in financing energy efficiency projects
- Engaging commercial financial institutions and building their capacity to finance energy efficiency projects on a commercially sustainable basis

Venture Capital Fund for Energy Efficiency (VCFEE)

The VCFEE, as envisaged by the Government of India under the National Mission for Enhanced Energy Efficiency, can assist in addressing the barriers and mobilizing some of the long awaited energy efficiency projects in the country. This fund will work as follows:

- Provide risk capital support to energy efficiency investments in new technology, goods and services, etc.
- Leverage private venture investments in the energy efficiency sector by identifying possible co-investment opportunities (not in competition with other private funds) with other venture capitalists
- Allow private venture fund players to capitalize the transaction costs associated with specific energy efficiency investments
- Help to create the volume in energy efficiency deals by the fund manager of VCFEE through advertising and the solicitation of energy efficiency opportunities
- Where it is co-invested with other venture capitalists with the same return expectations as private venture capitalists, this Fund could be last to be paid in case of liquidation of investment in projects
- Where it is co-invested with other venture capitalists with lesser return expectations than private venture capitalists, the Fund could be the first paid in case of liquidation of investments

Under this initiative, the framework for the development of financial institutions to promote energy efficient projects is in process. The institutional framework and RFP for hiring fund managers for Partial Risk Guarantee Fund (PRGF) and Venture Capital Fund (VCF) are being finalized.

6.3.4 Support, Information and Voluntary Action

6.3.4.1 Awareness-Raising, Promotion and Education

Under the National Manufacturing Competitiveness Council (NMCC), a core committee consisting of members from MoP, BEE and MNRE, was appointed to prepare a national plan to stimulate LED lighting in India. Several awareness raising-activities that have been undertaken include:

- LED exhibitions and workshops held in Delhi in May 2010, Hyderabad in August 2011, Mumbai in January 2012 and several workshops held across India in Gujarat, New Delhi, and Mumbai during 2013
- Light India 2012 – a major lighting exhibition and conference
- Publication of LED street lighting guide for municipalities and public works department.

- A comprehensive national awareness plan for LED technology and application in 2013 including advertisements, articles in newspapers and magazines, talk shows, electronic media and workshop presentations

6.3.4.2 Professional Certification and Accreditation

As per the Energy Conservation Act, it is mandatory for all designated energy consumers to designate an energy manager and to have energy audits conducted by an accredited energy auditor. The Government of India has specified that it is mandatory to pass a national level certification examination to become qualified as a certified energy manager or certified energy auditor. The Bureau has successfully conducted ten national certification examinations since 2004. After the tenth examination which was conducted in 2009, over 8,000 people have been qualified as energy managers, out of which over 5,700 have been qualified as energy auditors.

6.3.4.3 Educational Programmes

In order to make the next generation more aware of the efficient use of energy resources, it is necessary to introduce children to the concept during their school education. In this regard, the promotion of energy efficiency in schools is being conducted through the BEACON Project, which is now in its third phase. The project aims to train a minimum of three teachers as master trainers, from 30 schools, across several towns and cities in 22 states. These master trainers will assume the role of further training other teachers and students to ensure sustainability and continuity of the project.

Through this project, recommendations will also be made to the National Council of Education, Research and Training (NCERT) to update the science text books of seventh to ninth grade classes to include relevant chapters on energy efficiency as part of the school syllabus.

6.3.4.4 Energy Conservation Awards

The Energy Conservation Awards recognize innovation and achievements in energy conservation by industries, buildings, railways, state designated agencies, and the aviation industry, as well as energy efficient product manufacturers and municipalities. The goal is to raise awareness about the role of energy conservation in India's response to reducing global warming through energy savings. The awards scheme has been in operation since 1991 and includes over 30 sectors. In 2010, a new category for thermal power stations was also introduced to recognize their initiatives and efforts undertaken to conserve energy. The response from the industrial and commercial sector has been very encouraging, as is evident from the increased participation level from 123 in 1999 to 592 in 2010.

6.3.4.5 Painting Competition for Energy Conservation

The Ministry of Power developed the National Campaign on Energy Conservation 2010 which includes a painting competition on energy conservation at the school, state and national level to motivate children about energy conservation while providing a chance for them to explore their own creativity. The painting competition is first conducted at participating schools and then the two best paintings are submitted at the state/Union Territory (UT) level. The first two winners from each state and UT are invited to participate at the national level competition. In 2013, over 47,000 schools and 1.56 million students from the 4th, 5th and 6th standards participated in the school painting competition, which is very encouraging. The expressive paintings of the children reflected their interest in energy conservation activities and their concern about climate change.

6.3.4.6 BESCOM Efficient Lighting Programme

Launched in 2004, the BESCOM Efficient Lighting Programme (BELP) was a part of a DSM initiative launched by the Bangalore Electricity Supply Company (BESCOM) with the goal of promoting end-use efficiency in order to off-set its capacity increase targets. The effort received assistance from the Energy Conservation and Commercialization (ECO II) initiative funded by USAID and was implemented by the International Institute for Energy Conservation (IIEC).

In the initial nine months of the scheme, BELP offered 1.3 million domestic consumers the option to purchase BESCOM branded CFLs and 36 watt fluorescent tubes either through direct sales at discounted prices or through nine equal instalments recovered through BESCOM monthly bills.

Although originally launched for an initial period of nine months, BELP was extended until 2010.

6.3.4.7 Bombay Suburban Electric Supply

In June 2008, BSES launched a unique initiative to address two of the major priorities –energy conservation and safe disposal of CFLs. BSES' new scheme provides customers an opportunity to buy CFLs at heavily discounted prices and rewards them for turning in discarded CFLs and incandescent lamps.

In 2007, 25,000 CFLs were distributed during the first phase of an innovative reward scheme to tackle power theft by Bombay Suburban Electric Supply (BSES).

6.3.4.8 LED Demonstration Projects

In 2010, BEE launched the LED Village Campaign to convert existing incandescent household and street lights of a whole village with LEDs. This was done in order to showcase a comparison between LED and incandescent lamps with the objective of increasing the demand for LEDs in order to ultimately reduce their cost. Village demonstration projects have now been approved in 23 states while LED street lighting demonstration projects have been approved in 32 States.

Demonstration projects on energy efficient street lighting have already been implemented at Dimapur (Nagaland), Dibrugarh (Assam), Gandhinagar (Gujarat) and Bangalore (Karnataka).

6.3.4.9 BSES Activities

In October 2011, BSES Yamuna Power Limited announced collaboration with Osram to bring the next-generation of LEDs and CFLs to consumers in Delhi. Under the offer, consumers could purchase the lamps at heavily discounted prices. Additionally, with the purchase of an LED lamp, consumers would receive a free 15 watt CFL.

6.3.4.10 Initiatives at the Central Level in India

In India, the manufacture of high wattage incandescent lamps of 150 watts and above has been stopped. The production of 500 and 1000 watt halogen lamps has also ceased and in their place, eco halogen lamps of 400 and 750 watts have been introduced. Star ratings for linear fluorescent lamps with mandatory high lumen output have been proposed and 40 watt fluorescent tubes will not be included in the labelling programme.

6.3.4.11 Initiatives in Haryana, India[36]

The total installed electricity capacity of the Haryana state was estimated to be 4.86 GW in 2011-12. The source of electricity includes primarily thermal (3.85 GW), hydro (0.88 GW) and new and renewable energy (0.12 GW). There is no nuclear power generation in the state.

In Haryana, about 25% of the total power is being consumed for lighting, which increases to about 40% during the peak load time.

The various initiatives programme undertaken the Government of Haryana to promote energy efficiency include:

- Laws have been established for BEE labelling for lighting products
- Energy Conservation Building Code (ECBC) has been mandated in the state for all newly constructed state buildings
- To date, 115,000 CFLs and over 118,000 T5 fluorescent lamps have been replaced by LEDs in government offices with an investment of USD 0.83 million, resulting in annual saving of USD 1.53 million in electricity bills. This translates into an equivalent annual savings of 3.80 MW.
- There are no enforcement activities to ensure the performance standards and quality of products
- The state has developed a recycling programme for consumer waste, plastics and electronic waste. The guidelines adopted follow those developed by CPCB. Various NGOs have been identified to collect the CFLs from different local points for recycling.
- As a part of a promotional campaign, all the existing lamps have been replaced with LEDs at one of the villages in Panipat, Haryana
- Haryana State Utility, with support from the supplier, distributed 250,000 numbers CFLs from 2007 to 2008 without any cost.

6.3.4.12 Initiatives in Punjab, India[37]

The total installed electricity capacity of the Punjab state was around 5.24 GW in 2011-12, an increase of 0.47 % from the previous year. The sources of electricity include thermal (2.66 GW), hydro (2.23 GW) and new and renewable energy (0.35 GW). There is no nuclear power generation in the state. The various initiatives undertaken by the Government of Punjab to promote energy efficiency include:

- Laws have been established for BEE labelling for lighting products.
- Building codes have been mandated in the state for all newly constructed state buildings
- Various initiatives taken by Punjab Energy Development Agency (PEDA) for encouraging the shift towards energy efficient lighting are:
    - Awareness-raising campaigns
    - Under the BLY scheme, 4.8 million CFLs were distributed to domestic consumers by Punjab Corporation Ltd.

[36] Interview conducted and information shared by Department of Renewable Energy, Government of Haryana (HAREDA)

[37] Interview conducted and information shared by Punjab Energy Development Agency , Government of Punjab (PEDA)

- Demonstration project on LEDs in which the existing street lighting at Majitha Township, Amritsar in Punjab was replaced with LEDs, resulting in energy savings of around 80%
- Replacement of 1000 100 watt incandescent lamps with 10 W LEDs in households in Chunni Khurd, District Fatehgarh Sahib, Punjab, India

- There are no enforcement activities to ensure the performance standards and the quality of products
- No testing facility is available for the testing of lighting products before sale
- There are no guidelines for recycling of consumer waste, plastics and electronic waste

6.3.4.13 Initiatives in Gujarat, India[38]

The total installed electricity capacity of the Gujarat state was 19.0 GW in the year 2011-12, an increase of 44.92 % from the previous year. The sources of electricity include thermal (14.73 GW), hydro (0.77 GW) and new and renewable energy (3.5 GW). There is no nuclear power generation in the state. Gujarat Energy Development Agency (GEDA) has sponsored a village-level CFL programme.

In order to promote energy efficient lighting, various initiatives have been undertaken as mentioned below:

- In 1990, incandescent lamps were replaced with fluorescent lamps
- Replacement of electromagnetic ballasts with electronic ballasts for fluorescent lamps
- In 2007, the government mandated the replacement of incandescent lamps with CFLs and conventional 36 and 40 watt fluorescent lamps with 28 watt lamps in all the government offices
- In 2005, as part of the Jyotir Gram Yojna 100% rural electrification scheme, 30,000 CFLs were installed in 15,000 Village Panchayat Offices in order to reduce energy consumption and create awareness among the rural masses
- Ahmedabad Municipal Corporation has implemented a project to replace 10,000 high pressure sodium and fluorescent street lights with LEDs

6.3.4.14 Initiatives in Maharashtra, India

The total installed electricity capacity of the Maharashtra state was 20.35 GW in the year 2011-12. The sources of electricity include thermal (13.39 GW), hydro (3.33 GW) and new and renewable energy (3.63 GW). There is no nuclear power generation in the state. Maharashtra Energy Development Agency (MEDA) sponsored a village-level CFL programme and the Maharashtra state utility sold 500,000 CFLs between 2006 and 2007.

6.3.4.15 Energy Saving and Environmental Protection Measures by ELCOMA[39]

The Electric Lamp and Component Manufacturers Association (ELCOMA) represents the lighting industry in India. They have been involved in various initiatives to encourage energy efficiency in the country including:

- Strong promotion for CFLs in the domestic market

[38] Interview conducted and information shared by Gujarat Energy Development Agency , Government of Gujarat (GEDA)

[39] Interview conducted and information shared by officials from Electric Lamp and Component Manufacturer's Association of India

- Promoting electronic ballasts to increase growth of T8 and T5 fluorescent lamps and the development of the BEE star labelling programme for ballasts
- Calling for the phase-out of T12 lamps by 2013
- Phase-out of 150 watt and higher incandescent lamps since 2012
- Introduction of 75 watt incandescent lamp to replace 100 watt lamps following a phased-in approach
- Introduction of 40 watt eco-halogen to replace the 60 watt incandescent in a phased-in manner
- Introducing the concept of LED down lights in the retail segment to replace halogen and incandescent down lights
- Nationwide government initiative to replace street lighting with LED street lights
- Mercury content in CFLs to be less than 3 mg by end of 2013
- Safe disposal programme for CFLs to be launched in 2014

6.3.4.16 Initiatives by Military Engineering Services (MES)[40]

In order to achieve efficiency in lighting, MES has devised a three step strategy that includes:

- Energy efficient lighting products
- Renewable energy based light sources
- Energy efficient lighting design and installation

Some of the energy efficient lighting initiatives in facilities operated and managed by MES include:

- Phasing out of almost 100% of the incandescent lamps and replacement with CFLs.
- Phasing out of 100% of the magnetic ballasts with replacement with electronic ballasts
- Replacement of 36 and 40 watt linear fluorescent lamps with 28 watt lamps
- Installation of automatic timer controls for street lighting

6.3.4.17 Initiatives by Indian Railways[41]

Indian Railways consume about 1.8% of the country's total electricity. Indian railways have developed a document entitled "Vision 2020" which aims to achieve a 15% increase in energy efficiency by 2020. There are about 2.2 million CFLs, 0.8 million 28 watt fluorescent lamps and 8,000 LEDs being used by the Indian Railways.

Some of the energy efficient lighting initiatives undertaken by Indian Railways in railway stations across the country include:

- Use of energy efficient lighting products like T5 fluorescents and CFLs at railway stations, office buildings and in passenger coaches
- Use of LEDs for signage

[40] Interview conducted and information shared by officials from Military Engineering Services
[41] Interview conducted and information shared by officials from Indian Railways, Government of India

- Lighting through solar light pipes
- Sensors for switching on/off lights at the platforms during train arrival and departure
- Power factor improvement
- Through CDM, the Railway has supplied 1.4 million free CFLs to railway colonies to replace inefficient incandescent lamps. The project was registered with UNFCCC and was awarded a Special Jury Award at UIC conference in Venice in 2012.

