Study to Compare the Prevailing Policy Measures, Technical Standards and Techniques Including Labeling Schemes for Energy Efficiency/Energy Conservation with Advanced World

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List of Abbreviation

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BEC	Building Energy Code
kW	Kilo Watt
kWh	Kilo Watt Hour
MW	Mega Watt
RFO	Residual Fuel Oil
IECC	International Energy Conservation Code
HSD	High Speed Diesel
LCD	Liquid Crystal Display
LED	Light Emitting Diode
CRT	Cathode Ray Tube
CFL	Compact Fluorescent Light
UPS	Unbreakable Power Supply
PMO	High Efficiency Particulate Air
HVAC	Heating, Ventilation and Air-Conditioning
GHG	Green House Gases
tCO^2	Tons of Carbon Dioxide
ECOs	Energy Conservation Opportunities
NEA	Nepal Electricity Authority
EA	Energy Audit
EAT	Energy Audit Team
EMS	Energy Management System
INDC	Intended Nationally Determined Contribution
CCAR	California Climate Action Registry
EE	Energy Efficiency
TFC	Total Final Consumption

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Disclaimer:

Findings, interpretation and conclusions expressed in this report are based on information acquired from SAARC Member States, the documents available in printed and online versions and also on the knowledge and assumptions made by authors. These do not necessarily reflect the views of SAARC Energy Centre and the author does not guarantee the accuracy, completeness or usefulness of the information in this report, and as such not responsible for any errors, omission or losses which emerge from its use.

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Foreword

Improving energy efficiency is critical to achieving the ambitious goals of the Paris Agreement under the UN Framework Convention on Climate Change. Energy efficiency delivers not only reductions in energy consumption and emissions, but also many economy-wide multiple benefits, such as improved health and well-being, cleaner air and more jobs. Nonetheless there are common barriers and market failures that prevent countries from implementing energy efficiency actions.

SAARC is not an exception, having almost all of its Member States heavily rely on import of oils, yet having relatively less consideration for improving efficiencies in consumption. This not only has a direct impact on their import bill but also causes increases in environmental pollution.

Efficiency and conservation are key components of energy sustainability—Sustainability focuses on long-term energy strategies and policies that ensure adequate energy to meet today's needs as well as tomorrows.

In order to highlight the importance of Energy Conservation and Energy Efficiency in SAARC, SAARC Energy Centre (SEC) initiated this in house effort, "Study to Compare the Prevailing Policy Measures, Technical Standards and Techniques including Labeling Schemes for Energy Efficiency/ Energy Conservation in SAARC with Advanced world".

The study was carried out in house by Mr. Ihsanullah Marwat (Research Fellow – Energy Efficiency), under the supervision and guidance Dr. Shoaib Ahmad (Deputy Director Coordination), without his support it would have never been possible.

Main objective to initiate this study was to analyze the available Energy Efficiency/ Conservation policies and techniques adopted by the SAARC Member States in comparison with the developed world. While based on modern energy policies and efficient technologies deployed in advanced countries, suggest way forward.

The study is also backed by a visit to Member State India (being regional leader on the subject) while having similar conditions as rest of the Member States, to understand their present status in achieving Energy Efficiency and since having similar environment what challenges they faced and how they overcome.

Executive Summary

Often called as the priority fuel, improvement in end-use efficiency / conservation offers great opportunity to address energy security, price and environmental concerns. To achieve improvements in the efficiency of energy use, action may be required at one or more levels - from the lowest level of the consumer through to the highest level of global agencies. However, to introduce such programs, it involves many steps, ranging from developing and implementing relevant policies and regulations to arranging financing mechanisms mostly through financial intermediaries.

Upon evaluating Energy Efficiency policies and standards being adopted by SAARC Member States it was observed that different Member States are at different level in developing and adopting these policies and standards. Whereas some of the Member States are at very initial stage of their journey towards an efficient utilization of their energy supplies while some others are at far advance stage.

To assess and compare their status with, energy efficiency policies and measures in selected leading economies such as United States of America, Japan, Germany and China have been analyzed. It was found that although there is an overall huge gap, leading Member States are in a better position to not only achieve this target for their own but also can help other Member States to overcome this gap.

The study suggests some recommendation for better implementation of the concept such as energy prices should reflect real costs and consumers should be well informed, the quality of energy-efficient equipment and services should be controlled, regulations should be enforced and regularly strengthened, behaviors should be addressed as much as technologies, monitoring achievements and the impacts of measures is necessary to check the real impact of energy-efficiency policies, and International and regional cooperation should be enhanced.

1. INTRODUCTION

1.1 Background

Energy is the key component of economic development and prosperity of a society. It gives a push in keeping sustainable economic development. Energy use in developing nations has risen more than four times during the previous three decades and is relied upon to keep expanding quickly in upcoming years. In order to fulfill energy needs of expanding human population and to address the improved quality of life, expansion in the energy services is of high importance. Be that as it may, finding the energy resources to give these services could cause major financial and social issues. For a considerable number of the developing nations, a greater chunk of the additional energy required will be provided by imported oil, and rising oil imports will exert additional load on those nations, which are under stress with high oil import bills. Thus, constructing dams or power plants to cover higher needs for power could lead these countries considerably more into debt. Energy generations and utilization also contribute to harm native ecology in these developing nations, such as greatest levels of air pollution in some urban zones.

Improvement in energy efficiency is highly acknowledged for its role that it can play in filling the gap among supply and demand for energy. Yet, it is equally realized that such improvements are not being taken up by the society as rapidly as it could have been. Therefore special attention is, being diverted to the elements that determine the implementation, acceptance and awareness of these improvements.

Energy consumption patterns are arranged by the behavior of a large number of stakeholders at different levels including: energy consumers; energy appliances manufacturers and suppliers; producers; co-generators; local/ national financial institutions; governments and/or countries; and funding/ aid agencies. In order to successfully achieve energy efficiency improvements in its use, action may be required at one or more levels - from the level of the consumer through to the larger level of

multinational agencies. However, barriers to implementing these improvements may arise at all levels. (K.N.Reddy 1991)

The primary energy sources such as crude oil, natural gas and other conventional fuels are limited. These are formed by geological processes through solar energy accumulation into the earth over millions of years. The technology for utilizing non-conventional energy resources has to undergo further advancement. To cater for, a combination of supply side management (enhancing generation capacity intelligently) with demand side management (i.e., energy management on consumption side through energy conservation programs) is a best possible solution. There is a clear financial as well environmental edge of saving one unit in comparison to its production. Knowing the importance of energy conservation both developed and developing countries have to consider new measures to take maximum advantage of it. Energy conservation can be defined as an approach applied to energy consumption without compromising quality of life. Energy conservation will not only save huge foreign investment but will help allot in boosting the economy of the nations. (AnwarAl-Mofleh 2009)

In fact in such a situation we need to have supply as well as demand side management, simultaneously. Meaning that on one side we must consider addition of power supplies, but as a priority option first we have to go for energy efficiency and conservation so that the existing resources can be utilized optimally. Demand-side management options such as the use of energy-efficient appliances and practices would not require large investments on the part of the users. However, if a country needs to introduce such programs, it involves many steps, ranging from developing and implementing relevant policies and regulations to arranging financing mechanisms mostly through financial intermediaries. In most cases, however, the benefits of demand-side interventions are substantial and immediate and therefore more attractive if appropriate financing mechanisms are in place.

Thus energy conservation comes under short term planning that is what can be contributed on immediate basis. And this is in fact the most feasible part of the solution in all aspects whether it is time, cost or its adverse effect on our environment.

SAARC Member States not being an exception, mainly dependent on imported oil, are more desirous to efficiently manage their energy supplies. Although some of the Member States such as India, Sri Lanka and Pakistan are relatively at some advance stage to look after Energy Conservation and Efficiency measures by developing policies, independent institutions, appliances standardization etc., yet there is lot to go to achieve the desired goals. Also they have to take other Member States along with them who are putting their effort and keen to improve their energy consumption. This report will try to evaluate existing status of SAARC Member States in their efforts towards energy conservation and efficiency and to compare it with the advance world.

1.2 Objective of the study

The objective of the study is to highlight and compare available Energy Efficiency policies and standards adopted by the SAARC Member States with the developed world and suggest appropriate measures for the effective uplift their policies being successfully adopted by advanced countries.

1.3 Scope of the Study

Present study is an in house initiative with major focus on Energy Conservation policies and techniques with in SAARC Member States with respect to domestic sector only. Technical standards are also limited to appliances standardization and labeling schemes for domestic appliances.

It will cover existing and prospective issues & barriers that SAARC Member States may face in its way to energy efficiency. And to overcome these issues & barriers, solutions are proposed, for end user, producers, regulators and policy makers.

1.4 Methodology

Collection of secondary information and its further analysis was the basic methodology adopted to carry out this study. To the possible level, published reports, research articles

and energy data sources were mainly focused for collection of secondary information. Information was also collected through contacting representatives of different stakeholders, relevant government departments and partners in the Member States, energy efficiency researchers and service providers. Whereas most of the information, data and policies for the advanced world was taken from relevant agencies of those countries through internet, while a huge information was also available through scholarly articles that was considered in compiling this report. The author thoroughly reviewed gathered information and data, complied it in a uniform manner and self-analyzed on apple to apple basis for the gap assessment and way forward.

1.5 Limitation

Although this report has reached its aims, there were some unavoidable limitations. First of all the scope of Energy Efficiency is very vast and it would have never been possible to cover each of its roots being spread in every sector of the economy with in the available time rage. Second most of the updated information and data related to SAARC Member States was not available on internet, reports or scholarly articles that needed to be collected from the relevant agencies for each Member State. So collection of data with only resources such as phone, email and that form eight different Member States was not that easy.

1.6 Energy Efficiency – An Important Issue

The energy sector is globally facing huge challenges and the situation is even continuously worsening on daily basis. There are many new technologies and variety of measures for energy efficiency available all over the world, but the major problem is to identify ones that are proven to be the reliable and more effective in long run.

With the threat of global warming and the highly unpredictability with regard to future energy prices, energy efficiency has gained lot of priority in political discussions in many countries, especially importance of the energy efficiency in domestic sector. Per capita domestic energy use in the advanced world such as that of Europe has a declining trend,

partially due to energy efficiency improvements, whereas energy consumption and associated GHG emissions are expected to continue to rise from the domestic sector in most of the South Asia. Some of the major of causes for this includes high population growth rate, decline in joint family systems, interest for the indoor comfort etc. Several strategies such as reducing energy demand and increase in energy efficiency are highly important to bring in a change in energy consumption and its impacts of climate.

1.7 Definition and Scope of Energy Efficiency

Normally to reduce energy use, two types of approaches are used: 'energy conservation' and 'energy efficiency'. In policy debates, these terms are often used interchangeably yet both of these terms are very different (Herring, 1996). "Energy conservation is usually meant to reduce energy consumption through lower quality of energy services", such as: reducing domestic heating temperatures; Reducing speed limit of vehicle ; Capacity or consumption limits for appliances, met through some standards. Commonly it is considered as "doing with less, or even without, to save money or energy".

Whereas "Energy efficiency is simply the ratio of energy services out to energy input". Meaning that; taking out maximum of every single unit of energy that is produced or consumed. Typically it can be termed as up gradation process of technology caused by replacing old equipment with the newer having more efficient technologies and designs. Usually it is a produce of other social targets including comfort, productivity, financial savings, or fuel competition. On macro level measuring energy efficiency, is difficult task and it is very hard to quantify with time, and among sectors or countries.

Contradictory to the common perception, price of (products) fall with improvement in its energy efficiency, and hence stimulates consumption (Boardman 2014).

The significant upgrades in energy efficiency have been assimilated into increasingly and bigger products. At one point, we have to realize that ever higher standards of living are limiting our ability to control climate change, hence reducing our future quality of life. Similarly with domestic electrical and electronic appliances; The more they get efficient the larger quantities of these products are owned (e.g. more than one TVs per

household), thus overall total energy consumption increases. For instance, electricity consumption of domestic appliances and home electronics in UK has doubled during 1972 and 2002 (EST 2006).

1.8 Energy Efficiency – Measures and Policies

At individual level any decision related to cost, concerning energy efficiency, is usually based on a prioritizing the choice between the immediate cost and the possible future reduction in energy expenses due to improved energy efficiency. Fate of energy efficient solutions are always connected with the energy price, existing or expected, higher prices are always attractive.

From the energy efficiency viewpoint; to make a "good" decision for investment in domestic appliances or industrial equipment, a strong economic rationale is the most important yard stick.

In a free market economy, having deregulated prices of energy to end consumers, normally the prices should reflect the supply costs. However, due to many reasons, the prices usually reflect only a portion of the overall costs of energy. Almost none or negligible environmental external costs and long run marginal development costs are included.

Thus while purchasing appliances or making an energy efficient investment, the decision made by final consumers usually do not reflect the move towards global economic optimization, creating a gap between the actual accomplishments in energy efficiency and the achievements through an accurate price accounting system for all involved costs.

Often governments use taxation to decrease or suppress price fluctuations at the consumer level. So in that context, taxation always complements energy efficiency policies and measures. Though it is merely just a constituent of these policies and measures due to its much wider socio-economic aspects, but it surely determines the effectiveness of policies and measures.

Clear price indicators alone are not enough to attain a rationalization of energy usage. In fact to remove the usual barriers to energy efficiency, certain conditions are needed and to develop and structure the market for efficient equipment and devices:

- Efficient appliances and production equipment should be available;
- Good information for consumers about these appliances and equipment should be available; and,
- When necessary the availability of technical, commercial and financial services should be available.

In free market economy, Policy measures are therefore necessary to strengthen the role of energy prices; mainly to develop suitable market conditions for efficient equipment, and also to drive consumer choice towards the most cost effective solutions. They also aim at lessening the accepted failures in market mechanisms.

To justify the implementation of policy measures often three major causes of failures in market mechanisms are referred:

- Either the information is completely missing or partially, and cannot be provided at suitable cost;
- For energy efficiency investments such as in buildings, appliances, equipment, etc., decision-makers are not necessarily the actual users who are supposed to pay the cooling or heating bills: hence the overall energy service cost is not visible to the market;
- Financial limitations that the individual consumers faces are usually much severe than what is actually national discount rates or interest rates (long term) reveals, that makes short term profitability a preferred choice. This mostly forces consumers for more focus on the immediate cost of appliances and equipment, hence leading to less beneficial decision of selecting efficient appliances and equipment.

Therefore it is necessary that energy efficiency policies and measures (“non-price measures”) should balance the role of prices. One of the major aims of energy efficiency

measures is to create a favorable environment to speed up the development and the implementation of market efficient appliances and equipment, through:

- Complete awareness and education of end consumers;
- Producer's and distributor's Risk sharing;
- Research & Development in the field of energy efficiency;
- Dissemination of technology and expertise in the field of energy efficiency;
- Implementation of special financing models;
- Regulation for consumers and of appliances, devices and equipment.

Hence "Energy efficiency policy" should be considered in a broader aspect. It must include all public intrusions ("policy measures") targeting through appropriate pricing, institutional mechanism, regulation and economic or financial incentives.

1.9 Assessing Energy Efficiency Policies and Measures

Policies and measures for implementation of energy efficiency are not open. Irrespective of policy configuration and application plan, irrespective of the measures to be taken, there is always a cost to the taxpayer.

As a thumb rule, if the macroeconomic benefits of enhanced energy efficiency are accomplished with these policies and measures, offset the overall cost to the taxpayers; such energy efficiency policies and measures are considered as economically sound. The policies and measures can be termed more attractive and effective if the difference between the benefit and the cost is higher.

In order to ensure that public resources are effectively used, evaluation of energy efficiency policies and measures is highly important. The evaluation of energy efficiency policies can be done at two levels:

- In perspective of taxpayer: public resources engaged in the policies and measures.
- In perspective of macro-economic: the benefit that comes through real development in energy efficiency accomplished with the policies and measures.

At macro level tracking of energy efficiency is not that easy. From an engineering point of view, insulating a building makes it quite energy efficient by providing more comfort against lower energy consumption. But this individual intervention at micro level has no prominent contribution or visibility at macro until the whole lot of houses brings such technical improvements and majority of the appliances are improved or replaced with efficient ones. Similarly the same applies for industry.

Evaluating energy efficiency equally refers quantifying collective impact of all the interventions at the micro-level on the progress of energy utilization. From policy aspect, it is never expected to assess impact of each building or industrial unit; rather it expects an overall estimation or measurement of such micro-level improvements that would possibly contribute to the actual improvement in the sector wise energy consumption, and of course at national level.

1.10 Appliance Standardization and Labeling Schemes

Energy efficiency in appliances and labeling programs are usually considered as combination of two separate techniques, energy efficiency standards and energy efficiency labels. They can be used separately as well.

Irrespective of the format and design of the labels, they are always intended for the awareness/ information of the consumer to have choice while purchasing any appliance. Different approaches like product comparisons, energy consumption, certifications, and endorsements, could be considered in designing labels. Labels may not ensure the level of efficiency of an appliance; rather, such programs facilitate consumers in providing comparative information regarding energy efficiency and lifecycle cost, so they may opt to buy energy efficient appliances.

Whereas in case of “energy efficiency standards”; specific minimum energy performance conditions are set to be met by appliances and/ or categories of appliances. Implementation of such Appliances standardization and labeling schemes is also broadly distinguished in two categories i.e., voluntary basis and mandatory basis. Depending on several factors, government decides to whether go for voluntary or mandatory basis.

Selection of use of labeling scheme or standardization of equipment or to go for a combination; is the first step for the government in making a decision, depending on suitability for the country. While as mentioned earlier, the other decision for policy maker is to choose whether to go for a mandatory or voluntary program. For the successful implementation of such programs, this first step is very highly important. This is critically challenging and is solely dependent on vast authentic and dependable data. The policy maker should ensure availability of sufficient political will and support for plan. Economic & environmental costs and benefits analysis is a must for initiating energy efficiency program for appliances labeling and standardization. In addition assessment of the country's economic, institutional, cultural, and legal capacity is also very important for planning and implementation of such a program. To start with, the policy maker must gather relevant data and assess various available appliances for present and potential efficiency. It is also important to know whether the appliances are produced domestically or would be imported, and what kind of standards are adopted by other countries.

This information along with the understanding of national needs and organizational strength is used to find what minimum range of appliances should the efficiency program be started with, such as lighting, refrigerators, air conditioning etc., which scheme should be opted i.e., labeling or standardization would be best suitable for each product category to be covered. In order to determine the type, scope and stringency of the policy to be devised; the estimated costs and benefits of each approach should be clearly known. This analytical process will result in a decision complete in all aspects to select a program considering all possible prerequisites, allied supporting tools, possible consequences and prospective benefits (social and economic).

1.11 Potential for Energy Efficiency in the SAARC Region

The countries of South Asia are very much dependent on oil imports. Taking example of India, being the larger SAARC Member State, is globally third biggest importer of crude oil, after the U.S and China. Whereas regionally it's the largest oil importer, followed by Pakistan and Bangladesh. This demonstrates the huge potential for bringing

improvement in the efficiency of energy usage, in the entire region. Some of the potential areas that can be approached at regional level for energy savings could be:

- Regional energy efficiency standards for appliances e.g., for lighting, fans, refrigerators, air conditioners etc.,;
- Promoting and incentivizing renewable energy resources, and sharing technologies for tapping renewable energies
- Immediate action is needed for introduction of electric vehicles; promote the necessary research and development; set targets and devise incentivized plans for better deployment of these vehicles.
- Energy, food and water conservation through awareness campaigns.

Initiation of these measures could not only result in significant in oil imports reductions, but will enhance overall energy security situation in the region. Other potential benefits include the reutilization of these savings in alternative social sectors such as education, health etc.

2. ENERGY EFFICIENCY TRENDS

Nations across the globe are getting clearer about the pressing need to transform the pattern of energy usage. There are high concerns regarding energy security, the socio-economic impacts of elevated energy prices and raising issues of global warming have forced many nations to have more focus on devising policies and measures that encourages and endorse energy efficiency. It is now very clear that to ensure best utilization of world energy resources, such policies are needed that encompass a vast variety of options. Globally it is accepted that to achieve this target energy efficiency improvement is considered the proven easy, economic and viable option.

To devise and sustain comprehensive policies needs the availability of reliable, authentic and timely complete data that represents the distinctive features of the resources available and the economic activity in each country.

In past countries have been using the data of energy balances as a source of estimating source wise and sector wise energy consumption and as a mean to develop cumulative indicators (e.g., total per capita energy consumption). Cumulative indicators have the benefit that often they are easily available and even in wide range. Thus, in simple terms they tell us high-level developments in energy consumption patterns. Important point to note here is that if they are used incongruously, can generate misleading results, that's why their effectiveness is limited.

As varying underlying factors influences each major sector, depending on the sector evaluated, variety of clarifying data will be required. These data are usually not covered in energy balances and presently only available for a few countries. Thus, detailed data would be needed for end-use sectors if to establish estimates of overall energy efficiency.

It is not that easy and straightforward to develop state-of-the-art indicators, and it also requires human and financial resources to gather detailed data, and investigate the information. Many countries' recent struggle to collect further detailed end use data was very useful to create indicators for energy efficiency that helped in provision of significant information for understanding historic trends, measuring potential for saving

of energy and improving energy efficiency policies. However, there is lot more to do in this regard. The development of complete range of these detailed indicators won't be that easy to be done with in a span of few years. To build on the expertise that will be gained, it is vital for nations to set sector wise priorities – or segment wise priorities should be set.

2.1 Energy Efficiency Indicators

To analyze interactions between economic and social activities, energy consumption and CO_2 emissions, Energy indicators are considered an important instrument. Energy Efficiency Indicators not only guide us regarding trends in historic energy consumption, but also help policy makers, model and project future energy demand. In simple words Energy Efficiency Indicators, identifies potential areas for energy savings.

From energy policy perspective it is important to know that to what level improvements in energy efficiency could bring changes in "final energy intensity" in various countries. In order to estimate the effect of energy efficiency, it is important to distinct the impact of changes in several external factors that could influence energy demand with changes in energy intensities (which are a substitute for energy efficiency) such as the individual activity, economic structure etc. This can be achieved through decomposition approach which isolates and measures the effects of the different factors of changes in the activity, structure and energy intensities on sector wise and national level final consumption of energy.

Energy intensity is termed "as the energy consumed per activity or output for sub-sectors and end uses". Energy intensity is usually calculated in terms of energy consumed divided by an economic indicator such as GDP, exchange rate. Energy Efficiency impacts can be covered by changes in such non energy factors, thus substituting energy intensity for energy efficiency can produce misleading results.

Energy intensity as an indicator of energy efficiency:

Energy intensity is “a measure of the amount of energy used to produce a unit of output”. For any economic sector or process, if statistical data is available, energy intensity can be estimated. Variations in energy intensity (primary) are governed by enhancements in energy efficiency and also variations in economic structure, e.g., if economic activity moves away from high energy intensive industry to service sectors which is less energy intensive. Therefore declines in energy intensity can’t be considered as the only indication for improvements energy efficiency.

Development of Indicator using final demand: Indicators for energy efficiency should be developed by using final demand for energy. To represent energy efficiency improvements accurately, calculations for the development of indicators should be carried out at the best possible disaggregated end use level.

Since public can’t make any impact in terms of efficiency for primary energy conversion, that’s why the main focus of energy efficiency indicators is always on final energy demand. Yes in case to calculate efficiency of overall energy system, if resources and more importantly data is available, then there is significance of developing efficiency indicators for primary energy.

Similarly for CO_2 emissions associated with energy, indicators may be developed for primary as well as final energy consumption at the same time. It is always possible to develop CO_2 emission indicators for each level if data related to energy consumption is available by that source.

In order to develop energy efficiency indicators, countries should prioritize their high energy intensive sectors or opt for indicators that could help them to target specific priorities in policy. In case of less or no data available for highly energy consuming sector, then prioritize that end use sector for which some useful efficiency indicators can be calculated.

As mentioned earlier, ratio of energy consumption to GDP is defined as the most comprehensive indicator. Other indicators could be defined as the energy intensity of every key sector based on energy consumption. It is always helpful to use energy

consumption divided by both physical and monetary units, as per key drivers of that sector.

Indicators collectively give us a broader idea that what could be the causes behind energy consumption trends in a sector. Yet, further information is needed about key drivers of energy consumption how to provide analysis input for policy about influencing these trends.