Although Indian Railways is working to promote the use of LEDs and CFLs, they are experiencing challenges such as: the breakage of lamps due to vibrations from trains; reduction in lamp life by excessive voltage fluctuations (in remote locations); and inadequate light levels due to the collection of dust on the lamps.

6.3.4.17 Initiatives by the Central Public Works Department

The Central Public Works Department (CPWD) under the Ministry of Urban Development (MoUD), is one the largest construction and maintenance organizations in India. Several initiatives in energy efficient lighting have been undertaken by CPWD, resulting in significant amount of energy savings. These initiatives include:

- Procurement of star-rated labelled products
- Integration of day lighting and artificial lighting
- Specification for energy efficient lighting products and controls in existing CPWD building specification documents

6.3.5 Sustainability and End-of-Life Treatment Initiatives

Lighting equipment accounts for almost 4% of total mercury globally. Mercury content has increased to 1125 tonnes in 2010 from 700 tonnes in 2001. The mercury content for lamps in India ranges from 3-12 mg for CFLs and 15-60 mg per linear fluorescent lamps. The country has implemented various legislation including: management and handling trans-boundary movement of hazardous waste, 2008; biomedical waste management and handling, 2008;and the management and handling of e-waste rules, 2011.

6.3.5.1 Guidelines for E-Waste Recycling[42]

The CPCB prepared the "Guidelines for Environmentally Recycling of E-Waste" in 2008 which detailed the environmentally sound management and handling of e-waste. These guidelines were developed after several meetings and discussions with the Ministry of Environment and Forest (MoEF), Ministry of Health, Ministry of Industrial Policy and Promotion, Ministry of Information Technology and Confederation of Indian Industry. These guidelines provide the minimum practices required for the management of e-waste. Following are the salient features of these guidelines:

- Collection of e-waste - A producer is responsible for their products and may be involved in the establishment of the take back system for end-of-life electronic and electrical equipment. The producer responsibility could be either individual or collective.

[42] Guideline for Environmentally recycling of E-waste, Central Pollution Control Board, 2008

- Storage of e-waste - The storage areas for e-waste in a facility can be located on-site within the facility or off-site in warehouses
- The dismantling and segregation of e-waste are the first steps towards the recycling of e- waste. These are cost effective and labour intensive activities that are primarily carried out in the informal sector and need to be brought into mainstream recycling activity.
- Recycling and treatment of e-waste
- Identification of environmentally sound e-waste treatment technology at three levels based on material flow. Each level of treatment consists of unit operations, where e-waste is treated. After third level treatment, the residue is disposed of either in Treatment Storage and Disposal Facility (TSDF) or incinerated. The three different levels of treatment include:
    - First level treatment: e-waste items like TV, refrigerators and personal computers
    - Second level treatment: decontaminated e-waste consisting of segregated non- hazardous e-waste like plastic, Cathode ray tube (CRT), circuit boards and cables
    - Third level treatment: carried out mainly to recover ferrous, nonferrous metals, plastics and other items of economic value
- The various processes followed at different levels are :
    - The first level includes decontamination, dismantling and segregation.
    - The second level includes shredding and four special treatment processes including: electromagnetic separation; eddy current separation; CRT breaking and treatment; and density separation using water.
    - The third level treatment includes recovery of metals and disposal of hazardous e- waste including plastics with flame retardants, CFCs, capacitors, mercury, lead and other items.

6.3.5.2 Minimata Convention on Mercury

International efforts to address mercury got a significant boost with governments agreeing to a legally binding treaty to prevent emissions and releases at the Diplomatic Conference on the Minimata Convention on Mercury in October 2013. Over 140 countries, including India, agreed to the Minamata Convention that aims to reduce emissions and release of mercury into the air, water and land and identifies products that need to be phased out by 2020 including:

- By 2018 - CFLs for general lighting purposes 30 watts or less with mercury content exceeding 5 mg per lamp
- By 2020 - Linear fluorescent lamps for general lighting purposes – Triband phosphor < 60 watts with mercury content exceeding 5 mg per lamp
- By 2020 - Linear fluorescent lamps for general lighting purposes – halo phosphate phosphor 40 watts or less with mercury content exceeding 10 mg per lamp
- By 2020 - High pressure mercury vapour lamps for general lighting purposes
- By 2020 - Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps for electronic displays:
    - Short length (≤ 500 mm) with mercury content exceeding 3.5mg per lamp

- Medium length (> 500 mm and ≤ 1 500 mm) with mercury content exceeding 5 mg per lamp
- Long length (> 1 500 mm) with mercury content exceeding 13 mg per lamp

6.3.5.3 CFL Recycling by Manufacturers

All large manufacturers have already initiated activities for setting up recycling plants at their factories before the end of 2013.

6.3.6 Monitoring, Verification and Enforcement

6.3.6.1 Product Quality Testing Laboratories

Bureau of Indian Standards (BIS) Laboratories

The BIS is under the Ministry of Consumer Affairs, Government of India and is responsible for establishing the lighting standards in India. The BIS offers voluntary recognition for meeting various parameters including performance and energy efficiency levels set as per the BIS standards. The test standards set by the BIS establish the performance of a product by providing an Indian Standard (IS) mark. The products with an IS mark meet the performance criterion set by BIS.

The BIS has defined standards for both self-ballasted and single-cap CFLs. Although BIS issues many test procedure standards, it does not have the resources or capabilities to test all of these products. For some of the products, BIS uses outside laboratories for testing, such as, Electrical Research and Development Association (ERDA), Central Power Research Institute (CPRI), Regional Testing Centre (RTC), etc. They also use the services of the National Physical Laboratory (NPL), which is the national measurement reference laboratory for India. The BIS is organized into eight regional laboratories.

Lamps and Lighting

- Fluorescent lamps and ballasts are sent to NPL for testing
- Capability avails to test incandescent lamps.

Equipment

- A photometric integrating sphere that is calibrated at NPL once a year is currently used to test incandescent lamps only
- Life tests are currently done for incandescent lamps but not CFLs

Electronic Regional Test Laboratory (ERTL), North

The ERTL (North) is under the Ministry of Communications and Information Technology to assist the electronic and electro technical industry in India to be internationally competitive. This includes testing and facilitation of manufacturers to modify their designs to meet the desired requirements. Manufacturers' product tests are carried out at ERTL's facilities. Since test facilities are costly, ERTL does not build test facilities, but it helps others set up their own calibration laboratories and assists in obtaining National Accreditation Board for Testing and Calibration Laboratories (NABL) accreditation.

- ERTL can test a ballast in one or two days as per the IS 1534 (part 1) test standard, which claims to be the same as the International Electromechanical Commission IEC test

- ERTL can also test CFL intensity, measured in lux. For colour temperature, ERTL sub-contracts through a subsidiary
- Colour and harmonic tests are conducted by NPL for ERTL

Regional Testing Centre (RTC) Laboratory

The RTC has been set up under the Ministry of Small-Scale Industries and primarily conducts safety and performance tests to help small industries to succeed. RTC is NABL accredited and is also recognized by BIS for its entire product certification. RTC conducts test for magnetic ballasts only, as they do not have the capacity to conduct tests for electronic ballast. RTC also conducts test for incandescent lamps and is also planning to add CFL testing facility that would test both to IEC and IS requirements.

Electrical Research and Development Association (ERDA)

ERDA is a non-profit co-operative research institution, created by the Indian Electrical Industry and Utilities, with the support of governments of India and Gujarat. The laboratory undertakes testing, research and development of products and processes, calibration, and training. It has received recognition from various organizations in the government and public sectors, and from United Laboratories (UL), CSA, and IEC. ERDA has NABL accreditation and follows the Indian Standards (BIS Standard) and IEC/ISO standards. ERDA testing capacity includes the testing of linear fluorescents and electronic fluorescent ballasts as per IS and IEC standards.

Consumer Education and Research Centre (CERC)

The CERC is a consumer organization whose objective is to protect the consumer by testing consumer products in an unbiased manner. In the past, CERC has been given funds by USAID and UNDP to build test facilities. CERC has the capacity to test magnetic ballasts, electronic ballast for CFLs and CFLs as per IEC standards.

Central Power Research Institute (CPRI)

CPRI is a premier research organization in electrical power engineering. CPRI, an autonomous society, registered under the Ministry of Power, was established in 1960 by the government of India. CPRI conducts test and provides certification for electrical equipment and components. CPRI is equipped to test luminaries, fluorescent and compact fluorescent lamps and electronic and magnetic ballasts.

LED Testing Labs

As far as LED testing is concerned, the government of India is subsidizing the establishment of LED test facilities at existing test laboratories. Three LED testing facilities are going to be established in the near future and India is expected to have at least 12 test laboratories by the end of 2014[43].

6.3.6.2 Standards and Labelling Process

The BEE is responsible for developing the appliance energy efficiency standards and labelling programme in India. BEE accepts the results from test laboratories outside India if they are accredited by the International Laboratory Accreditation Cooperation (ILAC) or Asia Pacific Laboratory Accreditation

[43] Interview conducted and information shared by Electric Lamp and Component Manufacturer's Association of India (ELCOMA)

Cooperation (APLAC), but it does not have any mutual recognition agreement or memorandum of understanding to that effect.

BEE suggests the following for appliance and lighting labelling processes:

- Develop test protocols
- Identify testing laboratories
- Provide accreditation to identified laboratories
- Harmonize test protocols

BEE states that testing can take place in any accredited laboratory, but the laboratory needs to be accredited for the particular test procedure.

Accreditation

- The test laboratories that will be used for check testing and/or dispute resolution need to be NABL or ILAC accredited. Accreditation is also strongly recommended for manufacturers' laboratories but is not included in the regulations.
- NABL will have to accept other laboratories if they are accredited by accreditation bodies that are signatories of APLAC or ILAC
- BEE will accept the results of other laboratories if these laboratories are accredited by APLAC or ILAC

6.3.6.3 Strengthening Test Capacity

In 2004, India was flooded with the import of cheap CFLs which negatively impacted the image of CFLs, as these lamps did not last long and consumers felt that CFLs were not a good quality product. The government and industry took timely actions by making CFL standards mandatory and by putting "anti-dumping duty" policies in place. These two actions worked well and within 2 to 3 years, the penetration of CFLs in Indian homes increased significantly.

In order to ensure the quality of LEDs in the market, the following actions need to be implemented by the BIS, BEE and industry:

- Establish an R&D centre to study and discuss product quality with reference to Indian climate and economic requirements
- BEE should undertake a survey to study consumer behaviour and requirements, considering the affordability factor for LED lamps
- The product standards should be modified to ensure that the products withstand Indian weather conditions - hot and humid with a lot of dust in atmosphere
- To ensure one to one replacement with incandescent lamps, it is imperative to establish high standards for colour rendering and colour consistency in LED lamps
- Strict and rigorous testing of products should be done to ensure the delivery of a high quality product
- More manufacturers to work together to enhance production so as to reduce the cost and ensure delivery of an affordable replacement for incandescents

- Since LEDs have a very long life but the life of lamp depends on the quality of driver, it is very important that good standards are developed for drivers so that the complete lamp will deliver a very long life
- Undertake continuous roundtable sessions that engage regulators, manufacturers, researchers, consumers and energy efficiency experts. This collaborative effort will produce the performance criteria for the good lighting quality standards.

6.3.7 Lamp Production and Manufacturing[44]

The lighting industry in India currently is worth USD 2 billion and is growing at an average rate of 13%, with the base year 2005-06 when it stood at USD 0.9 billion. The total number of lamps produced by different manufacturers in India in the year 2012-13 was around 1429 million. Incandescent lamp production constitutes 55% of total production at around 783 million, CFLs at approximately 408 million or 29% of the total production of lamps. Linear fluorescent and HID lamps constitute 15% and 2% respectively, of total lamp production in the year 2012-2013.

In India, there are currently around 60 manufacturers with an estimated production capacity of up to 1 billion CFLs per year.

India is manufacturing almost 100% of incandescent lamps, 98% of CFLs, 100% of fluorescent lamps and 60% of HIS lamps for its current requirements as see below in Table 8.

Table 8: Manufacturing Capacity of India

	Incandescent Lamps	Compact Fluorescent Lamps	Linear Fluorescent Lamps	High Intensity Discharge Lamps
India	100%	98%	100%	60%

LED Lighting[45]

The market reveals that luminaires account for 23% of the total share. It is a growing segment with many global and domestic manufacturers establishing production facilities in India. LED lighting has only a 4% penetration rate in the Indian lighting industry but it is being considered as the future of lighting in India, along with CFLs.

The LED lamp market in India has been growing at an average rate of 60% over the last 4 years (from 2009-10 to 2012-13) and is expected to grow at an average rate of 43% over the next four years. The LED business was less than USD 60 million in year 2009-10 and has increased to USD 250 million from 2012-13. It is further expected to increase to up to USD 1 billion by 2016-17. There are 12 large, 15 medium and about 600 small manufacturers of LEDs in India.

The LED lighting scenario in India:

[44,43] Interview conducted and information shared by Electric Lamp and Component Manufacturer's Association of India (ELCOMA)

[45] Interview conducted and information shared by Electric Lamp and Component Manufacturer's Association of India (ELCOMA), India officials

- LED chips are completely imported however, the software for running chips is being developed fully in India
- Packaging is being done in India but has limited capabilities
- Technology for driver circuit design is fully present in India
- The fixture technology is present in India, but the sink design is primarily imported

The likelihood of migration from CFLs to LEDs among different customer segments:

- Governments of Maharashtra, Karnataka and Haryana promote the use of LEDs for all street lighting therefore, migration expectation is highest in the government sector
- Hospitality industry is exempt from paying customs duty on LED lamps and fixtures
- CFL and T5 fluorescents are preferred in offices but in the future, a shift would occur towards LEDs due to ever-increasing electricity prices
- Retail is a cost conscious market and currently prefer CFLs however, this may switch to LEDs in long run due to increasing electricity prices
- Residential sector is cost conscious and therefore, prefers other cheap options but if subsidiaries on electricity tariffs are removed, they would shift to LEDs

Efficacy and CRI

- 30% of LED products in India have efficacy less than 60 lm/W, 43% in the range of 60~70 lm/W, 22% in 70~80 lm/W range and only 5% have efficacy more than 80 lm/W
- 44% of LED products have CRI in the range of 60~70, 54% in 70~80 and only 2% have CRI more than 80
- Luminous efficacy is improving with technology advancement

Government Support

- In the 2011-12 financial budget, excise duty was reduced from 10% to 5% on LED lamps and LEDs required for manufacturing of such lamps. However, in the 2012-13 budget, the excise duty has been increased to 6%
- In 2012-13, the Special Additional Duty was fully exempted on LEDs used for the manufacture LED lamps
- Several state governments have reduced VAT on LED lamps. Delhi has reduced VAT on LEDs from 12.5 to 5% in the 2013-14 budget
- There is no difference in taxation among different categories of LED lamps

6.3.8 Off-Grid Lighting[46]

6.3.8.1 Overview of Off-Grid Lighting Status in India

India faces the most acute challenge for off-grid electricity access in the world, with 75 million of its 226 million households off the grid. Out of the off-grid population, a vast majority (94%or 71 million households) is spread across rural India where the electrification rate dips to 52.5%.