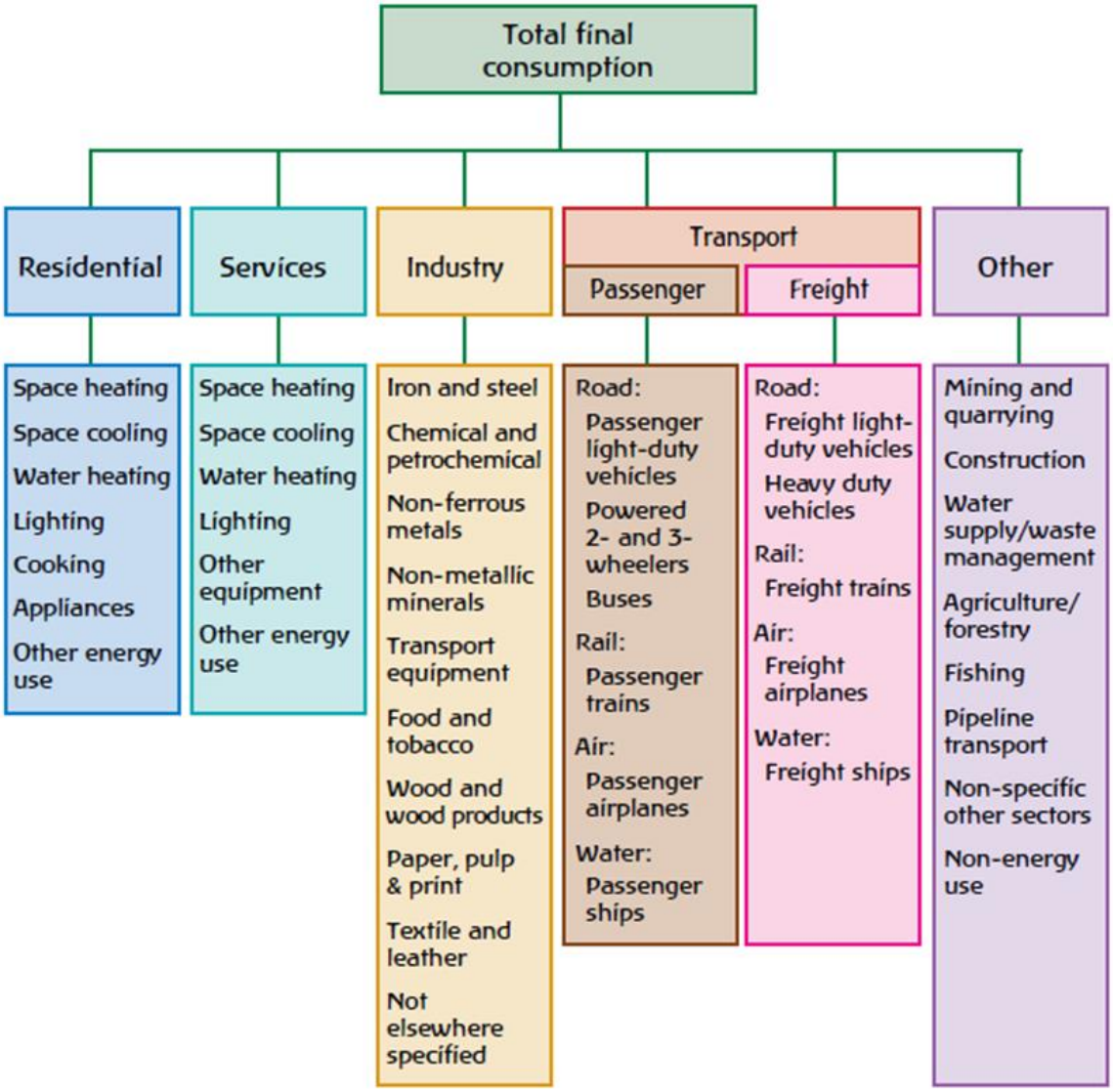


Figure 1 Indicator approach for Decomposition of sectors, sub sectors and final usage

End user behavior & energy efficiency: Role of the human behavior on energy consumption can supplement and magnify technological energy savings. Smart behaviors to conserve energy, smart choices and practices can be a substantial opportunity to tap additional sources of energy savings in sustainable manner. Human aspect of energy efficiency can supplement technological effort to fill the gap that exists between potential and actual levels of efficiency. Otherwise, it can be considered that negative behavioral factors cancel out saving accomplished through technical improvements.

Various research shows that the potential for energy savings through behavior based on the type of these behavioral changes are estimated in the range of 20% to 30%. Even some researchers claim that that behavioral changes having negligible or zero cost, cut energy consumption up to fifty percent. Just take an example, consumer mostly opt for the most efficient appliance if informed properly.

2.2 Indicators for the Domestic Sector

The domestic sector comprises of activities related to residential buildings such as apartments and houses covering all energy consuming such as lighting, space cooling and heating, cooking, water heating and the use of various appliances.

Energy usage trends in the domestic sector are governed by variety of factors, covering energy mix, change in population, overall energy efficiency improvements, rate of urbanization, number and sizes of dwellings, occupants per household, type of dwelling, building characteristics and age profile, income class and growth, consumer preferences and behavior, climatic conditions, energy availability, penetration rate of appliances, etc. In order to elaborate energy consumption trends, generally two main activity variables are picked for the development of energy indicators:

a) Residential floor area (for calculating space heating/ cooling) and

b) Number of occupied residences (for lighting, appliances, and water heating)

However, in order to understand how energy consumption is impacted by these factors individually, it is necessary to identify and pinpoint greatest potential area for reduction in energy consumption that could be prioritized accordingly for the development of energy efficiency policies.

Analytical framework can be defined in various manners for the development of energy efficiency indicators in the domestic sector. The depth of the accuracy is mainly dependent on the available data and the situation of that country, e.g., if a country has similar type of dwellings/ buildings, type wise classification won't be a priority.

Likewise, in some countries a clear classification of rural and urban households would be needed, if there is considerable difference in availability of equipment and fuels. At the same time if in a country same fuel and similar equipment is available in both rural and urban households and having same relative income, this division may not matter. Considering the case of SAARC, in most of the Member States, this difference is mainly about dwelling types between urban and rural household, and/or in fuel type in some cases.

List of most common indicators for domestic sector is given below:

- (Space heating/ cooling)
- Energy consumption/ dwelling (Space heating/ cooling)
- Energy consumption per floor area (Space heating/ cooling)
- Energy consumption/ capita (Water heating)
- Energy consumption/ dwelling (Water heating)
- Energy consumption/ capita (Lighting)
- Energy consumption/ dwelling (Lighting)
- Energy consumption per floor area (Lighting)
- Energy consumption/ capita (Cooking)
- Energy consumption/ dwelling (Cooking)

- Energy consumption/ capita (Appliances)
- Energy consumption/ dwelling (Cooking)
- Energy consumption/ unit appliance

Aggregate domestic energy intensity is the amount of total per capita energy consumption of residential sector, of occupied dwellings or floor-area. Energy consumption calculations against floor area and occupied dwelling are considered better indicators than energy consumption per capita.

3. ENERGY EFFICIENCY POLICIES AND MEASURES IN SAARC REGION

In the present era of world struggling with energy and environmental crises, compared to developed economies, SAARC region stands more vulnerable. Various amenities available to developed economies, such as low price energy and with little environmental effects; developing SAARC region can't avail at the moment. Similarly economic planning is placed on the lower priority. However, keeping in view that SAARC countries are at early stage of economic development, they can comfortably opt and implement efficient technologies and processes. In comparison to any other economic block, SAARC nations are in a better position to encash the benefits of energy efficiency improvement. Regional cooperation can play a vital role in the establishment of low energy intensity of economy in the SAARC region.

3.1 Afghanistan

Sector Assessment

Worldwide, Afghanistan is among the nations with lowest per capita electricity consumption: 100 kilowatt hours (kWh) per person per year. The grid connectivity in the country has also been reported to be very sparse with just 30% of the country connected to the grid. Within the network there is significant suppressed demand at about 2500 MW. This is significant compared to the 750 MW peak demand of the grid reported in 2014. The energy balance in Afghanistan is skewed in favor of energy import (in the form of fuel etc.). Post the Afghan-war the demand in cities has been increasing rapidly.

The installed capacity in the system stood at a little over 500 MW in 2014. The generation mix is shown in the Figure below:

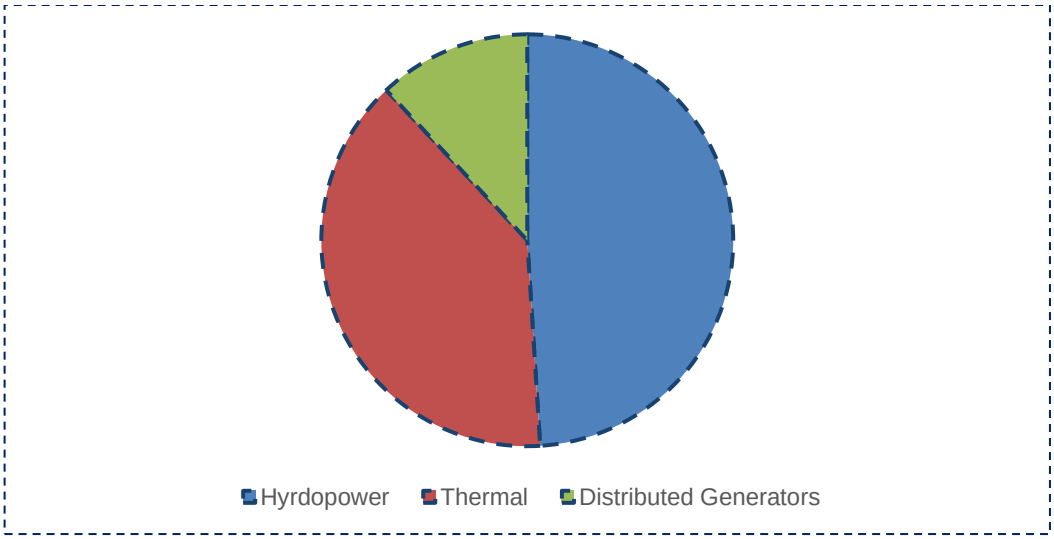


Figure 2 Afghanistan generation mix

There is a rising concern of the energy import bill. In 2014, nearly 97% of the country's oil needs were imported. Future development of hydropower would be dependent on being able to establish water usage treaties with neighbors with whom Afghanistan shares the river resource. It would be pertinent to mention that most of the installed thermal capacity in Afghan network is for emergency use and not for base load as is understood a normal practice in the world. This is due to high fuel costs

Access to electricity remains an issue within Afghanistan. The access is particularly problematic in rural areas where less than 10% of the population has access to electricity while more than 70% of the population is based there. This is also an economic issue as the GDP of the country mainly originates from rural areas (Asian Development Bank, 2015a).

From a renewable energy perspective, Afghanistan has very significant potential. These resources are estimated at:

- More than 20,000 MW of Hydropower potential.
- More than 65,000 MW of wind potential
- More than 200,000 MW of solar potential

Although metrics such as grid reliability have been improving, the frequent load shedding within the country means that increased reliance has to be based on backup generators.

Afghanistan is envisaging the development of its renewable resources along with a mix of conventional fuel power plants to help with energy security and reduce the load shedding problem.

On the side of the electricity grid, the key issue for Afghanistan is its islanded grid which is composed of several grid networks that have not been connected and synchronized. This has created an inherent inflexibility in the means of operation for the grids in these areas. The problems in connecting the network would include aligning the voltage levels and frequency of these networks. As the network is not connected, this also creates higher reserve requirements, failing which the system reliability has suffered. The combination of poor grid connectivity, lower reliability and inadequate generation of the grid in Afghanistan is felt particularly in the rural areas; although the larger cities like Kabul, Kandahar etc., have up to 75% connectivity, in the rural areas this drops to as low as 10%. To alleviate this situation, the Afghan government is looking into collaborating with developmental institutions and partners to extend the distribution network and connect the islanded grids. However, the focus of the distribution expansion is likely to be at the load centers of Afghanistan.

T&D losses in the region are significant and estimated to be around 47% by the ministry of Water and Energy in Afghanistan. The cost of the losses beyond what could be benchmarked as reasonable is in excess of US$70 million a year and this issue has been assessed to be significant for the financial sustainability of the Power Sector of Afghanistan.

The sector's financial sustainability is also impacted significantly by the tariff regime where the average total cost of the electricity service is estimated to be between 13 cents – 22 cents per kWh as opposed to the 8 cents – 12 cents per kWh that is being charged in the tariff. The financial sustainability and the tariff mismatch are also impacted by the risk of new investment in the country driving up the investment cost due the security concerns in the region.

Considering the objectives of this study, it is important to note that Afghanistan's energy end use distribution is quite unique in global context. While industries account for a

majority share in world's energy end use statistics in 2014, this spot is occupied by residential sector (73%) in Afghanistan. It is indicative of an economy, where with favorable global and internal conditions, high rate of growth can be achieved thus a corresponding increase in demand for energy. Energy efficiency thus becomes a priority focus area for policy makers to reduce pressure on scarce energy resources.

According to the Power Sector Master Plan for Afghanistan, (prepared in 2013 by Fichtner funded by ADB) in main load centers average domestic energy consumption is comparatively higher. In Kabul, average residential consumption is slightly above 3000 kWh and in Herat, it is close to 2600 kWh.

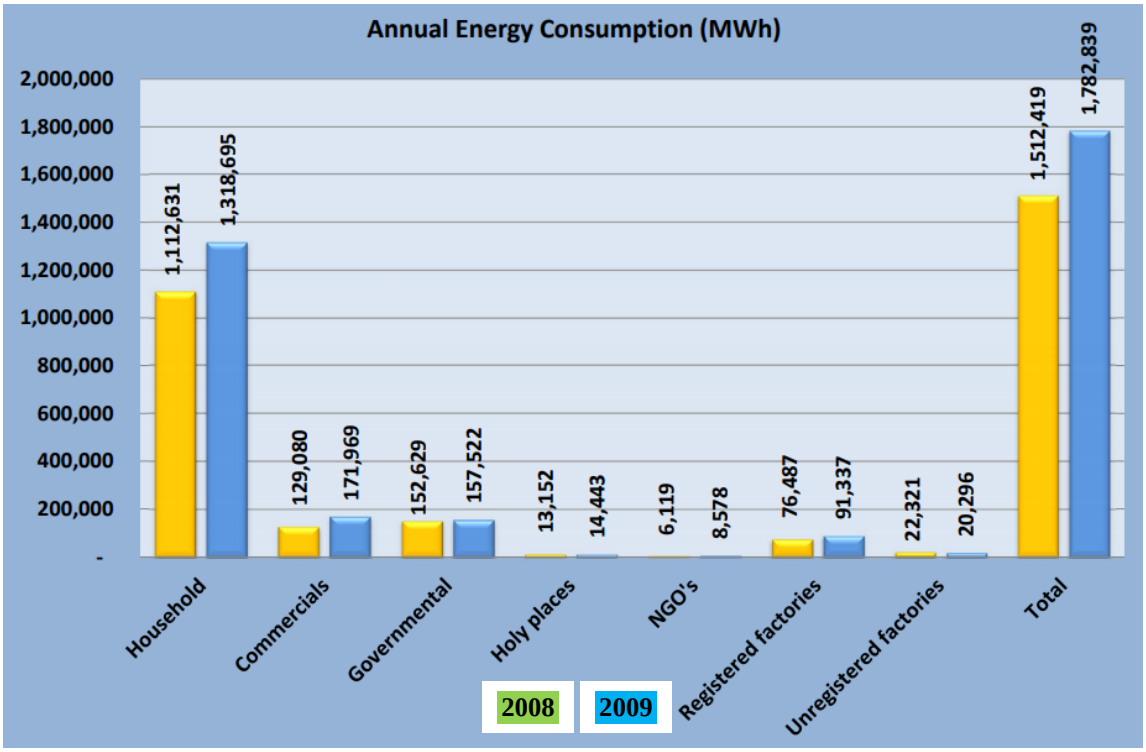


Figure 3 Afghanistan Annual Energy Consumption (MWh)

Institutional Framework

Afghanistan's main government institutions mandated for the development of energy sector are Ministry of Energy and Water (MEW) and Ministry of Rural Rehabilitation and Development (MRRD), each having distinctive mandates. However, time to time they do coordinate with each other. Planning and budgeting of projects is the responsibility of

Ministry of Economy (MOEc) and Ministry of Finance (MOF). Whereas the only state owned utility is Da Afghanistan Breshna Sherkat (DABS). Institutional arrangement in the rural energy sector of Afghanistan is shown in the flowchart below.

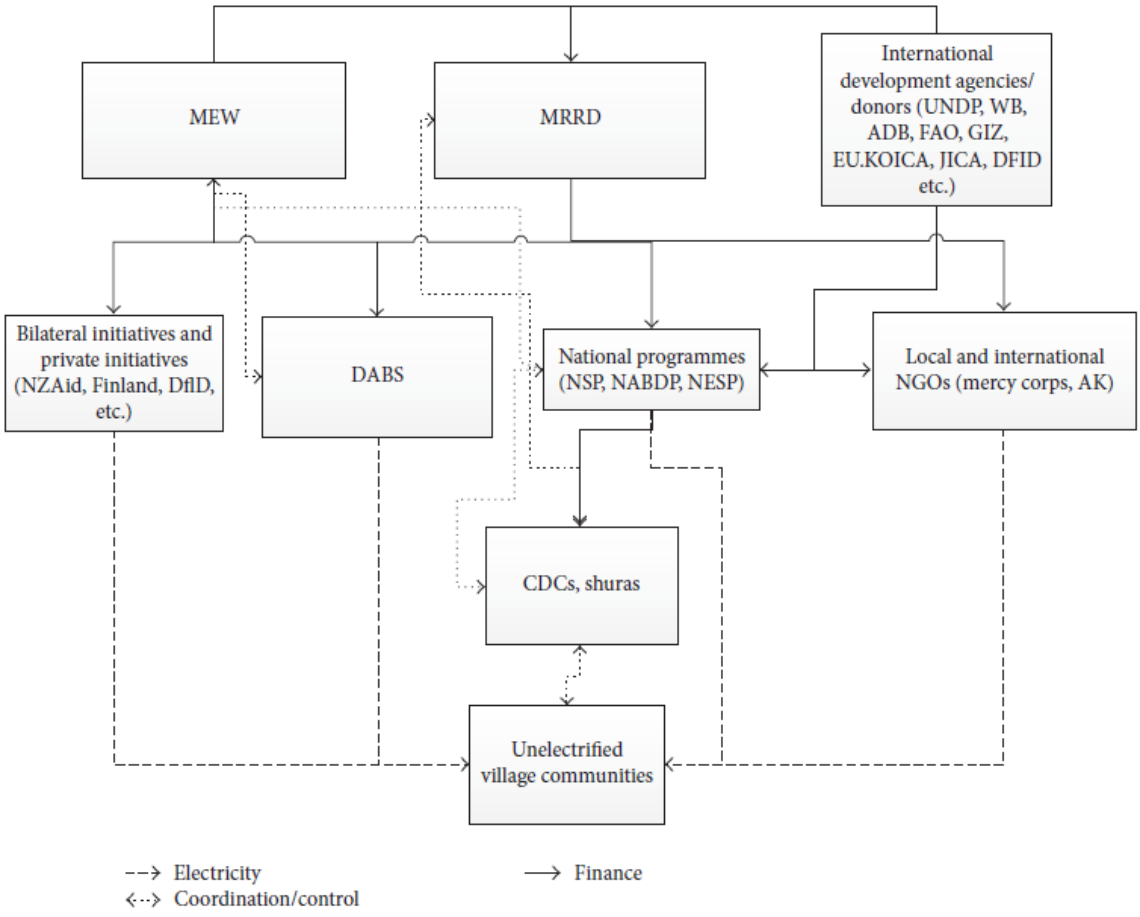


Figure 4 Institutional arrangement of energy sector (UNDP 2014)

Ministry of Energy and Water (MEW), as one of the key ministries to plan and direct the development of energy sector in Afghanistan, is currently looking after the energy efficiency initiatives in Afghanistan. MEW has prepared the Afghanistan Energy Efficiency Policy (AEEP) which aims to provide direction to the energy efficiency related activities in the country.

The Office of Energy Efficiency (OEE), has been proposed to be created in the Ministry of Energy and Water (MEW), will have primary responsibility for strategizing, planning, budgeting and coordinating the implementation of AEEP. A committee headed by deputy minister of MEW and comprising of relevant stakeholders will be responsible of creating

OEE. The OEE will work with a range of public and private sector representative institutions to achieve its objectives and will be developed into an autonomous decision making body on energy efficiency in the long term.

Ministry of Rural Rehabilitation and Development (MRRD) is mandated to develop rural energy services including poverty alleviation and improvement in the livelihood of rural households. However, for projects of district or provincial level i.e., of larger scale that than (1000 kW) as specified in the policies, then MRRD need to coordinates either with MEW and/or with DABS.

Afghanistan's highest decision making body in the energy sector is the Energy Steering Committee (ESC). Currently it is chaired by President's Senior Advisor on Technology and Infrastructure; other members include Ministers of Energy and Water, Mines and Petroleum, Economy, Finance and Inter ministerial Commission for Energy (I.C.E.). I.C.E. was created in 2006 through a presidential decree with the aim to develop coordination between donors and government and to harmonize investment targets in the energy sector. ICE remained very effective in terms of investment and governance of energy sector in Afghanistan, but to lack of fund ICE was closed in June 2012.

Technical and commercial losses

In Afghanistan Technical and commercial losses are very high. If total available gross electricity is compared with the total billed amount, the resultant net demand (billed units) shrinks to around 54 - 55%, and the rest goes as losses. It is logical that such a situation cannot sustain for longer period. DABS, has to find way out to bring these high losses lower. In this regard a target of 13% by 2021 and 10% by 2026 is set for commercial losses, with gradual reduction to reach 8% target for 2032.

Energy Efficiency and Demand Side Management

There should a clear classification among low and high regions in terms of electrification rates. Regions having higher electrification rates, Demand Side Management (DSM) and Energy Efficiency (EE) may help in actual to reduce the generation capacity requirement whereas the regions having low connection rates, DSM & EE measures could be balanced out by increasing number of consumers connected to that generation capacity.

Demand Side Management (DSM)

Reduction or shaving of peak loads to shift consumption from peak to off peak periods; can be achieved by switching consumers that do not have to be operated at a certain point of time to off peak hours either manually or automatically. While in manual way, consumers manage their appliances with preferred operation during off-peak times, while in the automatic or smart grid approach operation of selected appliances is controlled from the grid. In usual approach, different electricity tariffs are offered: a higher tariff for continuous supply and a lower tariff for consumers whom might be disconnected temporarily. The other system is based on a two tariff system model, high relatively high tariff (HT) is charged during peak times i.e., during high electricity demand and a low tariff (LT) during off peak hours.

A load curve for a typical day (23 August) is shown below. The main peak is evident in the evening time, when lights are turned on.

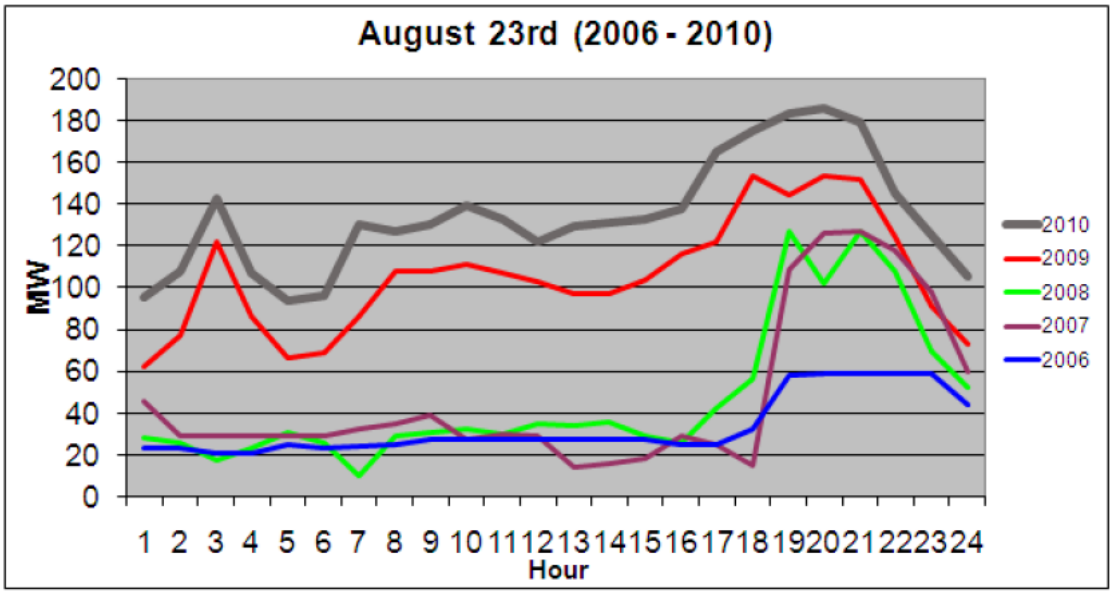


Figure 5 Load curve of a typical day

In Afghanistan, residential consumers dominate electricity consumption, and all of them have quite similar load profile, meaning that, even in regions having higher connection rate, introducing different tariffs may not have any visible impact on the load profile. Sometimes shifting of consumption to the LT period is not possible.

Afghanistan Energy Efficiency Policy 2016

Afghanistan is building its energy sector by integrating energy efficiency practices to reduce losses across entire range of energy value chain starting from mining and extraction, transformation, transmission and distribution and end use sectors.

The energy efficiency policy is a timely initiative that provides a direction to energy efficiency activities in the country by utilizing the collective strength and interdependencies of several stakeholders and government departments. It endeavors to achieve this by creating an enabling environment for the development of the energy efficiency sector in Afghanistan in short term, and facilitate private investment led energy efficiency market in long term.

The salient features of the Afghanistan Energy Efficiency Policy are:

1. It specifies clear goals, objective, strategies and targets to initiate and implement programs and projects applicable to the energy efficiency sector in Afghanistan
2. Within the strategic intent of improving energy efficiency across all sectors, the policy takes a note of importance of public sector demonstrating leadership in adopting energy efficiency practices.
3. It highlights the important role a government has in making energy efficiency practices a mainstream choice for businesses & households through awareness raising, making knowledge accessible, creating regulatory drivers and design of proper financial signals.
4. The Policy mentions the institutional arrangement for its implementation, mechanisms to finance energy efficiency policy and resulting activities as well as the promotion activities which can be used to create awareness and engage stakeholders.
5. It provides guiding principles for executing and managing the energy efficiency activities as a whole, as well as within individual ministries, departments and representatives from private industry

6. The strategic intents and related policy actions have been prioritized for their implementation at short term (TERM 1) and long term (TERM 2) basis, on the basis of its effectiveness and ease to implement
7. A monitoring and evaluation framework has been provided to evaluate effectiveness of institutions engaged in delivering woks resulting from this policy, both at program level, as well at policy level.