Kerosene is the most commonly used source for lighting by off-grid and under-electrified rural households and used throughout different states which include: Bihar, Uttar Pradesh, Jharkhand, Orissa, Assam, West Bengal and Rajasthan. These states collectively account for two-thirds of the total off-grid rural households (or approximately 50 million households) in India.

India has one of the highest subsidy levels for kerosene in the world. The government incurs an annual bill of approximately USD 4 billion for kerosene subsidies. Out of this, the subsidy for lighting alone is about USD 2 billion.

A transition towards solar LED lighting systems from fuel based systems would result in an annual savings of 6.7 billion litres of kerosene, 3.7 billion candles and 896 million batteries. Also, there exists a potential to avoid 18.1 million tonnes of CO_2 emissions annually. The annual monetary savings would be around USD 2.8 billion with a payback period of less than 22 months.

6.3.8.2 Solar Off-Grid Lighting Market

It is estimated that roughly 2 to 3 million solar lanterns and 1 million solar home systems were sold in India in 2012. Assuming that there are 75 million off-grid households in India, the estimated penetration of solar lanterns and home systems is extremely low at around 4 to 5%. It has been estimated that the current annual market size for solar lanterns could range between 300,000 and 500,000 units per annum with annual sales of solar home systems of approximately 100,000 units.

The Ministry of New and Renewable Energy (MNRE) is responsible for promoting PV systems in India and oversees initiatives to promote solar lanterns and home systems has begun.

Solar Lantern Programme

The programme provides solar lanterns to off-grid households through a grant subsidy of approximately USD 52 per lantern to households in off-grid villages. The subsidy is provided through State Nodal Agencies (SNAs) and exclusive retail outlets called Akshay Urja shops. The cumulative number of lanterns distributed through this programme during the year 2010 was approximately 800,000.

Remote Village Solar Lighting Programme (RVSLP)

RVSLP aims to provide a single-light solar home systems to 9,000 villages with 100 households in each. The programme provides subsidy support for up to 90% of the system cost or USD 160, whichever is less. It had already distributed 600,000 systems by 2010. This programme will be continued as a component of the Jawaharlal Nehru National Solar Mission (JNNSM).

[46] Lighting Asia: Solar Off Grid Lighting, International Finance Corporation, February 2012

Jawaharlal Nehru National Solar Mission (JNNSM)

The JNNSM aims to install 20 million solar home systems by 2022, to serve the lighting needs of approximately 100 million people across the country.

6.3.8.3 Off-Grid Lighting

In the recent years, manufacturers have moved from CFL to LED based lanterns. This trend is partly due to the fact that LEDs are more efficient, easy to use and have higher battery life. Currently, 3 watt peak (Wp) LED lanterns dominate the market. LED lamp wattages i range from 0.5 to 5 Wp, with lumen output ranging from 55 to 450 lumens and LED efficacy ranging from 20 to 110 lumens/watt. The performance of electronic circuits in these lanterns also varies widely with respect to charging, efficiency and type of circuit protection.

6.3.8.4 Distribution Models

Institutional Partnerships

Manufacturers team up with for-profit or non-profit institutions that have a significant presence in rural areas. Some examples include: D.Light with ITC e-Choupal, and Visual Lighting Equipment (VLE) and Schneider evaluating battery manufacturers for potential partnerships.

Company Owned Branches

Companies have opened branches in target regions to expedite the distribution process. For example, SELCO in Karnataka has 25 branch offices and 150 branch staff for solar lantern distribution across the state.

Micro-Franchising

Manufacturers identify micro-entrepreneurs at a village level, working closely with them on distribution, marketing and servicing.

Traditional Distribution Channels

Manufacturers sell their products to distributors, who in turn sell them to dealers. The dealer generally has a network of sub-dealers or micro-entrepreneurs, depending on the remoteness of the areas. For example, Tata BP Solar has 150 exclusive distributors throughout India.

6.3.8.5 Regulatory Environment

6.3.8.6 Case Studies[47]

Solar PV in Sunderban Islands in India:

The West Bengal Renewable Energy Development Agency (WBREDA) has undertaken many initiatives in the Sunderban Islands for ensuring the access of the rural population to quality and clean power. It initiated activities in 1996 and recently installed about 18 solar power plants with aggregate capacity of about 1 MWp in the region.

[47] Off grid electrisation experience in South Asia : Status and best practices, May 2010, The Energy and Resources Institute

WBREDA's model of implementation is usually in the form of a local mini grid by creating 11 kV and LT grid network depending on the capacity of the power plant and evacuation of power from the plant. To maximize the load factor, WBREDA establishes the plant near the load centre and creates a 2 -4 km of mini grid in the area for supply.

The mini grids are operated by Sagardweep Rural Energy Development Cooperative Society Ltd., formed by the local people. The responsibilities of the Society include: selection of consumers; planning for the distribution networks; tariff setting in consultation with WBREDA; revenue collection from consumers and passing them to WBREDA; and addressing consumer grievances. As the capital cost of the systems are subsidised to a large extent, the tariff takes into account the operating and maintenance cost of the systems.

Financing Support

MNRE offers capital subsidies on solar home systems and lanterns.

Subsidies

The government offers a subsidy of USD 0.5 per litre. The kerosene price pre-subsidy is USD 0.8 and post-subsidy is USD 0.3 per litre. The cost of kerosene is highly subsidized thus, reducing the competitiveness of solar products.

Import Tariff and Duties

- There is no import duty for solar cells, modules, panels, LEDs and charge controllers
- There is a 10% import duty on batteries and 5% import duty solar lanterns

Taxation Policies

- 5% VAT, as opposed to higher rates of 8-12% for other products and services
- No industrial clearances required
- Central excise duty exempted
- Financial support is available for the PV industry for R&D projects in association with technical institutions
- Proposals for up to 100% foreign direct investment in a joint venture qualify for an automatic approval

The rural banks operating in the area act as intermediaries between the cooperative and individual consumers to collect bills based on actual consumption. A minimum charge has been set that has to be paid by the consumer, irrespective of the consumption levels since the plant load factor has to be maintained for sustained supply cooperative societies. One of the reasons for the success of off grid power projects in the Sunderban region is that the tariff has been set according to the existing diesel generation tariff, as well as in line with the willingness of the consumers to pay.

As per WBREDA, the revenue collected from consumers is sufficient to cover 100% of the operational costs in addition to about 20% of the capital costs of the power plants.

Village Energy Security Programme (VESP)

The VESP, launched in 2004, is a community based initiative that that aims to provide clean, affordable energy in rural homes. The focus has been on finding ways for villages, particularly those located in remote

rural areas that are unlikely to be provided grid electricity in the near future, to achieve energy security based on locally available renewable energy sources (preferably biomass).

The programme places additional emphasis on cleaner options for cooking through improved cook stoves and biogas and the productive use of energy. To date, 79 test projects have been sanctioned, of which 55 have been commissioned in eight different states. These test projects have been undertaken in un-electrified remote villages and hamlets that are not likely to be electrified through conventional means in the immediate future. Based on a community-centric approach, a one-time grant (up to 90% of the project cost) was provided for the installation of energy systems capable of meeting the village's energy demands. The community, in some cases, also provided an equity contribution (either in cash or kind) to ensure ownership, required for success of any community-centric projects. An assessment conducted to review the performance, impact and lessons learned from the test phase found that the VESP projects served to motivate the community, especially the youth and their desire to develop their skills.

Lighting a Billion Lives (LaBL) Initiative

TERI has developed an innovative lending model for providing access to clean lighting through solar lanterns under its LaBL campaign initiative. The campaign, launched in 2008, aims to bring light into the lives of one billion rural people by displacing kerosene and paraffin lanterns with solar lighting devices. This will server to facilitate the education of children; provide better illumination and kerosene smoke-free indoor environments for women to do household chores in; and provide opportunities for employment both at the individual and village levels.

LaBL operates on fee-for-service or rental model where centralised solar lantern charging stations are set-up in villages to charge the lanterns and provide rental lanterns on a daily basis to households and enterprises. A typical solar lantern charging station consists of 50 solar lanterns with five solar panels and junction boxes. The charging stations are operated and managed by entrepreneurs (self-help groups or individual youths) who qualify as part of the LaBL selection process. These entrepreneurs are supported by local LaBL implementation partners called LaBL Associates. The rent is collected by the entrepreneur for the operation and ongoing maintenance of the charging stations and for replacement of batteries after 18-24 months of operation. TERI has successfully extended the campaign in 2441 villages, across 22 states in India, impacting more than 10,81,850 lives.

6.4 Maldives

Maldives is an island nation in the Indian Ocean consisting of around 1192 tropical islands. There are 194 inhabitable islands with about 105 tourist resorts and 60 industrial or agricultural islands. Maldives is a country with more territorial sea than land. The total land area is around 300 km^2. The total population of Maldives is around 350759 with a per capita income around USD 6405. The annual GDP growth is around 6-8% with tourism as the main economic activity.

Maldives has no conventional energy resources (e.g., oil and gas) that it can utilize to meet its energy needs. Therefore, the country imports petroleum to meet all of its energy needs. The bulk of these fuel imports is diesel fuel oil which is mainly used for power generation, both by the state power utility, and close to 1,000 other electricity generators in the outer islands. In 2012, the total cost of oil imports was around USD 470 million and constituted around 35% of GDP.

Regular and continuous electric power supply is available in only 24 of the 200 inhabited islands. These 24 islands have power generation provided by the government-owned company, State Electric Company Ltd. (STELCO). STELCO accounts for 35% of total electricity generation in Maldives.

The cost of electricity generation is 30-70 cents per kWh and is highest amongst the South Asian countries. The energy consumption is growing at a rate of 8.5-10% every year.

The yearly consumption of fuel is growing rapidly, thus the proportion of hard earned foreign exchange spent on fossil fuels is increasing. Renewable energy is used to power navigational lights (marking the reefs), communication transceivers on fishing boats and for power supply at remote installations of the national telecommunication network. These installations are not connected to the grid and are privately owned and operated. Solar energy is also used on a small scale for producing hot water for homes and in the tourism industry.

The telecommunication company of Maldives is the single largest user of renewable electrical energy, which is produced using solar energy. There are 177 sites, mainly utilizing solar power or solar-diesel hybrid systems. The largest site has a capacity of 3.5 kW while the total capacity is approximately 130 kW.

The government of Maldives is very much aware and concerned about environmental degradation and global warming. These are real threats to small island nations, especially for low-lying islands like those of the Maldives. The government is actively taking steps to reduce greenhouse gas emissions and other environmental pollutants in the Maldives, while concurrent efforts are being made to make the Maldives greener. The Ministry of Communication, Science and Technology has been given the task of exploring the feasibility of using renewable energy capable of providing reliable electricity supply to the islands.

6.4.1. Regulatory and Control Mechanisms

The Ministry of Housing and Environment was established to formulate policies related to environment, energy, water and meteorology, and develop regulations and standards needed for the implementation of legislation.

The Maldives Energy Authority (MEA) is an independent regulatory organization affiliated with the Ministry of Housing and Environment and operates under the guidance of a governing board.

6.4.1.1 Maldives Energy Authority (MEA)

The mandate of this agency is to:

- Provide advice to relevant government organizations regarding energy, and assist in decision-making in this sector
- Set the standards and regulations for the administration and monitoring of this sector according to government policy on energy
- Develop the regulatory codes and standards for the production and use of energy in the Maldivian context, and develop and administer the regulations for the provision of energy in the Maldives
- Set the standards for sources of energy that are imported into or sold in the Maldives
- Issue permits to parties that wish to provide electricity services; establish service fees provided by such parties; issue permits to parties that wish to produce electricity for their own use; and monitor the parties to ensure adherence to relevant regulations
- Issue permits to electrical technicians and set the standards for consultants

- Investigate issues between parties arising from non-compliance to the terms of agreements between providers and users of electricity
- Monitor the energy production and usage statistics in the Maldives; ascertain the energy requirements of the nation; and gather and disseminate research data

6.4.1.2 Energy Performance Standards

Currently, there are no minimum energy performance standards for linear, compact fluorescent and LED lamps.

6.4.1.3 Energy Labelling

The development of energy labels for lamps is in process.

6.4.1.4 Energy Codes for Buildings

There are currently no codes that specify energy efficiency norms for lighting.

6.4.2 Economic and Market-Based Instruments

6.4.2.1 Energy Service Companies (ESCOs)

ESCOs are yet to be established in the Maldives.

6.4.2.2 Harbour Lighting Programme

Two hundred 70 watt LED harbour lights have been distributed to five areas in the Maldives. These LEDs will replace 250W high pressure sodium lights installed in the harbour area. This will result in energy saving of 9650 kWh of electricity usage per month.

6.4.2.3 LED Distribution

Over 267,450 LEDs lamps have been distributed to government offices and councils with an objective to replace the standard fluorescent lamps with energy efficient types to reduce consumption in government buildings and road lights.

6.4.3 Fiscal Instruments and Incentives

6.4.3.1 Funds for Energy Efficiency

No funds currently are dedicated for energy efficiency.

6.4.3.1 Tax Reduction

There are no tax incentives for energy efficient products.

6.4.4 Support, Information and Voluntary Action

6.4.4.1 Exhibition to Promote Energy Efficient Products

An exhibition on energy efficient equipment is organized every year to create public awareness.

6.4.5 Sustainability and End-of-Life Treatment

Currently, there have been no guidelines established for environmentally sound mercury disposal from lamps and e-waste generated from LEDs.

6.4.6 Monitoring, Verification and Enforcement

6.4.6.1 Product Quality Testing Laboratories

There are no testing laboratories for the quality and performance testing of lamps.

6.4.7 Lamp Production and Manufacturing

Lamps are currently being imported from other parts of the world and there are no lamp manufacturers based in the Maldives.

6.4.8 Off-Grid Lighting[48]

The current focus is on meeting electricity demand with solar power rather than any off-grid lighting initiatives with efficient lamps. To promote renewable energy in the country, the Renewable Energy Technology Development and Application Project (RETDAP) was initiated in 2004 with UNDP as the implementing agency and the Ministry of Environment, Energy and Water as the national executing agency (UNDP 2007). RETDAP was designed to address policy, institutional, information, financing and technical barriers, to facilitate the widespread utilization of renewable energy resources in the country. One of the outcomes of the project was installation of a 12.8 kW solar-diesel hybrid system on Mandhoo Island in 2006. Additionally, two solar-wind systems have also been installed with UNIDO support in B. Ghoidhoo (8 kW, to power the community centre) and Fainu (8 kW, providing power for about 130 villagers).

Maldives Gas, a government-owned company, has also installed a solar-wind-diesel hybrid system in Ha Uligam (45 kW of solar and wind backed up by a 32 kW diesel generator to provide power to the 450 islanders) and M Raimandhoo Islands (40 kW solar-wind hybrid system). A MoU has also been agreed upon between Maldives Gas, State Trading Organisation and a Singaporean company, Daily Life, to install solar-wind-diesel hybrid systems in another 100 islands in the country (UNDP 2007).

The policies initiatives for a flexible and easy flow of cash have a major role to play in the proliferation of PV technology into the market, especially when market development is in the nascent stage and is dominated by the rural population.

Lack of information about the resource requirements and appropriate technologies are also major issues in developing the market in the Maldives.

6.5 Nepal

Nepal's energy resources are broadly divided into three categories: traditional, commercial and alternative. Traditional energy resources include all conventional types of biomass used for energy production. Energy resources with well-established market prices are grouped into the commercial energy category whereas

[48] Off grid electrisation experience in South Asia : Status and best practices, May 2010, The Energy and Resources Institute

indigenous renewable energy resources are grouped into the alternative category. Fuel wood is the largest energy resource in Nepal, providing about 77% of the total energy demand in the year 2008/09.

The share of petroleum of the total energy system is about 8% and has remained constant over the past few years. Other sources of commercial energy are coal and electricity, which contribute about 2% each to the total energy supply.

The shift away from traditional to modern energy sources has been slow. The share of commercial energy has increased from about 9% in 1995 to about 12% in 2008/09. Similarly there is a growing trend in alternative resources. For commercial sources, electricity consumption is growing with an annual rate of about 10%. In 2007/08, the power and energy demand grew by 11.31% and 10.76%, respectively. This growth has been more significant in the residential and industrial sector and less in other development sectors (NEA, 2009).

Electricity in the residential sector is primarily used for lighting. However, depending upon the degree of urbanization, it is also increasingly used for running domestic appliances (computers, televisions, etc.). With the growing rate of human migration from rural to urban areas, the use of electricity in the residential sector has increased sharply in urban centres. This has been further aggravated by the fact that many people that have a higher socioeconomic status and are equipped with modern electrical appliances, reside in these parts of the country.

Currently, only 48% of the population has access to electricity, and only 8% of people in rural areas have access to electricity, where it is being used mainly for lighting.

Approximately 23% of energy demand in the industrial sector is met by electricity which is primarily used for heating and lighting.

Electricity Act 2049 (1992)

This Act was instituted by the Ministry of Energy for the management and development of electricity. It was developed to regulate the generation, transmission and distribution, of electricity and to standardize and safeguard electricity services. It was enacted by the Nepalese parliament.

6.5.1. Regulatory and Control Mechanisms

6.5.1.1 Nepal Bureau of Standards and Metrology (NBSM)

The "Nepal Quality Standardization Committee" was established in 1976 under the Vice-chairman of the National Planning Commission along with a committee secretariat called the Nepal Institute of Standards (NIS). NIS went on working to develop national standards and also to formulate related acts and rules and the Nepal Standards Act 2037 (Certification Mark) and Rules 2040 were then disseminated. In 1981, the NIS was renamed and restructured into the Nepal Bureau of Standards (NBS) as a full department of the Ministry of Industry.

The main duties and responsibilities of NBSM are to:

- Work as a Secretariat to the Nepal Council for Standards (NCS)
- Assist NCS by formulating draft standards
- Grant the license to use the NS mark on industrial products, in compliance with relevant Nepal standards as approved by NCS

- Carry out inspection and supervision activities on industrial production and processes
- Carry out necessary surveillance in the market
- Provide testing facilities, calibration and laboratory accreditation services
- Appoint or designate inspectors
- Act as signatory on agreements with the industry on the proper use of licenses
- Renew, suspend or cancel a license to use the NS mark
- Carry out information dissemination, training and international relations on standardization, metrology and quality control, certification and laboratory accreditation

NBSM is a member of the International Organization for Standardization (ISO), 1991, International Organization for Legal Metrology, 1983 and International Electrotechnical Commission, 2001.

6.5.1.2 Energy Performance Standards

Currently, there are no MEPS for fluorescent, compact fluorescent of LED lamps. Minimum safety and performance specifications for fluorescent ballasts are defined in standard NS 444:2060.

6.5.1.3 Energy Labelling

There is no energy labelling of lamps.

6.5.1.4 Energy Codes for Buildings

The National Building Code, NBC 207:2003 (Electrical Design Requirements for Public Buildings) has stipulated the preferential use of fluorescent luminaries with the supplemental use of incandescent lamps to meet higher illumination level requirements.

6.5.2 Economic and Market-Based Instruments

6.5.2.1 Energy Service Companies (ESCOs)

The ESCO industry in Nepal is at a nascent stage and there is a vital need to support its growth. One of the key obstacles to ESCO operations is the lack of standardized and legally enforceable contracts, as ESCOs, clients, and bankers have little or no experience with performance contracting.

6.5.2.2 Nepal Energy Efficient Programme

Within the framework of bilateral development cooperation between Nepal and the Federal Republic of Germany, the joint implementation of the Nepal Energy Efficiency Programme (NEEP) was agreed upon in 2009. The leading executing agencies for implementation are the Water and Energy Commission Secretariat (WECS) and the German Development Cooperation – GIZ. NEEP is a technical cooperation programme with an eight-year lifespan with the first phase ending in 2014. It is conducted on behalf of the German Federal Ministry of Economic Cooperation and Development (BMZ).

The objective of NEEP is to broaden awareness on how to use energy efficiently and to balance energy demand and supply to ensure sustainable energy management and climate protection.

Approach

International experience has proven that the efficient use of energy is a win-win solution. The NEEP approach addresses three key components:

- Private households and industries reduce their cost for energy consumption
- Utilities may plan for less capacity additions and require less investment capital
- Less consumption of natural resources conserves the environment and climate

Policy Guidance for Energy Efficiency

NEEP will support the drafting of an energy efficiency strategy as well as a biomass energy strategy which will complement the national energy strategy. This policy sets the regulatory framework and incentives for the energy sector and energy consumers in order to balance supply and demand at a moderate economic cost.

The implementing agency for this component is WECS with the support of the Alternative Energy Promotion Centre to draft the biomass energy strategy.

Energy Efficiency in Households

Many imported electrical household appliances such as refrigerators, light bulbs and rice cookers are already energy labelled and provide consumers with an indication of electricity consumption. The implementing agencies are NBSM and NEA.

Energy Efficiency in Industries

Nepalese industries offer a huge potential to reduce production costs by using energy more efficiently. In order to tap this potential, NEEP supports capacity development of the Energy Efficiency Centre, under the Federation of Nepalese Chambers of Commerce and Industry, to qualify industrial energy auditors to conduct pilot energy audits.

6.5.2.3 Other Energy Efficiency Initiatives

The office of energy efficiency services was established in the Department of Industry in 1995 and provides:

- Detailed energy efficiency audits in some industries and hotels
- Energy efficiency study on boilers
- Awareness programmes for energy efficiency
- Training for energy auditors

6.5.2.2 Buy One, Get One Free CFL Scheme

Under the National Electricity Crisis Mitigation Action Plan 2069, the government of Nepal will provide a free CFL to every consumer for each CFL purchased.

6.5.3 Fiscal Instruments and Incentives

6.5.3.1 Funds for Energy Efficiency

Rural Energy Fund (REF)

The establishment of the REF supported by multiple donors is a key component of phase two of the Energy Sector Assistance Programme (ESAP). It builds on the existing interim REF and aims to promote good governance and credible fund management in the rural energy sector. It also provides subsidies and support for micro-hydro, solar energy and other rural electrification initiatives. The REF is supported by DANIDA, the governments of Norway and Nepal and other development partners.

6.5.3.1 Tax Reductions

Under the Load Shedding Minimization Action Plan 2069 introduced by the government of Nepal, the following initiatives have been taken:

- VAT and custom duty on the import of LEDs has been waived completely
- The government of Nepal and the Nepal Electricity Authority have proposed funding of USD 0.5 million to waive customs and VAT on free CFLs, LED linear lamps and electronic ballasts

6.5.4 Support, Information and Voluntary Action

6.5.4.1 Energy Efficiency Centre (EEC)

As part of the Nepal Energy Efficiency Programme, a bilateral initiative between the Nepalese and German governments, GIZ Nepal is supporting the EEC (an autonomous centre functioning under the FNCCI) to promote energy efficiency in industrial enterprises, with a focus on energy audit capacity building.

EEC has announced a series of three intensive training courses on energy audits for aspiring career professionals, which will be followed by a screening, certification examination and future association in NEEP sponsored energy audits.

6.5.4.2 Public Awareness Programmes

Nepal has produced informative audio and visual materials on energy efficient lighting products and disseminated them through radio, television and newspapers.

6.5.4.3 Government of Nepal Initiatives

- Energy auditing of hotels, government institutions and commercial buildings
- Use of CFL and LED lamps in hotels, government institutions and commercial buildings
- The use of occupancy sensors in large hotels
- Use of efficient lamps and luminaries
- Focused training for engineers in lighting design

6.5.5 Sustainability and End-of-Life Treatment

A report on "Identification and quantification of electronic products that will convert into E-Waste in Nepal" has been published under Ministry of Environment, Science and Technology by PACE Nepal Pvt. Ltd. The main objective of the report is to identify and quantify the electronic waste and the ways in which it is currently being processed and to provide guidelines for the management of e-waste. [49]

6.5.6 Monitoring, Verification and Enforcement

6.5.6.1 Product Quality Testing Laboratories

Under the Nepal Standard (Certification Mark) Act 2037, the Nepal Council for Standards (NCS) was formed as the governing body for quality, standards, testing and metrology activities in Nepal. NBSM also acts as the Secretariat to this council. The duties and responsibilities of the NCS are to:

- Review and revise national standards
- Recognize and adopt standards developed by other national bodies and international institutions
- Form committees and sub-committees as per future needs for the formulation of standards

The implementation of Nepalese standards is voluntary. However, under the provisions of the Quality Certification Mark Act, Nepal standards could be made mandatory for those activities related to the health and safety of the consumer.

6.5.7 Lamp Production and Lamp[50]

Nepal does not have the manufacturing capacity for CFLs nor fluorescent and HID lamps and import 80% of incandescent lamps as seen below in the Table 9.

Table 9: Manufacturing Capacity of Nepal

	Incandescent Lamps	Compact Fluorescent Lamps	Linear Fluorescent Lamps	High Intensity Discharge Lamps
Nepal	20%	0	0	0

The total number of sockets in Nepal is approximately 26 million. The total number of lamps consumed annually is around 12 million. The number of incandescent lamps consumed is 48% at about 6 million every year. The number of CFLs consumed is around 4 million every year and constitutes 32% of the total lamp consumption. Linear fluorescent and high intensity discharge lamps constitute 20% and 1% respectively, of total lamp consumption.

[49] Final Report on identification of electronic products, MOEST, PACE Nepal Pvt Ltd

[50] Interview conducted and information shared by officials from Electric Lamp and Component Manufacturer's Association of India

6.5.8 Off-Grid Lighting[51]

There are 3 million off-grid households in Nepal, the majority (approximately 97%) of which are in rural areas. The electrification rate in rural Nepal is as low as 34% compared to the national average of 44%[52]. Almost all grid connected households (approximately 2.4 million) in Nepal face severe power shortages or at least 12-14 hours of load-shedding every day. A study conducted by the World Food Programme found that kerosene is the predominant source of lighting across all regions in Nepal[53].

About 90% of kerosene is being consumed for lighting and at a current price of around USD 0.9 per litre, an estimated USD 0.19 billion is spent on kerosene for lighting alone.

A transition to solar LED lighting systems from fuel based lighting would result in annual savings of 6311 million litres of kerosene, 566 million candles and 36 million batteries. Also, there is the potential to avoid 883.2 thousand tonnes of CO_2 emissions annually. The annual potential monetary savings is USD 354.7 million with a payback period of less than eight months.

6.5.8.1 Solar Off-Grid Lighting Market

The Nepalese market for solar off-grid lighting is dominated by solar home systems. The market has a unique product known as "Solar Tuki" which has a 3 Wp to 5 Wp solar panel, two LED lamps that use nickel metal hydride rechargeable batteries. The lamp unit also has an outlet for connecting FM/AM radio. Tukis are priced in the range of USD 50 to 70 and come with a one-year warranty.

Nepal's market for solar lanterns is almost negligible due to the low warranty periods and lack of battery availability for timely replacements.

Alternative Energy Promotion Centre (AEPC) Programme

The solar home system market is heavily dependent on the government's subsidy programme and is managed by the Alternative Energy Promotion Centre (AEPC) which deals with the promotion of renewable energy in the country. It is estimated that solar system installations through the AEPC programme constitute approximately 75-80% of all installations. Almost 230,000 were installed up until 2012 in off-grid households out of the existing 3 million off-grid residences.

Subsidies range from USD 67 to 134, depending on system wattage and the remoteness of the housing location, as defined by AEPC. For example, for a 20Wp system priced at approximately USD 220, the subsidy would range from 30-60% of the price, depending on the remoteness of the location.

The total subsidy amount disbursed by AEPC up to September 2010 was in the range of USD 20-25 million.

Solar Tukis have been included in the AEPC's subsidy programme since 2008. The subsidy support is limited to Tukis that have a minimum capacity of 5 Wp with the subsidy amount of USD 27. The cost of 5 Wp Tukis is around USD 70 and the subsidy offered (27 USD) is approximately 40% of the cost.