3.2 Bangladesh

Sector Assessment

The economy in Bangladesh has been growing at very significant rates with the GDP growth estimated to be over 6% for 2015 and 2016. The success of the power sector in increasing installed capacity is one of the underlying reasons of this growth. However, this rapid economic growth has resulted in significant increase in the electricity demand of the country. Although, as of 2014 the installed capacity of the country stood at above 11,000 MW compared to a peak demand of around 7,700 MW, the country has faced chronic power outages due to the actual deliver capability of the generation system being considerably lower due to the condition of the generation equipment being classified as relatively poor (Asian Development Bank, 2015b). The energy mix of the country is as follows:

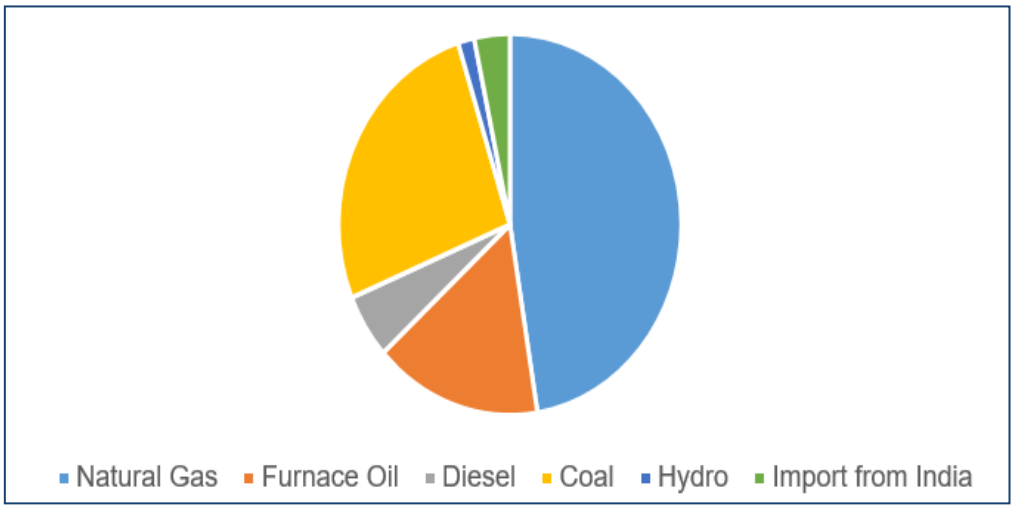


Figure 6 Bangladesh energy mix (Asian Development Bank, 2015b)

The country suffers from limited electrification of the country with the only 70% of the country being electrified as of 2015. Increasing access to electricity is one of the major policy aims of the country with significant requirement in transmission and distribution infrastructure required to enable it. According to the Seventh Five Year Plan for Bangladesh, the future power sector requirements have been envisioned as:

Table 1 Future power requirement of Bangladesh (Seventh Five Year Plan)

Financial Year	Public Sector (MW)	Private Sector (MW)	Total (MW)
2016	334	1271	937
2017	738	3337	2599
2018	867	1943	1076
2019	1716	3036	1320
2020	1247	2997	1750
Total	4902	12584	7682

Tariff regime in the country, given the high penetration of imported fuels in the energy generation mix, has not progressed to the point where entire cost recoveries are being done. Although in recent years, evidence was found that the tariff related regulation in the country was improving. However, increase in tariff remains a politically sensitive subject.

As a heavy gas user with marginal oil resources, Bangladesh has a structural need for energy efficiency. Even if the per capita energy consumption in commercial sector is only 8% of the global average (2% of US, and 3% of that-of Europe and Japan), 57 million people currently live without basic electricity services, representing a large, untapped consumer demand for electricity services on an already stressed power sector

Bangladeshi Parliament in May 2012 established the “Sustainable & Renewable Energy Development Authority” (SREDA) being a national nodal organization to promote demand side energy efficiency and conservation on national level.

The Government of Bangladesh targets to improve energy intensity by 20% in 2030 as compared to the level in 2013: It is expected that a total of 95 million toe (worth BDT 768 billion) would be saved during this period.

Three Energy Efficiency & Conservation programs will be promoted under EE&C Master Plan, including, Energy Management Program, Appliances Labeling Program and Energy Efficiency Buildings Program. Large energy consuming entities, residential, commercial and industrial sectors will be targeted. A total of 5.3 Mtoe/ year i.e., energy savings of approximately BDT 100 billion/ year is expected to achieved during 2015 and 2030, with the implementation of the these Programs.

Additionally, for the awareness of power end users and enhance their investments in Energy Efficiency products, the Government of Bangladesh considers it very important to provide Energy Efficiency Finance Program. Financial incentives such as interest loans, preferential tax and subsidies shall be provided to reduce financial burden on end users to purchase energy efficient electric appliances and industrial equipment (Bangladesh, Energy Efficiency and Conservation Master Plan, 2015).

EE (Energy Efficiency) Labeling Program

With the boost of economy, the number of home appliance, purchased by people will surely increase in future. To achieve the Energy Efficiency & Conservation target by 2030, average efficiency of each home appliance is expected to increase 20-30%. To promote Energy Efficiency and Conservation in residential sector, this labeling program is one of the most effective measures. Diffusion of highly efficient appliances contributes a lot in reducing energy consumption (kWh) and also to electricity demand.

Figure 7 Bangladesh Energy Efficiency Appliances Label

Initially Labeling Programs are started as voluntary program, since mandatory program needs complete provision of efficiency testing services. It requires long time and funds for the administration of EE&C to provide testing facilities. For voluntary program, manufacturers and importers join the program on voluntary basis, either they sue their in-house laboratories or they outsource to some external laboratories.

Energy Efficiency Building Program

Energy consumption in buildings is also increasing rapidly in Bangladesh. Especially new construction of buildings is rapid in city area. This calls for adoption and implementation of counter measures to address this issue. Bangladesh National Building Code (BNBC) has been revised and is in the process of publishing by Ministry of Housing and Public Works that will cover energy conservation in buildings too. It is the core program to promote energy efficient buildings.

Energy Efficiency & Conservation measures for buildings include:

- Insulation measure to reduce incoming heat into a building such as thermal insulation, control air leakages of doors/ windows etc.
- Introducing energy efficiency appliances and equipment for buildings
- Use and maintain building and building equipment in effective and efficient manner

However, there is huge potential for EE & C in all sectors of the economy for effective and rational use of energy, and to implement EE & C measures in Bangladesh.

Programs for Financial Incentive in EE & C

To promote EE&C policies and culture, financial support is a key element. It encourages public to apply EE & C tools into their houses, business and industries.

By definition financial incentives, are monetary rewards to motivate general public behavior to implement a project and to hence achieve targeted objectives. Also, in general financial incentives always had good effects to raise awareness among masses in implementing EE & C. Financial incentives are always considered to have a positive economic impact that helps governments in adaptation of a market based pricing system.

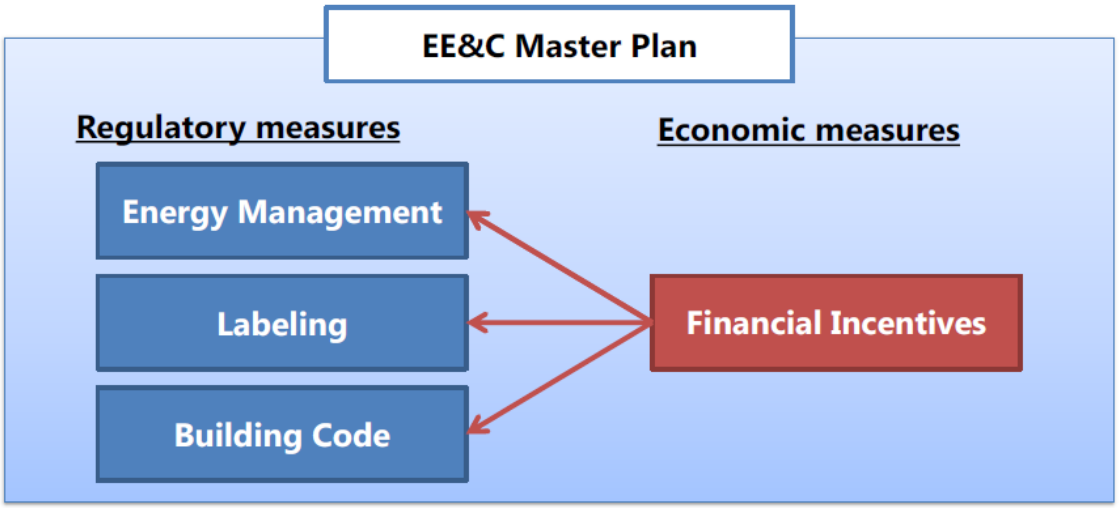


Figure 8 EE&C Policies and Financial Support/ Incentives

3.3 Bhutan

Sector Assessment

The energy sector situation in Bhutan has been improving over the past decade with the strengthening of the institutional arrangements in the power sector. Bhutan is the only country in South-Asia in which the generation capacity is nearly in surplus.

Energy plays a unique role in Bhutan's economy in the context that the contribution of the energy sector has been quite significant. It has accounted for:

- Up to 40% of government revenue
- 45% of export earnings generated by Bhutan through export of electricity to India
- 25% of the GDP

The energy balance scenario of Bhutan is shown in the figure below:

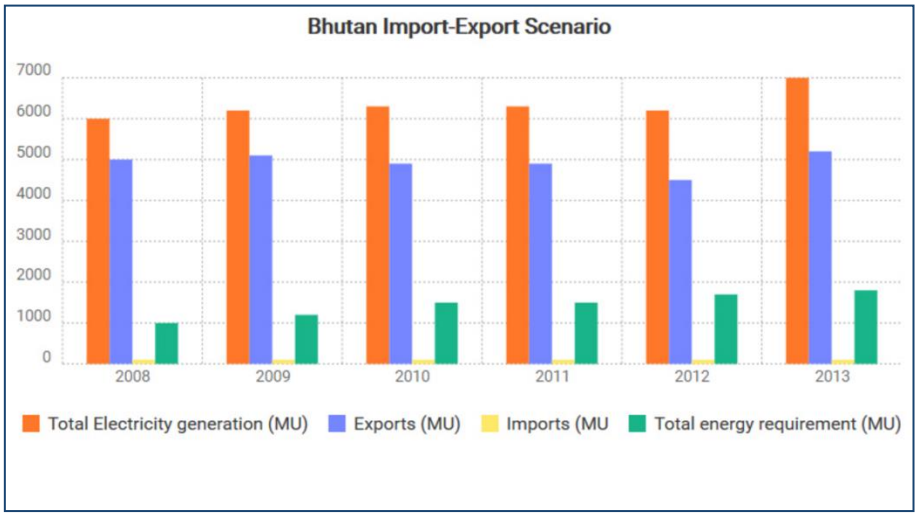


Figure 9 Bhutan Import-Export Scenario (SARI)

Hydropower exports have been playing a significant role in the economic growth of the country; the GDP growth rate between 2003 and 2012 was a very significant 14.5% annually on average. With increased economic growth, the income level of the local population has also increased. This has consequently resulted in improved living conditions and therefore increased electricity demand in the country.

Understanding the actual constraints and real challenges of the energy sector in Bhutan requires looking at the difference of the load profiles during different periods of the year. The Power Generation sector in Bhutan relies almost exclusively on hydropower. The Hydro power resources are run of the river type resources without having storage capability. The power station output varies significantly between seasons and during winter when the rivers dry up and the power output drops significantly. This creates huge mismatch between the indigenous generation capabilities of Bhutan with the local demand. Currently the measures used to compensate for this drop in electricity output include:

- Curtailing power to industries in the winter
- Importing electricity from India in the winter

However, as India grapples with its own electricity shortages, this may become a problem in the future as Bhutan may not be able to import electricity for its needs (Asian Development Bank, 2014b).

Bhutan's Power Sector has been undergoing institutional change along several fronts. Previously, the power sector was managed by the government through civil service rules and regulations. A shift away from this bureaucratic structure happened in 2002 with the formation of the Bhutan Power Company. This institutional reform along with the corporatization of the sector has allowed the Bhutanese Power Sector to deliver results in areas such as electrification etc. that would not have been difficult to achieve otherwise.

The institutional reform and overall corporatization has also been coupled with the tariff reform of the sector. Increased emphasis has been placed on achieving cost recovery benchmarks in the country as well as ensuring that there is an adequate return on investments made in the power sector to ensure a more financially sustainable development in the sector. This resulted in understanding that the actual cost of electricity supplied to the various consumer categories within the country as well as implementing a tariff regime that allows for appropriate cost recoveries.

From a financing perspective, the financial position of the energy sector in Bhutan is relatively healthy. The energy companies operating in Bhutan including the Bhutan Power Corporation (BPC), the domestic power supply provider, and the Druk Green Power Company (DGPC), which is responsible for the hydropower projects, have been both profitable. It is important to note that the sector has achieved adequate self-finance and debt servicing capabilities.

Bhutan currently has an ambitious electrification program aiming to achieve hundred percent electrification of the country by 2020. The majority of the electrification programme has been undertaken through grid extensions. The cost of this program has been economically efficient; however as the programme is extended to more far flung and remote rural areas the cost of grid extensions is expected to rise.

Bhutan's extensive hydropower potential has been mapped to be 30,000 MW of which nearly 80% is deemed to be feasible from a techno-economic perspective. The T&D losses are reported to be around 9.25% (Ministry of Economic Affairs, 2015). Bhutan envisions deployment of 10, 000 MW of hydropower generation.

The government recognizes that the overall supply situation in Bhutan is skewed heavily towards hydropower and that long-term energy security requires thinking along the lines of fuel diversification. These views were reflected in the 2013 Alternative Renewable Energy Policy developed by the Government for Bhutan. The key objectives of the policy include:

- Diversifying the energy resource mix leading to increased long term energy security
- Reduction of fossil fuel imports
- Reduction of greenhouse gas emissions
- Stimulating social and economic development – this is envisioned to be done via a combination of attracting power sector participation and governmental interventions

The government is planning to diversify the fuel mix using wind, solar, biomass as well as micro hydropower based power systems.

3.4 India

Sector Assessment

The power generation industry in India has grown from a level of about 1700 MWs of installed capacity in 1950 to about 65,000 MWs in 1991 when private ownership was given a fillip, then to about 1,12,000 MWs when power generation was de-licensed in 2003. As of June 2016, India's total installed generation capacity (grid-connected utilities) was of the order of 3, 03, 000 MW.

The private sector's contribution in India's power generation capacity as of June 2016 is 41%, followed by State sector (34%) and Central Sector (25%). This increase in

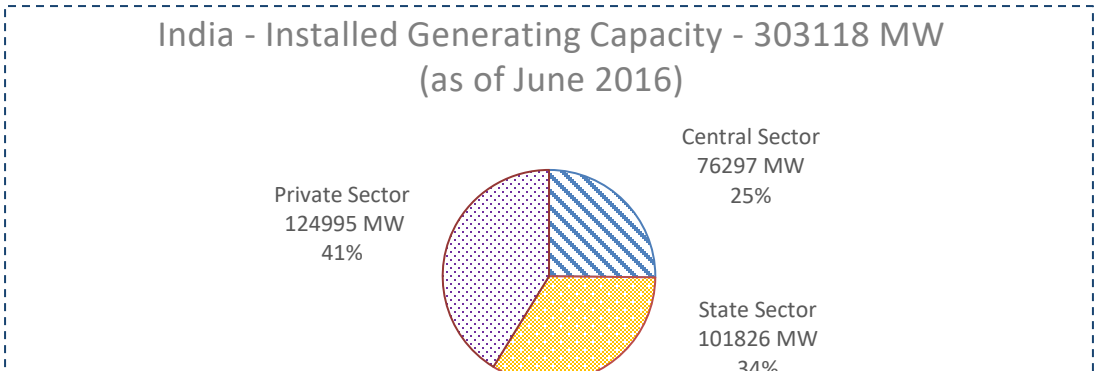


Figure 10 India Installed Power Generation Capacity - Ownership-wise – as of June 2016 (CEA)

contribution from private sector has been because of various policy initiatives taken by the Government and increased investor interest. This includes the Mega Power Policy introduced in 1998, the Electricity Regulatory Commissions Act in 1998, the Electricity Act 2003 and the Tariff Policy.

Majority of the power generation capacity in India is coal-based, followed by hydro and renewables.

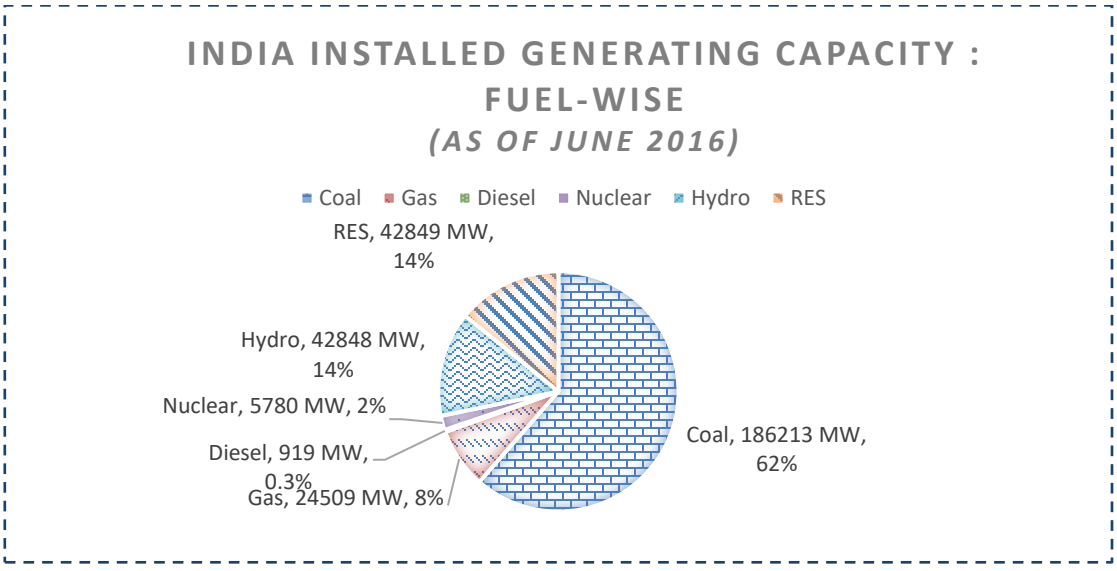


Figure 11 Installed Power Generation Capacity - Fuel-wise – as of June 2016 (MoP, CEA)

The Electricity Act 2003 replaced the Electricity Act 1910, Electricity Supply Act 1948, and Electricity Regulatory Commission Act 1998. It had three clear objectives:

- To introduce Competition
- Protect interest of consumers
- Provision of power to all

For the power generation industry, the key change facilitated by the Electricity Act was to de-licence power generation. This led to substantial investments from the private sector. The Electricity Act also formally recognised power trading as a licenced activity, giving a further fillip to increased power generation through creation of a power market.

The following chart illustrates the structure of power industry of India:

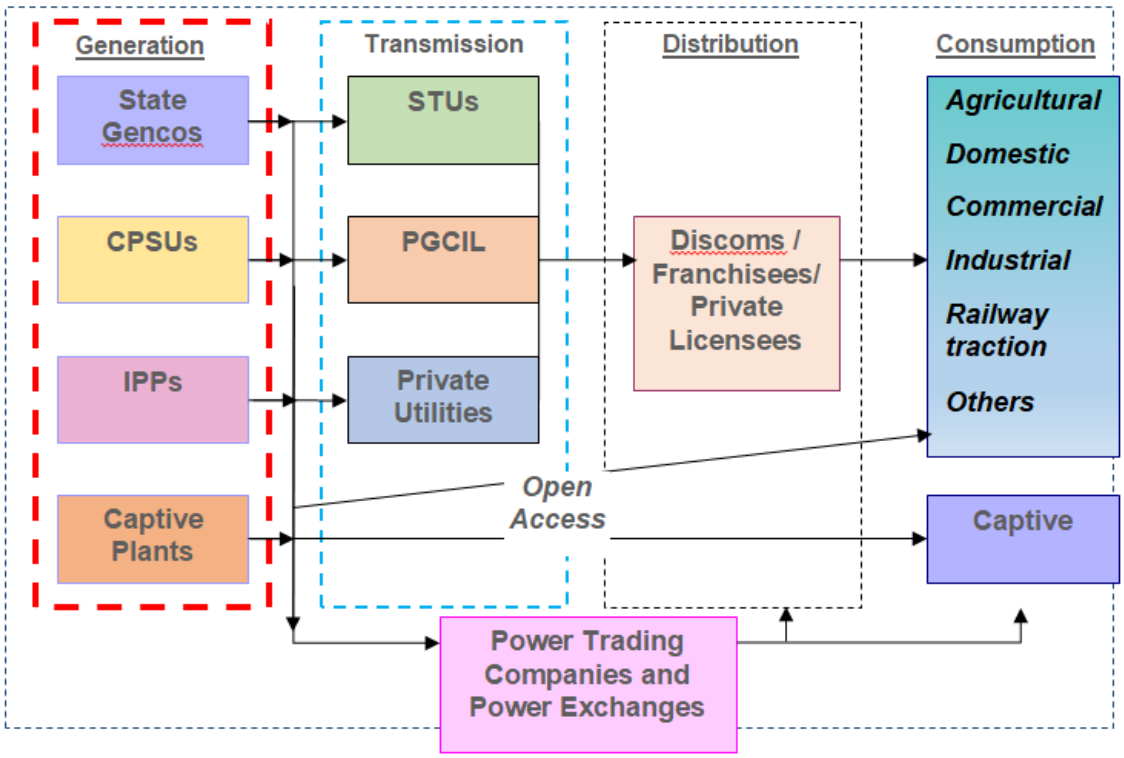


Figure 12 Structure of the Indian power industry

State Gencos: State Government owned Generation Companies

CPSUs: Central Public Sector Units-Central Government owned Generation Companies

IPPs: Independent Power Producers

STUs: State Government owned Transmission Utilities (intra-State lines)

Discoms: Distribution Companies (State Government owned and privately owned)

PGCIL: Power Grid Corporation of India Limited - Central Government owned Transmission Utility (Inter-State lines)

The Growing Trust towards RES Sources in the Energy Mix: The growing share of renewables in the energy mix and a decrease in fossil fuel consumption appears to be an almost certain trend in India, as it is in most parts of the world.

The current installed capacity of renewables in India includes 6560 MW of Solar PV, 200 MW of Solar Thermal, 4270 MW of small hydro, 26,800 MW of wind power. 4830 MW of biomass and about 115 MW of Waste to Energy, thus totalling to about 43000 MW. The capacity with intermittent output is therefore already of the order of 33,000 MW. Though the number does not appear dramatically high with reference to the total installed generation capacity in the Indian power system, the fact that many of these assets are concentrated in certain geographical segments of the country has already resulted in significant constraints from the grid in those areas, including curtailment of output.

The Government of India has given a mega thrust towards renewables by deciding to add 1,75,000 MW of renewables by 2022. The power generation and supply scenario is therefore poised to take a different turn. The impact is not only likely from the point of view of cleaner generation but also in shifting of peak loads on the grid. It is expected that solar power, of which 1,00,000 MW is to be added by 2022, would cater to much of the afternoon peaks in the grid.

This renewables capacity addition target of 175 GWs includes 60 GW of ground-mounted solar, 40 GW of rooftop solar, 60 GW of wind, 10 GW of small hydro and 5 GW of biomass based power. Seen against the fact that the current installed capacity in India of all forms of grid-connected power is about 300 GW, the renewables target is indeed huge.

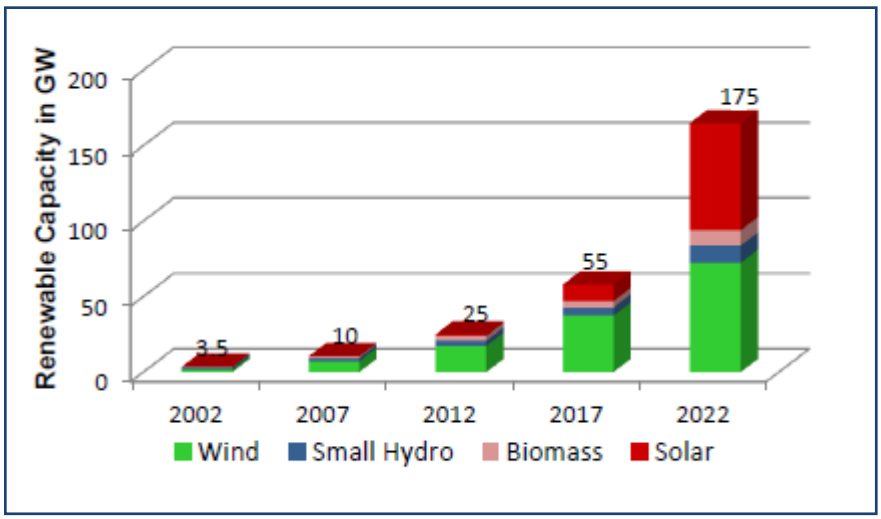


Figure 13 India – Renewables capacity addition trajectory (MoP, CEA)

The Government of India also proposes to raise the solar purchase obligation to 8% by 2022, a substantial increase from current levels of about 1%. All new coal and lignite based generation projects would also have a renewable generation obligation for which the quantum would be stipulated. Also, no inter-State transmission charges and losses are to be levied for solar and wind power. However, this exemption may last only for some years until the renewables sector establishes itself. It is also possible that these policies could vary at the intra-State level.