In 2009, AEPC piloted a new model for the financing of solar home systems called 'Credit Financing solar home systems - 2065.' Partner organizations for this project are Winrock International, Sana Kisan Bikash Kendriya Sangh and the National Cooperative Federation. The objectives of this pilot were two-fold:

[51] Lighting Asia: Off grid Lighting, International Finance Corporation, February 2012
[52] 2008 numbers
[53] Comprehensive Food Security and Vulnerability Analysis (World Food Programme)

- Enhance the capacity of selected local financial institutions to provide loans for system installation; and
- Facilitate linkages between commercial/development banks, local financial institutions and solar companies.

Nearly all the major system components are imported. While the solar panels are mostly imported from India and China, batteries are imported from India, China and Bangladesh. Linear fluorescent lamps are manufactured locally, but CFLs are imported. Charge controllers are locally manufactured, while the lanterns and Tukis are imported.

6.5.8.3 Regulatory Environment

Financing Support

There is a 50% subsidy on the solar lighting product cost. Currently there is no established credit financing mechanism and the market is heavily dependent on subsidies and funding.

Subsidies

There is a government proposal for providing a subsidy of around 0.13 USD per litre (up to 5 litres every month) to people in off-grid areas. Assuming that a subsidy on kerosene does come into effect, it will not be too high to negatively impact the adoption rate of solar lanterns and systems.

Import Tariff and Duties

There is no import duty on solar photovoltaic cells, modules, panels, LEDs, and solar Tukis, but there is an import duty on solar lanterns of 10% and on batteries of 1%.

Taxation Policies

The components used in solar systems are exempt from VAT which encourages the manufacturer of assembly units.

6.6 Pakistan

The energy sector is the single largest source of GHG emissions in Pakistan. It accounts for nearly 51% of these emissions and is followed by the agriculture sector (39%), industrial processes (6%), land use change and forestry (3%) and waste (1%)[54]. As such, the most important targets for mitigation efforts focused on the reduction of GHG emissions are the energy and agriculture sectors.

Pakistan's energy sector has a high reliance on natural gas and a very low reliance on coal which is in contrast to the patterns of primary energy consumption and electricity generation worldwide. It is largely for this reason that the CO_2 emissions per unit of energy consumption in Pakistan are among the lowest in the world. However, with this consumption pattern, Pakistan's natural gas reserves have depleted to such an extent that it will be difficult to maintain even the present level of production for long. Similarly, local oil resources are also extremely low. The only sizable fossil fuel resource available in Pakistan is coal with an estimated resource base of 185 billion tons. Pakistan has no alternative but to seek meeting an

[54] National GHG inventory 2008

increasingly large proportion of its future energy needs through the use of its practically unutilized vast coal resources.

The power sector in Pakistan is a mix of hydro power and thermal units dominated by two vertically integrated public sector utilities - the Water and Power Development Authority for all of Pakistan except Karachi, and the Karachi Electric Supply Corporation for the city of Karachi and its surrounding areas. There are a number of independent power producers that contribute significantly to electricity generation in Pakistan.

Fossil fuels constitute 65%, hydro constitute 31% and nuclear constitutes 4% of total power generation. The increase in the installed capacity over the last five years is not substantial, as the generation capacity in year 2006-07 was 19 GW and in 2010-11 it was 22 GW. The total electricity generation in the year 2010-2011 was 90 TWh and the consumption during the same period was 74 TWh. The contribution of lighting to the total electricity consumption during 2010-11 was around 16%. Although the consumption is lower than the generation, power thefts and transmission and distribution losses mean that Pakistan faces a serious deficit in electricity.

From 1980 until today, the demand for energy in Pakistan has grown almost six-fold and it is estimated that it would double again by 2015.

The key issues that Pakistan currently faces with regard to its energy needs may be due to: inefficient energy utilization; indiscriminate use of subsidies; lack of public awareness; ineffective or unenforced legislation; and underdeveloped infrastructure.

In order to provide the necessary strategic and operational impetus, the government should consider making energy efficiency and energy conservation key themes in the integrated energy plan as mentioned in 10th five year plan (2010 – 2015).

Pakistan's economic growth rate is at 5% per annum according to industry experts while during the same period, energy growth will be at 6.25% per annum[55]. Pakistan, like other developing countries, is expected to double its demand for energy every 12 years. This will put a huge burden on Pakistan's resources.

The National Energy Conservation Centre (ENERCON)

The National Energy Conservation Centre (ENERCON) is part of the Department of the Ministry of Water and Power, and serves as a federal focal agency to initiate, catalyze and coordinate all energy conservation activities in all sectors of the economy. With this mandate, ENERCON has developed its vision to "steer Pakistan towards an energy efficient and environment friendly tomorrow". Energy efficiency and energy conservation activities implemented by various stakeholders including the public sector as well as private sector entities, are also coordinated by ENERCON.

ENERCON has been charged with a wide range of responsibilities including:

- Formulating energy conservation programmes in all the main energy-consuming sectors including: agriculture, buildings, industry and, power and transport
- Planning and initiating energy conservation action nationwide
- Outlining policy guidelines to support energy conservation initiatives
- Developing a comprehensive database on opportunities for energy conservation

[55] Integrated Energy Plan 2010-2025, EAC, and Ministry of Finance

- Supporting training activities on energy conservation applications
- Undertaking field research and pilot demonstration activities on specific energy conservation options and technologies
- Monitoring the implementation of conservation programmes by other public and/or private sector entities
- Implementation of standards and labelling programmes for household appliances
- Raising consumer awareness about various energy conservation and energy efficiency techniques

National Energy Conservation Policy

Pakistan today is faced with an energy deficit which, if not addressed immediately may seriously hamper the pursuit of sustained economic growth. The National Energy Conservation Policy, prepared by ENERCON, outlines guidelines to enhance end-use efficiency in various energy consuming sectors of the economy. The policy is meant to generate sufficient activity to promote energy conservation practices and affect energy savings of a perceptible magnitude at the national level.

6.6.1 Regulatory and Control Mechanisms

The Pakistan Standards and Quality Control Authority (PSQCA), under the Ministry of Science and Technology, is the national standardization body. In performing its duties and functions, PSQCA is governed by the PSQCA Act, 1996. PSQCA is a member of ISO, IEC, and International Organization of Legal Metrology (IOLM). PSQCA has also been established to advise the government on standardization policies, programmes and activities to promote industrial efficiency and development, as well as on consumer protection.

6.6.1.1 Energy Performance Standards and Energy Labelling[56]

Currently, MEPS for CFLs have been established and voluntarily followed. The standards referred to for developing the MEPS are PS IEC 60969. PSQCA is the agency responsible for the development and approval of standards, whereas ENERCON is the responsible agency for implementation of the programme. At present, there are no LEDs standards in Pakistan.

An energy efficiency standards and labelling policy and programme have been adopted, however, they are not being implemented as of yet. In order to provide the institutional support necessary for the effective and efficient use of energy, draft legislation Pakistan Energy Efficiency and Conservation Act -2011) is in approval process by parliament.

ENERCON is presently implementing a Global Environmental Facility (GEF) funded project "Barrier removal to the cost-effective development and implementation of energy efficiency standards and labelling" (BRESL). The project began in January 2010 and is expected to be complete by December 2014.

The BRESL project has achieved the following:

- Energy efficiency standards testing protocols have been adopted for all the six targeted appliances
- MEPS have been adopted for CFLs, electronic and magnetic ballasts, and fans and motors

[56] Interview conducted and information shared by ENERCON officials and Minimum Energy Performance Standard (MEPS) for Self- Ballasted Fluorescent Lamps, ENERCON, June 2013

- Energy efficiency labelling procedures for endorsement labels and logos have been finalized and approved, and will be launched soon

6.6.1.2 Building Codes

The Building Energy Code of Pakistan is a prescriptive code and establishes maximum allowable overall heat transfer coefficients, thermal transmittance values and window shading coefficients. The Code also specifies minimum standards for lighting and air-conditioning equipment.

6.6.1.3 Alternative and Renewable Energy

The Alternative Energy Development Board (AEDB) has been created by the government of Pakistan and acts as the central national body for renewable energy. In 2006, the "Policy for Development of Renewable Energy for Power Generation (Small Hydro, Wind and Solar Technologies) was published, which focuses on renewable energy deployment and facilitates renewable energy markets by providing investment friendly incentives.

6.6.2 Economic and Market-Based Instruments

6.6.2.1 ESCOs

ESCOs are yet to be established in Pakistan. However, it has been identified that in order to establish ESCOs, energy efficient improvement organization under ENERCON needs to be established, which shall facilitate the establishment of ESCOs.

6.6.3 Fiscal Instruments and Incentives

6.6.3.1 Tax Incentives

The government has provided tax exemptions on imported CFLs, and LED lighting fixtures.

6.6.3.2 Funds for Energy Efficiency

- The National Energy Conservation Fund (ECF) was established as a part of the implementation of the UNDP/GEF-funded Fuel Efficiency in the Road Transport Sector initiative from 1996-2005. This fund allocated USD 3 million out of the total grant of USD 7 million for a revolving loan fund to promote energy conservation investments
- For energy savings project financing, Pakistan has received USD 780 million from the Asian Development Bank

6.6.3.3 Proposed Revolving Loan Fund for Energy Efficient Lighting

ENERCON established an energy conservation revolving loan fund to promote energy conservation in the transport sector. Although a demand for energy efficient lighting was demonstrated by frequent financing requests, this was outside the scope of the fund. Since 2002, the fund has grown by approximately 5%.

The proposed revolving loan fund is a long-term, sustainable funding option designed to overcome local financing barriers by providing financing for the purchase of energy efficient lighting technology, which is currently unavailable. The interest rate is 3-10% per annum, which has been finalized after stakeholder consultations. This covers the exposure/credit risk and any additional expenses incurred by the bank returns

to ensure sustainability. Once successful, it will also serve as a model for other energy efficient technology (appliances, HVAC, etc.) to replicate success and multiply impact.

6.6.4 Support, Information and Voluntary Actions

Through the ECF, ENERCON has taken an initiative to establish energy audit labs for demonstration, training and public awareness programmes. Sessions on energy efficiency audits have been completed by ENERCON officials in universities.

A national awareness campaign on energy and environmental conservation was launched in July 2003 to promote energy conservation and sustainable energy use. Under the campaign, several energy audits were conducted across industries, buildings and several workshops and training programmes were also held.

Pilot projects and activities in lighting sector included the:

- Distribution of 30 million CFLs among households to replace inefficient incandescent lamps
- Promotion of energy efficient street lights in residential areas
- Replacement of inefficient incandescent lamps in the government buildings with energy efficient lighting products
- Development of building energy codes to maximize the use of sun light during the day
- Creating awareness among the general public about energy efficient lighting technologies and discouraging the use of decorative lights
- Planning of phasing out of inefficient incandescent lamps

Other efficiency activities that have occurred in Pakistan include:

- AEDB "100 Solar Homes Per Province" programme –solar energy demonstration project to change the status quo by providing local communities with the comfort of lighting, cooking and clean drinking water
- Commercialization of wind power potential in Pakistan –to identify existing impediments to the use of renewable energy sources in Pakistan, proving suggestions on how to overcome them, and conducting the requisite planning for an initial demonstration project

6.6.5 Sustainability and End-of-Life Treatment[57]

The Ministry of Environment has adopted guidelines for the disposal of mercury in CFLs at the local level and with manufacturers.

Local Level Guidelines

Local area authorities responsible for municipal functions install CFL collection points to ensure that these lamps are separated from the rest of household waste. These collection points are to be installed in central locations such as local retail shops, post offices, bus stops etc. to ensure that it is convenient for the

[57] Guidelines for disposal of mercury content of CFLs, ENERCON, 2011

consumers to return their spent CFLs. The drop off containers are to be positioned in a prominent and easily accessible location that is clearly marked. The goal is for the collection points to only accept intact CFLs, and no breakage should occur during the drop-off or temporary storage process.

Manufacturer Guidelines

It has been identified as the corporate social responsibility (CSR) of the CFL manufacturers for the environmentally safe life cycle and safe disposal of lamps through environmental friendly mechanisms that adhere to the following guidelines:

- Non-operational CFLs should be returned to the designated retailer under an incentive system to ensure customer satisfaction
- Spent CFLs must be stored in containers without hard bottoms (plastic containers are preferred to avoid any breakage)
- Transport CFLs carefully to the recycling facility to avoid any damage
- Ensure that proper certified disposal facilities and contractors are available in market
- Appropriate crushing should be done under vacuum extraction, followed by segregation of glass, phosphor powder and liquid/vaporized mercury.
- Mercury vapours are collected and absorbed on an activated carbon pad

It should be noted that no recycling or recovery plants for mercury have been installed in Pakistan.

6.6.6 Monitoring, Verification and Enforcement

6.6.6.1 Appliance Testing Body

The Pakistan Council of Scientific and Industrial Research (PCSIR) was established in 1953 to promote the cause of science and technology in the country. The 21- member Council is the policy making body of the PCSIR and composed of a Chairman, three members of the governing body, three laboratory directors, four representatives from four ministries, four Directors of Industries, one from each province and six industry representatives.

The Electrical Measurement and Test Laboratory (EMTL) was established at the PCSIR Laboratories Complex, Lahore to provide services for the assessment of the performance and safety of electrical products, in compliance with relevant national and international standards.

The laboratory facilities at PCSIR have the capacity to conduct electrical and photometric tests on light sources products in addition to safety tests for CFLs, linear fluorescent, tungsten halogen and HID lamps, as well as magnetic and electronic ballasts.

6.6.6.2 Strengthening Test Capacity

Currently, three laboratories for CFL testing exist but none of the laboratories are accredited with PCSPQ.

6.6.7 Lamp Production and Manufacturing[58]

There are various reasons for the production of inefficient lighting products in Pakistan. This includes: the unavailability of quality raw materials at lower prices compelling manufacturers to use low-cost and low-quality materials; outdated manufacturing processes; and a lack of consumer demand for energy efficient appliances.

Pakistan imports 80% of CFLs, 30% of fluorescent lamps, 75% of HIDs and 10% of incandescent lamps as see below in Table 10.

Table 10: Manufacturing Capacity of Pakistan

	Incandescent lamps	Compact Fluorescent Lamps	Linear Fluorescent Lamps	High Intensity Discharge Lamps
Pakistan	90%	20%	70%	25%

The total number of light sockets in Pakistan is approximately 300 million. The total number of lamps consumed every year is around 194 million. The number of incandescent lamps consumed is 57% of the total lamp consumption and at about 110 million every year. The number of CFLs consumed is around 16 million every year and constitute 8% of total lamp consumption. Linear fluorescent and HID lamps make up 32% and 3% respectively, of the total lamp consumption.