India with 3.4 percent of the world energy consumption is the sixth largest energy consumer. The main energy products consumed in India are primarily electricity, oil, coal, gas, and biomass. India's per capita primary energy consumption is quite low at 529 kgoe in comparison with its similar to China and much lower than the developed economies.

The residential sector is though the major consumer of final energy with about 39% share yet is important to mention that final commercial energy consumption of domestic sector is only 19%. This is due to the fact that in rural areas biomass dominates household energy consumption.

Energy Intensity Trend

Energy Conservation Act, 2001, seems to be the key driving element for all the major policy measures and programs that have happened recently as a result of BEEs strong programs. There is no doubt about the improvements in energy intensity of the country. Gross domestic product (GDP) and energy consumption are often directly related. The most common indicator to measure energy usage efficiency of an economy is, in fact energy-intensity of GDP. Energy intensity trends indicate an improvement over the past 28 years (1980–2008) (BP, 2009). Interestingly, there is an observed de-coupling of the energy consumption, with increasing GDP. GDP multiplied by 2.3 times over the period 1990–2005, whereas energy consumption multiplied by only 1.8 times (Stephane et al, 2009). Perhaps it could be due to the increasing contribution of the service sector to GDP. Energy intensity of industrial sector is continuously declining due to several factors, that includes operational shifts of the economy toward low energy intensive activities (services sector), and improvement of energy efficiency in high energy intensive industries. Since growth rate of services much higher than industrial as well as overall growth in GDP, its share to the economy has raised from 44% in 1990 to 52% in 2005 (Prayas, 2009). The contribution of services sector towards GDP has increased to nearly 62% by 2007 from around 34% in 1980 (Balachandra et al., 2009). It is the most rapidly growing economic sector in the country with 8.5% over the period 2000–2005. Service sector comprises a wide range of activities such as information & communication technology to simpler services like repair & maintenance and small retail stores including unorganized sector. Final energy consumption in this service sector is almost 6 times less than the industrial sector with an implication on the overall reduction in energy intensity of the country. If this growth in services continues to overtake the industry, energy intensity will keep declining. Comparatively high energy and electricity prices for industry also have controlled energy growth, which results in slower reduction in industrial energy intensity. In comparison with USA and China, freight energy intensity in India, i.e., the energy required per tonne-kilometre of freight, whereas much lower than that of Europe.

Policy regimes (about the policy and its impacts)

Globally, to meet the rising energy demand and to minimise resultant GHG emissions; energy efficiency Improvements are considered as low hanging fruits. However, to promote energy efficiency measures, apart from favourable market mechanisms a strong policy framework is required. A broader review and analysis of the Indian policy trends in terms of energy efficiency is given below:

Initial Phase 1: 1970s

The first initiative toward integration of energy policy into national development policy came in 1970 with the setting up of Fuel Policy Committee (FPC), the time when there were major upheavals in terms of worldwide oil market. The committee submitted its report in 1974, in which suggested to form an Energy Board that will ensure integration of energy into the national development plan. This was followed by the formation of Petroleum Conservation Action Group in 1976, which was later rechristened as Petroleum Conservation Research Association (PCRA) in 1978. Another Working Group on Energy Policy was formulated in the 1970s to comprehensively review the energy situation in India. Its recommendations on appropriate policy measures for transition to nonconventional sources of energy provided the backdrop for the Sixth Five Year Plan (1980–85).

Phase-2: 1980s

This was an interesting phase as it marked the liberalization of the economy. An inter-ministerial working Group on Energy Conservation was formed in 1981, to give recommendations on policies and programs to achieve the targets set for energy conservation. The Seventh Five Year plan led to the formation of (ABE) during 1983 to provide energy policy input directly to the prime minister's office. Apart from its various recommendations, Advisory Board on Energy recommended commissioning of the Indian Law Institute during 1987 with the purpose to prepare draft Energy Conservation Bill to be enacted through Parliament. This bill helped to allow the government in taking measures that were considered essential and beneficial in conserving energy and to make suitable and rational utilisation of energy resources. The Bill also facilitated to

establish a Nodal Energy Conservation Organization (NECO). However, the draft Bill could not be tabled. This was followed by setting up of Energy Management Centre (EMC) as a registered body, in place of NECO, through a government order during 1989. It will be under the general administration of the Department of Power, Government of India. In various regions of the country a large number of industrial and commercial sector consumers EMC coordinated and conducted energy audits. It was done with the help of National Productivity Council being the local lead agency and with the support from the United Nations and different agencies of the USA.

Phase-3: 1990s

The Indian government, upon failing to present the draft Bill in Parliament, made another attempt to get this Bill passed in 1996. However, the bill could not be brought to the House. Meanwhile, mandatory Energy Audit was introduced the two states of Kerala and West Bengal for large consumers in 1992 and 1995, respectively. The audits covered electricity, oil, and coal consumption. Other states like Gujarat and Tamil Nadu also introduced mandatory audits in similar manner for all high tension electrical consumers. As a consequence, the large consumers became more acquainted with energy audit.

Phase-4: 2000 and onwards

All the efforts taken by the Central government and various State governments in the 1990s culminated with introduction of the Energy Conservation Bill (Bill No. 21 of 2000) by the Government of India. The Bill led to the creation of a separate body called the Bureau of Energy Efficiency (BEE), which inherited all the rights and liabilities of the EMC. The latter ceased to exist thereafter. Finally the Bill got passed through the Parliament, and upon receiving assent from the President in September 2001, it became an Act.

Energy Conservation Act, 2001

Energy Conservation Act empowers central government and to some extent, state governments: so as to specify standards for energy consumption and to ensure application of mandatory labelling for appliances; the prohibition of production, sale/

purchase and import of appliances that do not conform standards; to notify and monitor the high energy consumption units; to prescribe energy-conservation building codes to use energy efficiently and its conservation; to get building audit by an accredited energy auditor for energy consumption in the identified manner and time periods. It also directs the designated consumers to take steps for efficient use and conservation of energy such as appointing a certified energy manager; during the energy audit informing designed agency about energy consumption and action taken on the recommendation of the accredited energy auditor, complying with energy consumption standards, and implementing schemes for efficient use and conservation of energy, if the prescribed energy consumption standards are not fulfilled. According to the Bill, Central governments can modify the "energy conservation building codes" in accordance to local and regional climate conditions and also guide residents or owners of a new commercial building for compliance of the provisions of "energy conservation building codes"; and if considered necessary, government can issue directions to any nominated consumer to conduct energy audit of his building/ complex through an accredited energy auditor.

Bureau of Energy Efficiency (BEE)

With institutionalization of energy efficiency through the "Energy Conservation Act", a statutory authority called BEE was established on March 1, 2002. In order to enable delivery mechanisms; BEE targeting that energy efficiency services should be institutionalized, and to apply energy efficiency in all sectors of the economy. The main objective of BEE is reduction in energy intensity in the overall economy. BEE functions as regulator since it is a recommendatory body to the state Government to implement the Energy Conservation Act and facilitation, market development and market transformation functions such as arranging of trainings for personnel and experts in the techniques for efficiency and conservation of energy; develop and promote testing facilities; strengthen consultancy services; facilitate and formulate implementation of demonstration and pilot projects; promote use of energy efficient processes, equipment, devices and systems; promote new ways for financing of energy efficiency projects and

provide assistance to other institutions to promote energy efficiency and conservation; prepare educational curriculum on efficient use of energy and its conservation, etc. Apart from a rigorous awareness generation and capacity-building program, some of the key achievements of BEE follow ing its establishment are as follows:

- Energy Conservation Building Code (ECBC)

ECBC launched during 2007, the Code attempts to reduce the baseline energy consumption by supporting adoption and implementation of efficiency measures in commercial buildings. Central government has powers to advise ECBC for commercial buildings or complex (Section 14 (p) - Energy Conservation Act, 2001). The ECBC sets minimum energy standards for all new commercial buildings with a connected 100 kW load or having contract demand of 120 kVA. ECBC covers min requirements of the building envelope, mechanical systems and equipment including cooling and heating, complete lighting system, hot water, and electrical motors so as to achieve energy efficiency in various climatic zones of the country.

- Standards & Labelling Scheme

In 2006, on voluntary basis, energy labelling scheme for tubular fluorescent lighting and refrigerators was launched. Information to be provided by the labels about the energy consumed by an appliance is on a scale of one to five stars; with the larger the number of stars, the higher is the energy efficiency and greater savings of power. This is helping consumers to make informed and mature decisions. At this point of time, majority of the fluorescent tube lights available and sold in the country, as well as almost two third of the air conditioners and refrigerators and are covered by the labelling scheme. Under “Standards and Labelling” program in 2008–09; BEE has also included many widely used appliances and equipment including motors, transformers, geysers, TVs, fans, agricultural pumps and LPG stove.

- Bachat Lamp Yojana (BLY)

BLY is a programmatic CDM (Clean Development Mechanism) based CFL (compact fluorescent lamp) scheme is a public–private partnership (PPP) program initiated by the central government. The purpose is to improve lighting efficiency in the household sector of India by making CFLs available at prices at par with incandescent bulbs through provision of a framework to distribute high quality CFLs at about Rs.15 each. The scheme attempts to control the CFL's high cost through the CERs (certified emission reductions) that the project will generate. Through this scheme, incandescent lamps of 60 and 100 watt were targeted to replace with 11–15 and 20–25 Watt CFLs, respectively.

- Program for Star Rating of Office Buildings (Existing Buildings)

To speed up activities related to Energy Efficiency in commercial buildings, a program for star rating of buildings has been developed BEE. In terms of specific energy usage, actual consumption of the building, (in kWh/ m^2/ year) is considered under this scheme. 1–5 star scale is provided to rate office buildings, buildings labelled with 5 stars is the most energy efficient. In start, the scheme shall target the three climate zones for office buildings with and without air conditioning: (i) hot and dry, (ii) compo-site, and (iii) warm and humid. However, the scheme shall be extended afterward to other building types and climatic zones.

3.5 Maldives

Sector Assessment

Maldives, a small island country is located in the Indian Ocean. With reference to Sri-Lanka, it is located in the southwest consisting of about 26 major atolls and 1,190 tiny islands lying. Only 33 of these Islands have an area greater than 1 km^2. The country has more territorial sea than land. The population is highly concentrated on relatively few islands. Atolls and inhabited islands are at larger distances from each other and cost of transport is significant.

The economy is mostly service oriented. The scope for agriculture and manufacturing is limited within Maldives. The primary industries are:

- Tourism (70% of GDP)
- Fishing and Fish Processing (10% of GDP)

The country has shown strong Economic Performance over the past two decades with the growth rate on average being 7% (SARI/EI, no date). Figure below illustrates the energy consumption situation in Maldives:

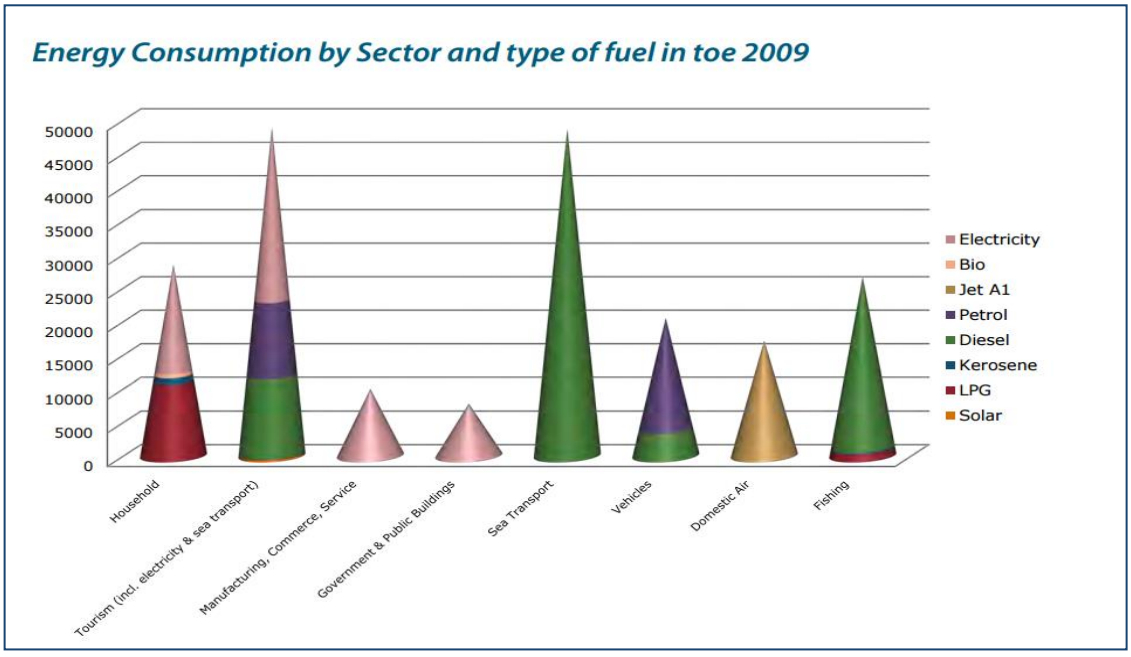


Figure 14 Energy Consumption by sector and type of fuel in toe 2009 (Maldives Ministry of Housing and Environment, 2010)

The energy needs and Motives are met primarily though import of fossil fuels. Given its unique to graphical situation Maldives does not have access to conventional energy e.g. fossil fuels and hydropower etc. This situation makes energy security a priority for Maldives. It also puts the country at a greater risk and exposure to the market prices in the world energy market.