6.6.8 Off-Grid Lighting[59]

6.6.8.1 Overview of the Off-Grid Lighting Status in Pakistan

Of the total population of 197 million people (almost 11 million households), approximately 44% of the households are off-grid, with the figure at 81% in rural areas.

A World Bank survey indicates that 30-45% of rural households in Pakistan use kerosene as a primary or secondary source of lighting. The study also indicates that 80-90% of kerosene users in rural Pakistan are off-grid[60].

A transition towards LED based solar lighting systems from fuel based systems would result in annual savings of 197 million litres of kerosene, 9.4 billion candles and 74 million batteries. Also, there exists a potential to avoid 1548.4 thousand tonnes of CO_2 emissions annually. Yearly monetary saving of around USD 1.1 billion USD, with a payback period of less than 6 months, could be achieved in Pakistan.

6.6.8.2 Solar Off-Grid Lighting Market

Currently, there is no national level governmental programme to promote solar home systems or solar lanterns. This is despite the presence of the Alternate Energy Development Board (AEDB), a dedicated government agency tasked with the promotion of renewable energy in Pakistan.

[58] Interview conducted and information shared by ENERCON officials, Pakistan and ELCOMA, India

[59] Lighting Asia: Solar Off-Grid Lighting, International Finance Corporation, February 2012

[60] Changing Patterns of Household Expenditures on Energy, World Bank, 2009

This may be due to the issues experienced with a pilot project launched by AEDB in 2005. The objective of this project was to distribute systems for free and collect fees to provide after sales service through a trained village representative. The pilot was implemented in three phases covering 68 villages. However, lack of adequate funds and inadequate planning for after sales service and the fee collection mechanism, meant that the project did not meet its goals.

There are only a small number of solar off grid lighting companies in Pakistan. Most of these companies primarily work with institutional clients, military housing projects and telecom companies where large system installations are required.

Manufacturers rely on imports for product components and assemble the systems. The solar panels are primarily imported from Japan, China and Germany and the LED light sources are imported from China. Batteries are both imported from China and locally procured.

6.6.8.4 Regulatory Environment

Financing Support

No subsidy is offered on kerosene. The high cost of kerosene provides an opportunity for consumers to look at alternative options such as solar lighting.

Import Tariff and Duties

- 32% import duty levied on solar photovoltaic cells modules/panels
- No tariffs or duties on LEDs
- 10% duty on batteries and 15% on ready-made solar lanterns

Taxation Policies

There is no VAT for the components used in solar home systems but a general sales tax of 17% is applicable.

6.7 Sri Lanka

Sri Lanka's electricity supply includes three primary sources: hydro power, including small hydro; renewables such as solar and wind power; and thermal power, including biomass, coal and other fuel oil sources. Hydropower accounts for 48 %, renewable sources for 2% and thermal power constitutes 50% of the total electricity generation.

The annual electricity generation in Sri Lanka was about 11,800 GWh in the year 2012-2013 and the installed power plant capacity during the same period was about 3312 MW[61]. This installed capacity comprises 1584 MW of hydro power, 1638 MW of thermal power and 90 MW of non-conventional energy resources[62].

In the early 1990s, hydro power generation accounted for over 90% of the country's annual electricity requirements, however due to increased demand, the situation has changed drastically. Hydro power contribution has now been reduced to 40-50%. It is also noteworthy that the electricity demand in Sri Lanka

[61] CEB-Statics 2012
[62] Ibid

has been rising at a rate of 7% per annum over the last two decades. Thermal power stations in Sri Lanka run either on diesel, gas or other fuel oils. The Norocholai Coal Power Station, the only coal-fired power station in Sri Lanka, was commissioned in late-2011and generates 300 megawatts of electricity.

To improve the demand and supply situation, Sri Lanka has taken several actions to maximize the efficiency of energy utilization thereby minimizing greenhouse gas emissions. The first legislation for energy efficiency was the establishment of the Energy Conservation Fund, 1985 and the second major action was the establishment of Sri Lanka Sustainable Energy Authority (SLSEA) Act No.35 of 2007.

SLSEA is in the process of implementing a National Energy Management Plan from 2012-16 under the guidance of Ministry of Power and Energy. To stimulate national economic activity without creating an additional burden on the energy sector, they have set the target of achieving energy savings equivalent to 20% of total energy consumption of year 2010, by 2020. The industrial and commercial sectors, which account for around 60% of the electricity consumption in the country, are key areas to implement energy conservation measures in order to achieve these targets. Energy efficiency is Sri Lanka's key strategy to mitigate greenhouse gases emissions and to improve energy security while ensuring economic competitiveness.

National Climate Change Policy

The Ministry of Environment, the national focal point for the UNFCCC and Kyoto Protocol, has established a Climate Change Secretariat which is headed by the Director of the Climate Change Division. It has adopted a comprehensive national approach to address climate change challenges

To accept broader input, integrate diverse viewpoints, and bring together principle actors, the National Advisory Committee on Climate Change (NACCC) was created under the Ministry of Environment and Natural Resources (MENR), and all activities pertaining to climate change are to be coordinated by NACCC.

6.7.1 Regulatory and Control Mechanisms

6.7.1.1 Minimum Energy Performance Standards

Currently, regulations for energy efficiency have been defined which prohibit the import and sales of CFLs that do not comply with the minimum performance grading. In Sri Lanka, performance grading has been defined as the index for evaluating energy performance of CFLs. Performance grading includes rating lamp efficacy, power factor and colour temperature coefficient. Out of these parameters, lamp efficacy contributes to 90% of the performance grading. Based on this grading, star ratings have been assigned. For example, a CFL with a performance grading above 70 will be 5-star certified while one with a grading of 50 or less would not qualify.

6.7.1.2 Labelling of CFLs

In Sri Lanka, SLSEA is empowered to

- Implement energy labelling and standards programme for appliances
- Specify consumption limits
- Control the manufacture, import and sales of appliances which are less efficient than the specified limits

SLSEA is the authoritative agency and, in collaboration with the Sri Lanka Standards Institution (SLSI,) implement the energy standards and labelling programme.

The CFL was the first energy labelled product introduced in Sri Lanka in 2000. This was achieved through joint efforts of Ceylon Electricity Board (CEB), SLSI, Energy Conservation Fund, SLSEA and the National Engineering Research and Development Centre (NERDC).

The NERDC carried out tests on energy performance while the other three state organizations worked on setting up standards, sample selection for testing, label design etc.

The energy efficiency standard for CFLs was published in 2002 as SLS 1225:2002, 'specification for energy efficiency rating for self-ballasted lamps (integral type CFL)'. Initially labelling was voluntary, but in 2007, it was made mandatory.

6.7.1.3 Star Rating Criteria for Linear Fluorescent Lamps

The standards followed for developing performance standards for linear fluorescent lamps are SLS 566, which are compliant with IEC 81 and IEC 61. The star rating for linear fluorescent lamps has been defined based on the efficacy values, depending upon the hours of operation of the lamp. For example a linear fluorescent lamp with 100 hours of operation, having an efficacy lower than 60 lm/W will not warrant a star rating and a linear fluorescent lamp having an efficacy of 90 lm/W will be certified as 5 stars.

In addition to the star rating, the following information is available on energy labelled linear fluorescent lamps:

- Rated power (watts) of the appliance, the value quoted by the manufacturer
- Actual power consumption (watts) of the appliance, established after a laboratory test
- Energy consumption per month based on actual power consumption (considering 4 hours of operation per day)

6.7.1.4 Energy Codes for Buildings

The first Energy Efficiency Building Code (EEBC) of Sri Lanka was developed by the CEB in 2000. EEBC-2000 was the major precursor which prompted SLSEA to develop a new code for energy efficient buildings, by reviewing and amending EEBC-2000, making allowance for advancing technologies and modern society requirements.

SLSEA has developed a "Code of practice for energy efficient buildings -2008'. The code ensures the reduction in energy consumption and demand in the country. It sets maximum allowable loads for building lighting systems, as well as lower limits for acceptable efficiencies for commonly used lighting components (lamps and ballasts). Minimum luminous efficacy and maximum allowed ballast loss for linear fluorescent, HID and incandescent lamps, have also been defined in the code.

6.7.2 Economic and Market-Based Instruments

6.7.2.1 Energy Service Companies:

The following ESCOs have been registered with SLSEA:

- Energy Audit Services
- Energy Efficiency Services

6.7.3 Fiscal Instruments and Incentives

6.7.3.1 Tax Incentives:

The government has provided grants to waive off the import duty for CFLs.

6.7.3.2 Loans

The government has taken following initiatives to increase the use of CFLs:

- Interest free loans to purchase lamps from utilities
- Loan repayment in twelve instalments with electricity bills

6.7.3.3 Energy Efficiency Financing

The Sustainable Guarantee Facility is a mechanism to provide technical and financial guarantees for energy efficiency improvement projects developed by ESCOs. Some participating financial institutes are: Hatton National Bank, Sampath Bank, Commercial Bank, NDB Bank, DFCC Bank, Seylan Bank and Bank of Ceylon.

6.7.3.4 Sri Lanka Carbon Fund (SLCF)

The SLCF was established in 2008 and is a State owned private company with the government as the major shareholder with 51% of the equity. The balance share capital is to be raised from other sources, including the private sector. The SLCF can assist in emissions reduction by facilitating the establishment of clean energy generation plants (solar, wind, hydro and biomass), and by facilitating energy reduction in different sectors.

6.7.4 Support, Information and Voluntary Action

6.7.4.1 Energy Manager and Energy Auditor Schemes

SLSEA has regulated the hiring of Energy Managers in industries. To date, 182 Energy Managers have been appointed in different sectors.

6.7.4.2 CFL Programmes

Some of the programmes which have been implemented include:

- 1995/1996 - CEB purchased 100,000 CFLs which were then sold at discounted prices
- 1997/1999 - import duty was waivered for CFLs and interest free loans were offered by CEB
- 2000/2002 - along with interest free loans on CFLs, energy efficiency rating standards for CFLs were also developed
- 2003 - energy efficient labelling was launched for CFLs
- 2004 - 3 stars were set as minimum energy efficiency rating in order to qualify for the CEB loan scheme

6.7.4.3 Promoting Energy Efficient Products

Energy efficient lamps are provided at lower prices under "Supiri Parhan Programme." Energy efficiency awareness programmes are also being conducted regularly at schools.

6.7.4.4 Regional Centre of Lighting (RCL)

In view of the widespread benefits expected through the introduction of efficient lighting, RCL has been established recently within the SLSEA, with assistance from the South Asia Regional Initiative for Energy, funded by USAID. The knowledge partner for this initiative is Lighting Research Centre, which is a part of Rensselaer Polytechnic Institute from the USA. The main objectives of RCL are:

- To increase the awareness and affordability of energy efficient, reliable and clean lighting technologies, and their applications to reduce the electricity demand from lighting;
- To catalyze regional manufacturing of energy efficient lighting products with an objective to improve the economy of the region and to make lighting affordable to many underprivileged citizens; and
- To train and educate the necessary workforce in the region to create sustainable lighting in South Asia

6.7.5 Sustainability and End-of-Life Treatment

6.7.5.1 E-waste Management

A national policy on Waste Electrical and Electronic Equipment (WEEE) waste management has already been drafted and many public-private partnerships have been established to manage this waste in a sustainable way. The Ministry of Environment and Renewable Energy and the Central Environment Authority (CEA) are heading the efforts as policy makers and enforcers of the law.

In addition to achieving a draft policy for WEEE management, Sri Lanka has also implemented the "Electronic Waste Management Project" under the purview of CEA. Under this project, an MoU has been signed with 14 partner organizations in an effort to manage electrical and electronic waste management.

The partner organizations included representation from the telecommunications industry (Telecom, Mobitel, Dialog, Etisalat, Hutch, and Lanka Bell); home appliances industry (Singer and Abans; office appliances industry (Metropolitan, E-Wis, Virtusa, and ABC Trade and Investments); and service providers (Geo Cycle and Green Link).

6.7.5.2 CFL Disposal Management

Orange Electric invested USD 0.5 million to set up a CFL recycling plant with the capacity to recycle up to 30 million lamps per year.

6.7.6 Monitoring, Verification and Enforcement

6.7.6.1 National Engineering Research and Development Centre (NERD)

The National Engineering Research and Development Centre (NERD) was established in 1974 under the Sri Lanka State Industrial Corporation Act. NERD has a statutory board under the Ministry of Economic

Reform, Science and Technology. Some of the projects implemented by the centre include lamp testing and solar PV and solar home system testing.

The testing includes testing of PV panels, inverters, batteries, and lamps which covers the whole system for a rural installation. The centre has received funds from the UNDP and the World Bank for capacity building.

CFL s

NERD has the instrumentation to test CFL and electronic ballasts. There are three manufacturers of CFLs in Sri Lanka for which NERD conducts tests that include colour and power factor. CFL importers also have to bring their products for testing at NERD. Lifetime tests are currently not performed at NERD due to a lack of demand for this test. There is no accelerated test procedure for a CFL life test and the manufacturers do not want to wait or possibly cover the costs, for the length of time a conventional life test would take.

The primary electric utility in Sri Lanka, CEB, has a voluntary scheme for the labelling of CFLs. This programme allows consumers to purchase lamps from qualified suppliers and the cost of these lamps is paid through the electricity reduction in monthly bill. Only labelled lamps qualify for this programme. Lamps are tested by NERD and labelled by SLSI. The SLSI test protocols for CFLs are in line with IEC 969:1998.However, for energy labelling a new Sri Lankan standard, SLSI 1225:2002, is used.

Linear Fluorescent Lamps

NERD is planning to carry out testing of fluorescent lamps (T5, T8, and T12 lamps up to 52 inches in length) and they are currently in the processing of defining the specification of reference ballasts and linear fluorescent lamps.

6.7.6.2 Sri Lanka Standards Institute (SLSI)

SLSI is the national standards body of Sri Lanka, established under the Bureau of Ceylon Standards Act of 1964. The institution functions under the Ministry of Science and Technology and is governed by a council appointed by the Minister of the Sri Lanka Standards Institution Act of 1984. SLSI, by virtue of being the national standards body, in Sri Lanka is a member of the ISO. As a member of the ISO, it exchanges copies of national standards and is responsible for disseminating information on standards, technical regulations, and standards related activities to the community at a national level.

SLSI has a product certification scheme that does testing and issues the SLS mark to demonstrate compliance with their test standards. This is a voluntary mark, except for twenty locally manufactured products that have been mandated to meet the SLS mark requirements through the directions issued by the Commissioner of Internal Trade.

6.7.6.3 Ceylon Electricity Board (CEB)

The Demand Side Management Branch of the CEB is interested in labelling for several products, such as, lighting, fans, refrigerators, motors, etc.

6.7.6.4 University of Moratuwa, Center for Energy Studies

The University of Moratuwa has established a Centre for Energy Studies which is involved in research activities in energy efficiency and the environment related to energy. Continuous professional development activities and advisory services in the above areas are also conducted by the centre, and it plays a facilitative role in testing.

6.7.7 Lamp Production and Manufacturing[63]

Sri Lanka has the full manufacturing capacity for incandescent lamps and is importing 40% of their CFL and fluorescent lamp requirements, along with 90% of HIDs as see below in Table 11.

Table 11: Manufacturing Capacity of Sri Lanka

	Incandescent Lamps	Compact Fluorescent Lamps	Linear Fluorescent Lamps	High Intensity Discharge Lamps
Sri Lanka	100%	60%	60%	10%

The total number of light sockets available in Sri Lanka is approximately 36 million. The total number of lamps consumed every year is about 26 million with incandescent lamps accounting for 50% of total lamp consumption at around 13 million annually. The number of CFLs consumed is around 7million every year and constitute 27% of total lamp consumption. Linear fluorescent and HID lamps comprise 15% and 8% respectively of total lamp consumption.

Currently, CFLs are manufactured by five to six manufacturers in Sri Lanka.

6.7.8 Off-Grid Lighting

According to the IEA 2009, almost 75% of the rural households are connected to the electricity grid, while 2% of the households are provided with basic electricity connection through the off grid option. To improve the electricity rate, the 2006 National Energy Policy of Sri Lanka envisaged extending electricity to 98% of the households by 2016 through on-grid and off-grid energy systems.

In the off-grid sector, small hydro power has been the preferred option, with the first off-grid village hydro scheme commissioned in 1992. Apart from micro hydro, solar photovoltaic home systems have also been used to a large extent, to provide access to electricity. The Sri Lankan government, having recognized the problem of access to electricity, worked with the World Bank to lay the foundation for this transformation through the Energy Services Delivery Project (ESD) in 1997.

The 2002 Renewable Energy for Rural Economic Development (RERED) project took grid/off-grid electricity services to the next level, reinforcing the World Bank's commitment to green energy. Increased demand fuelled additional financing from IDA that further enhanced the project. The project addressed one of the most important barriers to renewable energy development in Sri Lanka, namely the availability and access to sufficient long-term credit. This was achieved by encouraging commercial banks to lend to renewable energy projects in order to demonstrate that the risks are manageable and that lending would also be profitable.

The RERED Project included a $115 million credit from the International Development Association (IDA) and an $8 million grant from the Global Environment Facility (GEF), from 2002-2011.This project aimed to provide off-grid electricity services to invigorate the rural economy to empower the poor to improve their

[63] Interview conducted and information shared by officials from Electric Lamp and Component Manufacturer's Association of India

standard of living. RERED also aimed at establishing grid-connected investment projects to encourage competition in the power sector, provide capacity addition and diversity, and achieve greater sector efficiency and transparency.

The RERED, and its predecessor ESD project, fully complemented the grid-based extension undertaken by the Ceylon Electricity Board. Over the past decade, the project has electrified more than 130,000 rural households through solar home systems and independent mini grids. It has also provided 1,000 off-grid electricity connections to small and medium enterprises and public institutions thereby, helping thousands of rural households to switch from poor-quality kerosene lamps to more efficient electric lighting[64] .

Under this project, the private sector initiative was instrumental in reaching rural households on a large scale for supplying solar home systems of modular sizes. The ESD credit programme resulted in a dramatic increase in the development of grid-connected and off-grid renewable energy projects, prepared and implemented by the private sector and village communities. The project catalysed the solar market by installing 20,953 solar home systems, with a total capacity of 985 kW, against a target of 15,000 systems; 31 MW of mini hydro capacity installed through 15 projects against a target of 21 MW; and 350 kW of capacity through 35 village hydro schemes serving 1,732 beneficiary households against a target of 250 kW through 20 schemes (RERED, 2010).

In the renewable energy sector, currently a dedicated agency for renewable energy development and energy efficiency by the name of Sri Lanka Sustainable Energy Authority (SLSEA) is responsible for promotion of renewables (including off grid electrification of villages).

Success of the off grid projects in Sri Lanka can be attributed, to flexible project design responsive to the needs of implementing organizations, suppliers, and beneficiaries.

To address the challenge of identifying the right beneficiary and assess their ability to repay loans to minimize credit losses, the ‘Power Fund for the Poor’ project of ADB, the targeted households, in Governments in India, The Renewable Energy for Rural Economic Development project has expanded Sri Lanka's generation capacity has also provided off-grid electricity to over 116,000 remote rural households. The Renewable Energy for Rural Economic Development (RERED) project has supported the development of 185.3 megawatts (MW) of renewable energy capacity (or about 65% of the total renewable electricity generating capacity in Sri Lanka as of March 2012.) The project has also provided off-grid electricity to over 116,000 remote rural households (or about 0.5 million people).

In the off grid sector, small hydro power has been the preferred option with the first off grid village hydro scheme commissioned in 1992. Apart from the micro hydro, solar photovoltaic home systems have also been used to a large extend to provide access to electricity. The Sri Lankan Government recognized the problem of access to electricity and worked with the World Bank to lay the foundation for this transformation through the Energy Services Delivery Project (ESD) in 1997. Now, School children can study with electricity with reduce in Indoor air pollution and improvement in safety, replacing the use of kerosene oil lamps.

Financing solar home systems program in Sri Lanka

The most popular solar home systems financing model under Sri Lanka’s Renewable Energy for Rural Economic Development Project is consumer credit through the microfinance institutions that work closely with solar companies. The project’s centrepiece has been the market-based credit program available to PCI

[64] RERED 2010

(participating credit institutions) - commercial banks, microfinance institutions, and leasing companies that meet eligibility criteria. The solar companies, via their dealer networks, sell solar home systems and offer operation and maintenance services. The business model is structured through a memorandum of understanding between the microfinance institution and the solar company, key features of which are a buyback scheme and identification of the consumer service responsibilities of the two parties.

The RERED project comprises 11 PCIs namely five commercial banks, two licensed specialized banks, two leasing companies, one finance company, and one microfinance institution (ESMAP 2008). The PCIs can refinance up to 80 percent of their loan amounts. They access credit at the average weighted deposit rate, repayable in 15 years with a maximum 5-year grace period. In turn, they offer households, community-based organizations, and private developers sub-loans which are used to for financing solar home systems, village hydropower systems, and mini-hydropower projects respectively. The sub loans have a maximum maturity of 10 years with a 2-year grace period, not exceeding the useful economic life of the equipment financed.

The PCIs assume the credit risk on the refinanced sub-loans and repays them according to an agreed-on amortization schedule, regardless of whether their borrowers repay. Following this model, the Sarvodaya Economic Enterprises Development Services (SEEDS)—the project's key PCI in solar home systems financing and a recognized leader in off-grid energy services delivery in remote rural areas—financed more than 60,000 systems during the period 2002–06.

Barriers

The two common barriers in the promotion of PV market in the Sri Lanka are lack of R&D sector focused on solar energy development and the funds availability. Also the people awareness and the availability of technologies are other barriers which hold back the growth of the market. Political inconsistency is one of the prime concerns of the funding given by the international funding agencies. But, with a successful example of Bangladesh one can learn that with more of people's willingness and interest in taking initiatives market could be created.

Benefits

Transition towards LED based solar lighting system from fuel based lighting system would result in an annual savings of 120 million litres of kerosene, 65 million candles and 16 million batteries. Also, there exists a potential to avoid 324.8 thousand tonnes of CO2 emissions annually. The annual monetary saving of around 86.6 million USD with a payback period less than 1 month could be achieved. The annual monetary saving of around 86.6 million USD with a payback period less than 1 month could be achieved.

7.0 Strengths, Weakness, Opportunities and Priorities in the Region

There are strengths, weaknesses, opportunities and priorities for the region that are based on the various policies adopted and initiatives taken. They also arose from discussions with the various regional country stakeholders during the two day conference held at New Delhi in September 2013.

7.1 Strengths

All countries are making efforts to enhance their energy security:

Energy for food, heat and light is a key requirement for human development. To guarantee universal access to modern energy services, it is important to ensure optimum energy use in spite of the lack of energy generation. Energy security—the ability of a nation to secure a sustainable energy supply to meet its energy needs at reasonable prices—has thus, become a major energy policy imperative. All the countries of South Asia region are making efforts to enhance energy security.

Sufficient numbers of lamps to meet the domestic demand are available:

There is a high volume of energy efficient lamps in the market that consume less energy to produce the same amount of light. These lamps also last much longer than traditional types.

Well defined government bulk procurement procedure:

Well defined guidelines for bulk procurement by the governments in different countries are in place to ensure the purchase and sale of efficient lamps.

Governments are aware of the advantages and willing to transition to efficient lighting:

Governments in countries throughout the region understand that efficient lighting leads to national financial, energy and environmental benefits. They are working to streamline the process for those involved in framing and implementing policies in the lighting sector.

Almost all countries experience power shortages which compels them to use efficient technologies:

The energy sector is of critical importance due to the widening gap between the supply and demand of power. Efficient lighting helps to reduce this gap in order to achieve self-sufficiency in the energy sector.

Countries have already undertaken initiatives, including financial incentives and supporting policies, for the promotion of efficient lamps:

In view of universal concerns over global energy security, competitiveness, and environmental protection, most of the countries in the region have been involved in initiatives (e.g. distribution of lamps free of cost or at a subsidized price) which helps to reduce energy consumption from lighting per capita.

Availability of technology:

With new innovative methods in the lamps manufacturing process, the cost of producing energy efficient lighting (CFLs and LEDs) has been decreased over the years.

Global and national sustainability concerns:

South Asian countries are aware of and have taken several steps to address environmental sustainability.

Competiveness in countries has led to the establishment of relevant organizations:

Globally, energy efficiency represents a major potential for greenhouse gas reduction. In recent years with increased awareness of sustainability, along with spiking oil costs, there are many establishments, like ELCOMA in India, which focuses on energy efficient lighting for many sectors for both public and private organizations.

Sharing of initiatives undertaken in South Asian countries:

More effective dissemination of information about the initiatives underway in various South Asian countries, along with the sharing of policies developed for efficient lighting within institutional mechanisms, plays a significant role in the transition to efficient lighting in the region.

Efficient lighting is a recognized measure to address climate change mitigation:

Climate change is now widely acknowledged as one of the key challenges of the twenty first century. Efficient lighting helps to significantly reduce CO_2 emissions, and demonstrates the huge potential as a key measure to address climate change mitigation.

7.2 Weaknesses

Lack of testing labs and facilities:

A key barriers to improve energy efficiency in the lighting sector is to ensure that there are a significant number of testing laboratories however, there is a lack incentives and funding for installation of these labs.

Standards for CFL are available in most of the countries but only in India for LEDs:

The lack of industry standards and wide variations in early product quality delayed the adoption of CFL technology for many years and same is happening in the case of LEDs.

Cost, affordability and economics for buyers:

Inefficient incandescent lamps turn more than 80% of the energy they consume into heat rather than light. CFLs are gradually replacing then and although the upfront cost is more expensive, the cost is quickly decreasing due to improved manufacturing and economies of scale. LEDs have emerged as another option and although their initial cost is still well above that for CFLs, LEDs last a very long time and replacement lamps are few, if any. Thus, total life cycle costing needs to be taken into account and communicated to end users.

Unreliable quality of innovative products in the market, like LEDs:

The quality and energy efficiency of LED products varies widely. The widespread availability of poor quality and unreliable LED products means that there is a huge barrier to promote these efficient lighting technologies in the market.

Awareness and training about the overall product benefits:

With proper training and awareness-raising, this would help to communicate the important benefits of efficient lighting products that relate directly to energy savings, environmental improvements and economic success.

Gap in monitoring and enforcement of the quality standards:

Developing and harmonizing minimum efficiency and quality standards is very important for the transition to efficient lighting. However, the lack of political will at both the government and private levels for monitoring, verification and enforcement (MVE) activities and quality standards, leads to inefficiency in the lighting market.

7.3 Opportunities

Manufacturing:

As LED and CFL lamps begin to mature as a technology, they promise a bright future for efficient lighting. Manufacturing facilities can be upgraded, expanded or established and would further generate significant job opportunities which would help in the transition to efficient lighting.

Skilled manpower:

There is limited skilled manpower for the design and installation of efficient lighting and even less formal training opportunities for engineers. This also impacts the penetration of energy efficiency in the lighting market. So, there is an opportunity to target skilled manpower as a means to enhance energy efficient lighting.

Access to electricity:

Developed countries face the combined challenge and opportunity of access to electricity for everyone. Energy efficient lighting ensures universal access to modern energy services and helps countries to have better access to electricity.

Withdrawal of subsidies which lead to high electricity prices:

An important reason for the slow penetration of efficient lighting products is due to low energy prices as a result of subsidies for electricity charges. State-specific, energy efficiency incentive programmes also play a significant role for the penetration of energy to the masses. However, with an effective energy efficiency drive, a huge potential savings in energy can be achieved and the subsidies can be withdrawn.

Reduction of peak load (load shedding):

Most commercial and industrial facilities pay a considerable portion (as high as 40%) of their electric energy bill as demand charges for the peak demand created by electrical loads. Lighting is the second largest

contributor to summer peak demand in commercial facilities. Automatic reduction of electrical demand in a building by shedding lighting loads is the by-product of energy efficient lighting.

Large market potential:

The lighting market provides one of the best opportunities for saving energy. As the volume of consumption in the lighting sector is huge, it demonstrates a significant potential for manufacturers and consumers to make an immediate move to energy-saving lighting.

Potential for cross learning:

One of the greatest potentials to save energy in lighting can be achieved through knowledge sharing and the pooling of information from across all of the countries throughout the South Asia region.

Promotion of efficient lighting technology based on past experience:

Energy efficient technologies like LEDs have already been promoted throughout many parts of the world and their growth is very significant. This leads to a huge opportunity for a real and sustainable transition to efficient lighting both regionally and globally.

7.4 Priorities

Development of standards and specifications for different applications:

Minimum performance specifications and evaluation procedures need to be developed as a top priority for different applications such as street lighting, industrial lighting, etc. The development of harmonized standards and specifications would help to improve and penetrate the efficient lighting market in South Asia.

Creating an enabling policy environment for more efficient products:

The development of an enabling policy framework necessary for energy efficiency in lighting is one of the most important priorities. Governments should require and promote improved lighting systems design and management. This should be done with the integration of efficient lighting systems in building codes.

Market demand push and financial incentives

Energy efficiency programmes provide a range of financial and other incentives to industry which helps market push and energy efficiency. Increased market demand and the push for efficient lighting products, would help the transition to efficient lighting.

Enhancing lab capacity:

Dedicated research centres, upgrading of existing labs and establishing new labs would facilitate the availability of tested quality products in the market which will ensure the existence of energy efficient lighting systems.

Strong monitoring and enforcement systems:

To help South Asian countries achieve the benefits of energy efficiency, there is immediate requirement for strict monitoring, verification and enforcement systems to remove inefficient and poor quality products from the market.

Awareness and training on efficient lighting products:

Additional and continuous awareness-raising and training programmes on efficient lighting need to be organized in all of the regions of South Asia.

Developing environmentally sound management for lighting products:

Maintaining health and safety standards by utilizing lamps which are free of mercury would provide consumer confidence in the transition to efficient lighting.

8.0 Conclusions for the South Asian Region

There is no doubt that each country in South Asia understands the impact of climate change well and has made attempts to combat it. These countries also know of the impact that efficient lighting can have, not only in lowering energy bills or reducing the gap between energy demand and supply, but also bringing sustainability both at country level and global level by reducing greenhouse gas emissions. However, due to some barriers around policy, finance, technology, and the overall environmental development, the launch of an effective and sustainable energy efficiency programme for a smooth transition to efficient lighting is yet to take off in a big way.

In spite of the fact that efficient lighting, which is a technologically sound and economically viable option for improving energy efficiency in the countries, the penetration in the energy efficiency sector is far below than expected in South Asia. The key points observed from the countywide assessment are as follows;

- There are around 2.6 billion light points in the South Asian region, out of which 39% are still inefficient incandescent lamps. CFLs account for 18% of the total light points.
- The total electricity consumption in the region is approximately 875 TWh per year. Lighting accounts for 15% of the total electricity consumption. The phase-out of inefficient incandescent lamps has potential to save up to 5.5% of the total electricity consumption and approximately 36% of the total electricity consumed only by lighting, in the region. This would also lead to avoiding about of 43 Mt of CO_2 per year.

Existing Policies and Capabilities to Support the Transition to Efficient Lighting in the Region

Regulatory and control mechanisms:

In most of the countries in South Asia, MEPS, labelling, energy codes and energy conservation acts are already in place. India, Pakistan and Sri Lanka have comprehensive systems; however Bangladesh, Bhutan and Nepal have processes in place that are only moderately well advanced.

Economic and market-based instruments:

In the region, a few countries like India and Sri Lanka have already established energy saving companies (ESCOs). Low interest bank loans are being offered and other market- based instruments have been developed in India, Pakistan and Sri Lanka.

Financial instruments and incentives:

Tax rebates are provided in India for energy efficient lighting. Several subsidies and international grants are available in Bangladesh, India, Pakistan and Sri Lanka. Funding for renewable energy programmes is available in Nepal.

Support, information and voluntary action:

In all the countries of the region, several awareness campaigns and demonstration projects have been carried out to promote energy efficient lighting.

Sustainability and end of life approaches:

Countries like Pakistan and Sri Lanka have already prepared guidelines for e-waste management and CFL mercury disposal and recycling. India has developed e-waste management guidelines and agreed to the Minamata Convention for CFL mercury management. Countries like Bangladesh, Bhutan and Nepal have yet to establish such guidelines.

Monitoring, verification and enforcement:

There are government ministries for framing policies and authorities to enforce them to ensure quality products and take corrective actions if required, in Bangladesh, India, Pakistan and Sri Lanka. However, the way enforcement authorities' function varies from country to country. Moreover, the authorities are more concerned about providing quality checks at the production level, as compared to performing quality checks after procurement and during implementation. The countries which are more dependent on imports have approved specifications for importing efficient lighting products but they lack facilities for quality checks after import.

Product quality and testing capacities:

Most of the countries like Bangladesh, India, Pakistan and Sri Lanka have laboratories for product quality testing and are already in the process of expanding them to ensure quality products in the market.

Production and manufacturing:

Lamp manufacturing industries have been established in Bangladesh, India, Pakistan and Sri Lanka. Countries like Bhutan and Nepal are currently importing lamps from other countries within the region and lack such facilities.

After analysing the policies and capabilities existing in South Asia as indicated in Table 12, South Asia offers a very "STRONG" regional readiness for a transition to efficient lighting.

India, Pakistan and Sri Lanka have almost all of the policies in place and capabilities required for a transition to efficient lighting and their relative readiness towards a transition is strong. Bangladesh has yet to formulate environmentally sound disposal guidelines for CFLs and e-waste, but it has all the other policies and capabilities and makes a very strong case for an immediate transition to efficient lighting.

Bangladesh, Bhutan and Nepal have yet to develop many required policies and capabilities and their relative readiness towards immediate transition is just "Moderate".

Table 12: Existing Policies and Capabilities in South Asia

	Regulatory and Control Mechanism	Economic and Market Based Instruments	Fiscal Instruments and Incentives	Support, Information and Voluntary Action	Sustainability and End-of-Life	MVE	Product Quality and Testing	Production and Manufacturing	Relative Readiness
India	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Strong
Sri Lanka	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Strong
Pakistan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Strong
Bangladesh	Yes	No	Yes	Yes	No	No	Yes	Yes	Strong
Bhutan	No	No	No	Yes	No	No	No	No	Limited
Nepal	No	No	No	Yes	No	No	No	No	Limited
South Asia Region	Strong	Moderate	Strong	Strong	Moderate	Moderate	Strong	Strong	Strong

9.0 Recommendations for the South Asian Region

There is a need to develop a regional road map towards the phase- out of inefficient lighting in the South Asian region. The recommendations for the region are provided below:

Set Minimum Energy Performance and Quality Standards for CFLs and LED Light Sources

While efficient lighting represents a viable and cost effective tool to address climate change mitigation, the prevalence of low quality products in the market represents a significant barrier to the full realization of this strategy for region. Quality standards should only be used to keep poor quality CFLs and LEDs out of the market and not to act as a barrier to hinder good quality products. There is a need for agreement on CFL and LED performance and quality levels that focuses on a set of criteria that covers all important aspects of performance, not just one or two attributes. Therefore, it is recommended to set minimum energy performance and quality standards for CFL and LED light sources in order to reduce the entry of low quality products in the market and to increase consumer confidence.

Promote and Improve Labelling Schemes for CFLs and LEDs

Voluntary approaches to product efficiency are limited, and research shows that in the long term, it is important to have mandatory testing and labelling of all products in the market. CFLs and LEDs should be addressed as other appliances, with a programme in place to test products; to provide labelling of all products in the market so that consumers can easily identify high efficiency models; and eventually adopt minimum energy performance requirements.

Develop an Agreement to Recognize Test Results Throughout the Region

Many countries in the region either have limited laboratory facilities or lack facilities capable of carrying out testing procedures at internationally acceptable levels, to help in developing standards and ensuring quality of the product. Some countries do have lab facilities where testing can be performed based on internationally procedure or procedures. Products tested and certified by these labs based on specified test procedures should also be recognized in other countries. Therefore, it is recommended to develop regional agreement on ways to mutually recognize test results across nations in South Asia.

Harmonize Testing Procedures and Standards

There is a pressing need for a uniform regional process to test and assure the quality of CFLs and LEDs sold in South Asia. Nearly all South Asian governments that have efficient lighting programmes in place, use the internationally developed and accepted test procedures.

South Asian governments should state their support for the complete adoption of common test procedures for testing the quality and energy performance of lamps. They can also come to an agreement to establish common MEPS .This simple step would not require adopting any new standards, but rather would solidify the common use of an existing international standard that would facilitate the testing and foster the development of a system to compare CFLs and LEDs manufactured and sold anywhere.

Develop Strong and Sustainable Fiscal Instruments

The high initial costs of CFL and LED lamps hamper the effective and sustainable transition towards efficient lighting. Therefore, all the countries in this region are required to ensure that fiscal instruments, ranging from reduced VAT rates or subsidy mechanisms, to ESCOs, are used to overcome this barrier.

Increase Public Awareness about Quality and Costs

Government agencies, the private sector (including manufacturers and retailers of CFLs and LEDs), and NGOs in the region are required to take concrete action to increase awareness of the availability and importance of high-quality efficient lighting products through media campaigns and voluntary actions. Buyers shall also be educated to understand the difference between initial costs of the product as compared to total cost which also includes replacement and operating costs over their average rated life.

Develop Environmentally Sound Policies and Guidelines

Considering the potential that exists in the region for the replacement of inefficient incandescent lamps with CFLs or LEDs, it should be mandatory for each country to develop environmentally sound waste management policies and guidelines supported by proper enforcement mechanisms. Import and export policies should also include recycling, recovery and disposal guidelines for mercury and e-waste.

Regional/Bilateral Cooperation

In order to ensure a sustainable transition to efficient lighting, it is necessary to have a harmonized plan through which the expertise, infrastructure (lamp manufacturing capacity and testing capacity) among countries could be mutually shared. The recommendations are:

- Certification of testing labs
- Funding from South Asian Association for Regional Cooperation (SAARC) and exploration of other funding options
- Harmonization the lighting standards in the region
- Sharing of information to bridge the gap for technical advancement
- Formal and informal communication, such as networking in the region
- Establish a Centre of Excellence for lighting in the South Asian region

The Way Forward: Regional Roadmap

The South Asian region can work together to:

- Promote energy efficient lighting in order to gradually phase-out inefficient lighting technology by 2020
- Develop a policy framework to phase-out incandescent inefficient lighting by 2016
- Create different technological options with manufacturing capabilities in each country

South Asia Participation in the UNEP en.lighten initiative

It is also highly recommended that South Asian countries join the voluntary Global Efficient Lighting Partnership Programme proposed by the UNEP-GEF en.lighten initiative. Joining the en.lighten Global

Partnership would help each country leverage international resources and signal a readiness to bring the benefits of efficient lighting to every household, preserve the region's unique environmental assets and tackle climate change.

Given that the South Asian region is in a strong position to transition to efficient lighting by phasing out inefficient lamps, we suggest that countries consider the en.lighten integrated policy approach to achieve a sustainable transition. Specifically, the region needs to strengthen the following:

- Regulatory framework and minimum energy performance standards
- Supporting policies and mechanisms
- Monitoring, verification and enforcement capabilities
- Environmentally sustainable management of lighting products, including collection and recycling

As part of the en.lighten Global Partnership, South Asian countries may find opportunities to share and learn best practices from their peers worldwide, choosing programme models that are appropriate for their social, political and economic situations; identifying new partners with whom they can cooperate; and aggregating their efforts to achieve sustainable and significant successes in efficient lighting.

References

- Bangladesh standards and testing institutions http://www.bsti.gov.bd/
- Barrier Removal to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling 2013, Feasibility study report on regional ES&L harmonization for CFL
- Bureau of Energy Efficiency http://www.bee-india.nic.in/
- Bureau of Indian Standards http://www.bis.org.in/other/copy.htm#
- Climate change in Sri Lanka
  http://www.fukuoka.unhabitat.org/projects/voices/sri_lanka/detail03_en.html
  http://www.climatechange.lk/About_us.html
- E-waste Management in Sri Lanka
  http://www.ips.lk/talkingeconomics/2013/06/utility-vs-environment-sri-lankas-policy-outlook-on-managing-waste-electrical-and-electronic-equipment/
- Electric Lamp & Component Manufactures' Association of India (ELCOMA) Reports
- Energy efficiency funds in Pakistan
  http://www.the-esa.org/news/articles/-/pakistan-receives-bank-loan-for-energy-saving-initiatives
- Energy efficiency public awareness programme in Pakistan
  http://www.enercon.gov.pk/index.php?option=com_content&view=article&id=96&Itemid=67
- Environmental management of lamps in Bangladesh
  http://www.newagebd.com/detail.php?date=2012-07-31&nid=19052#.UiryXMZyA9Y
- Grameen Shakti as ESCO in Bangladesh
  http://www.gshakti.org/index.php?option=com_content&view=article&id=53&Itemid=66
- International Energy Agency 2012, selected indicator table for 2010 in Key world Energy statistics
- Lites.asia 2012, National standards and labels document, India
- Lites.asia meeting 2012, Beijing, Lighting standards and development process in Sri Lanka
- Lites.asia Workshop 2013, Jakarta, National Energy Conservation Centre and Ministry of Power, Pakistan

- Lites.asia Workshop 2012, New Delhi, National Standard, regulations and labelling requirements for lighting products in Bangladesh

- Ministry of Environment and Forest, Central Pollution Control Board, March 2008, guidelines for environmentally sound management of E-Waste

- National Energy conservation centre (ENERCON), Pakistan http://www.enercon.gov.pk/index.php?option=com_content&view=article&id=59&Itemid=59

- Nepal Energy Efficiency Programme http://wecs-neep.gov.np/

- Off-Grid Lighting Sri Lanka http://www.worldbank.org/en/results/2013/04/11/sri-lanka-lights-up-renewable-technology-light-up-rural-communities

- Pakistan Standards and Quality Control Authority http://www.psqca.com.pk/standards-development-centre.htm

- Regional Centre of Lighting in Sri Lanka http://www.rclsa.net/contents/research-by-regional-center-for-lighting-south-asia

- Report of the Working Group on Power for Twelfth Plan (2012-17), Government of India, Ministry of Power

- Sri Lanka Standards Institute http://www.motr.gov.lk/web/index.php?option=com_content&view=article&id=179&Itemid=125&lang=en

- Sri Lanka Sustainable Energy Authority (SLSEA) http://www.energy.gov.lk/sub_pgs/energy_managment.html

- UNDP-SARI Energy programme 2003, Energy efficiency standards and Labelling for appliances

- UNEP-GEF en.lighten initiative, achieving the Global Transition to Energy Efficient Lighting Toolkit 2012

- UNEP-GEF en.lighten initiative, Country Lighting Assessment reports 2010

- World Bank Funding for energy efficiency

http://www.hindustantimes.com/India-news/NewDelhi/World-Bank-funds-Indian-project-on-energy-efficient-fans/Article1-1079844.aspx)