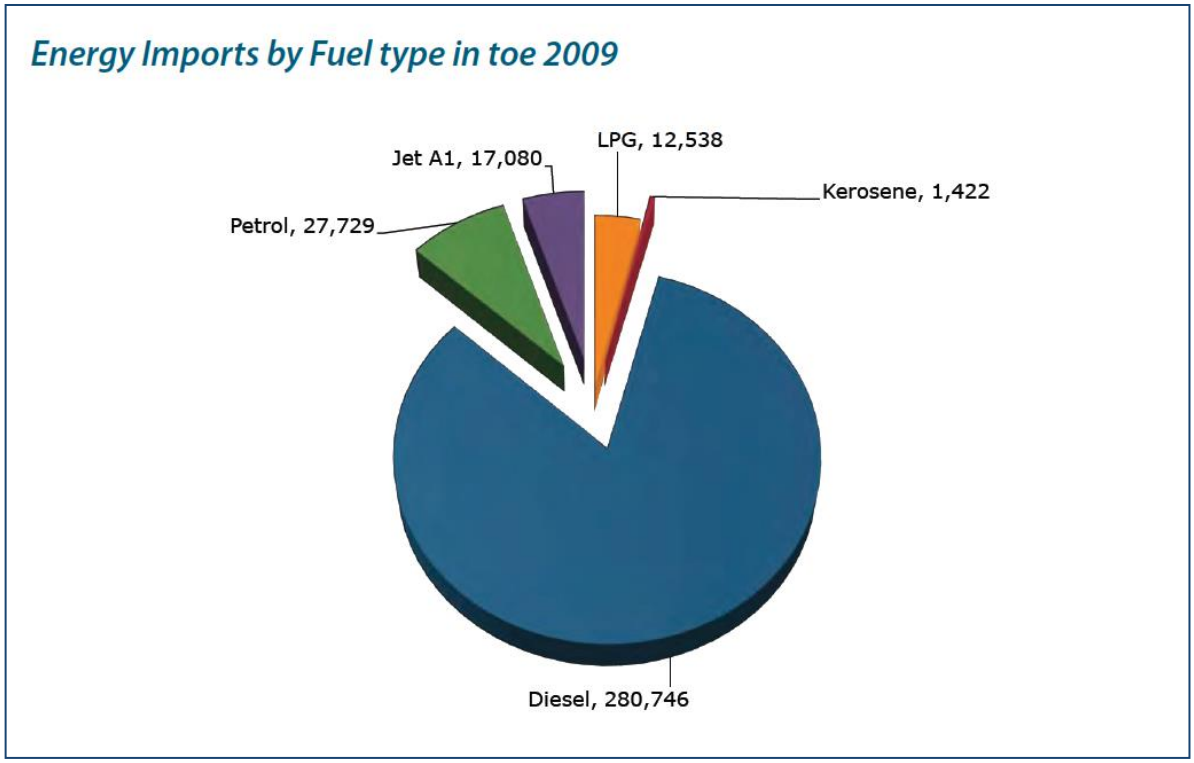
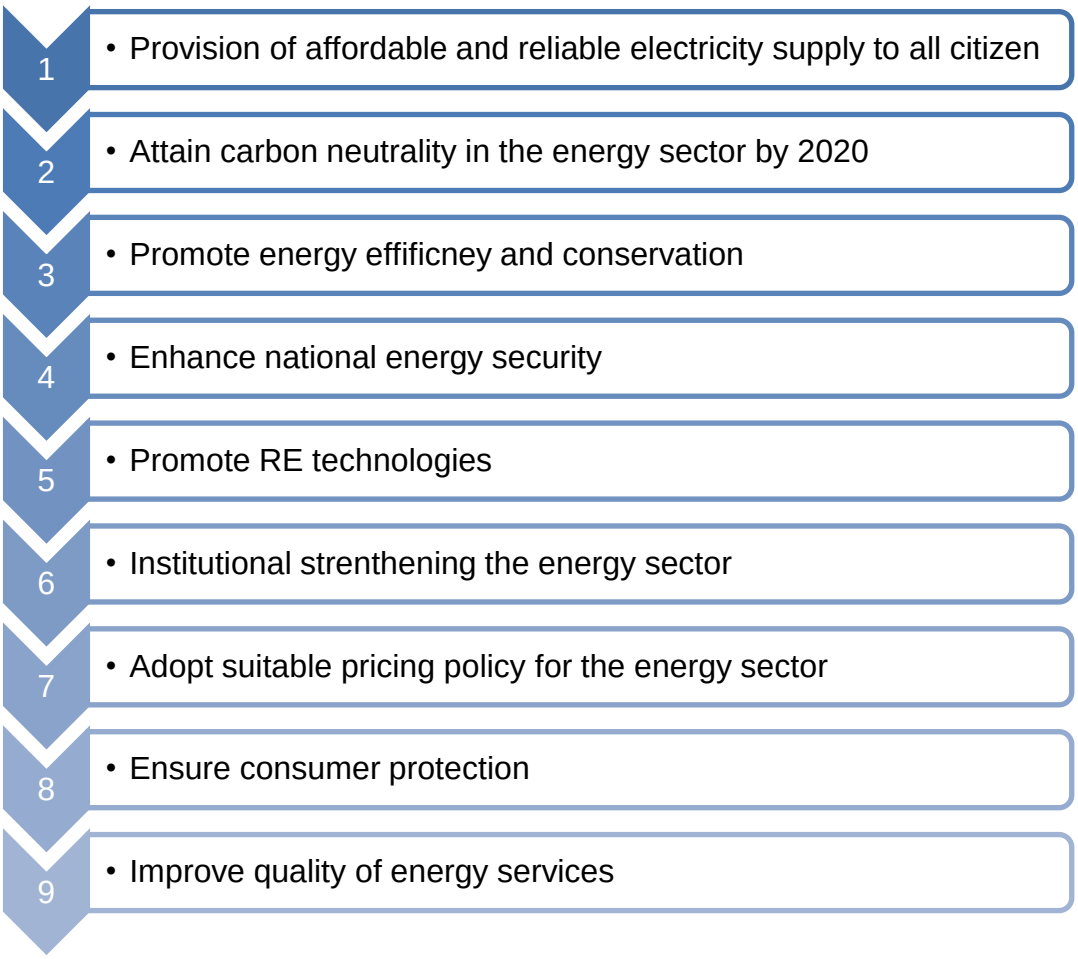


Figure 15 Energy imports by fuel type in toe 2009 (Maldives Ministry of Housing and Environment, 2010)

The unique situation in Maldives makes it a potential area for storage application as it can make a significant impact allowing Maldives to take advantage of the natural resources of renewables and reduce its overall energy import bills.

To assess the potential application areas of Energy conservation/ energy efficiency within Maldives, the main energy policy aims of the Maldives Government were reviewed. These are as follows:



The main issues in the energy sector in Maldives which serve as barriers in achieving the national energy policy goals include:

- The dependence on fossil fuels as it has no local production sources for Petroleum, gas and oil. Because of the geographical topology hydropower is not possible and diesel required for fuel in the power generators in Maldives is imported. This exposes the country's international market prices as petroleum products now account for over 31% of the imports of the country.
- The legal and regulatory framework within Maldives is still evolving. The government has identified key areas of Focus which include:
    - Widening access of all citizens to clean, affordable and reliable energy
    - Increasing the energy security within the Country
    - Increasing renewable energy production within the country

- The policy aims for the energy policy within the Maldives which are formed by the Ministry of Environment and Energy to achieve some of the aforementioned objectives include:
    - The creation of regional utilities
    - Setting up and developing regulators to regulate the energy sector

  These measures require focused action and multiple facets of the energy sector including technical issues, legal and licensing aspects, regulatory developing and financial frameworks for taking the energy sector forward. Currently, the existing institutions within the country seem to have limited capacity to implement the measures within the energy policy.
- Access to adequate financing remains a problem within the energy sector in Maldives.
- Increasing energy prices has meant that the Government has had to subsidise the electricity prices for the Citizens. This has subsequently placed substantial financial Burden on the government.
- In terms of Manpower, the electricity system in Maldives has faced issues due to unavailability of appropriately skilled Manpower for the maintenance, operation and management of energy systems.
- An assessment done to evaluate the barriers for increasing the penetration of renewable energy in low income countries several other financial barriers were identified for the renewable energy sector. These factors would also be relevant for increasing demand for energy efficiency interventions in Maldives. These include:
    - the absence of a framework; this would include appropriate frameworks and agencies for development, implementation, and monitoring;
    - Insufficient development of standardized instruments which includes tariff schemes
    - Investment risk perceptions reducing available investment

To increase the energy security of Maldives, fuel diversification is being pursued as a priority policy. Due to the nature of the islanded network within Maldives, the fuel imported for electricity generation for the islands in Maldives is stored in the main region of Male' it's neighboring islands. The transportation cost of fuel to the 190 of the islands of the Maldives, this results in a significant disparity in the cost of electricity and subsequently other consumer goods in the region. This creates potential for energy efficiency interventions to reduce the subsequent cost of energy. This also has potential synergies with the renewable energy potential for the country which has significant solar potential and pilot projects based on distributed solar deployment have started to emerge.

Although the sector has limited sector-level planning, consolidation has happened in recent years. Two utility companies have been formed which have potential to improve planning. The government is also reported to be developing a medium-term plan for the power sector which includes technology evaluation.

Energy Efficiency and Conservation

On demand side energy efficiency always makes good economic sense, because of the user's commitment for paying initial or capital cost as well as operating cost up till he owns it. Whereas the energy cost (operating cost) over the appliances' life, can be several times greater than the capital cost. This makes it very logical to buy energy efficient appliance since it pays back. Yet, because of lesser awareness among general public and also high capital cost of these appliances, Maldivian rarely opt for such products.

Like other SAARC Member States Maldives is also severely need to control generation expansion and thereby reducing its oil imports. It is clearly understood that with the peaking of oil supply in near future, upward pressure will directly affect energy prices. Simultaneously, larger effects on the global climate due to emissions from burning fossil fuels are also not hidden from any one. In context of Maldives, rise in sea level is the major and direct effect that threatens the mere existence of Maldives.

Energy conservation and efficiency improvements are one of the broad solutions to address the above mentioned problems, having clear objective of providing same energy services through reduced primary energy consumption.

Strengthening Maldivian Initiative for a Long-Term Energy Strategy (SMILES) project was among most effective activities in Maldives on energy conservation and efficiency that was executed by MEEW. With the objective to support the development of a long term energy strategy in the Maldives, three energy specific areas were considered. In first area it covers options to decelerate the high growth rate of electricity demand in Malé. Secondly to search for targeted places to introduce wider use of RE sources so that dependence on fossil fuels can be reduced in the outer islands. The third area is to develop strategies and policies to introduce public transport in Malé.

Institutional Framework:

To bring about sustainable development as stipulated in Maldives' *Climate Change Policy Framework 2015,* as a desirable tempo and achieve mitigation target, energy investment in both RE & EE must be mandated and guided to through climate change provisions. This must be done in harmony with other adaptation opportunities and LED activities to achieve true climate resilience.

Policy Framework:

Maldives Climate Change Policy Framework - 2015

One of the policy goals was to:

"*Strengthen a low emission development future and ensure energy security for the Maldives*"

That is strategized in the policy that to:

- Strengthen the legal and regulatory framework for promoting EE, RE and energy conservation.
- Strengthen existing policies and plans on RE and EE.
- Develop management capabilities of the energy sector institutions through appropriate training, empowerment and proper delegation of authority.

- Increase public awareness and advocate EE measures and EE appliances (through labeling)
- Encourage new and innovative Low Emission Development (LED) measures and technologies.
- Facilitate R&D and technology transfer programs to aid the exchange innovative ideas.

Programs:

On the occasion of World Energy Day 2015, the Ministry of Environment & Energy in collaboration with Strengthening Low Carbon Energy Island Strategies Project conducted the Energy Efficiency Photography Competition to create awareness of the public on energy efficiency and energy conservation.

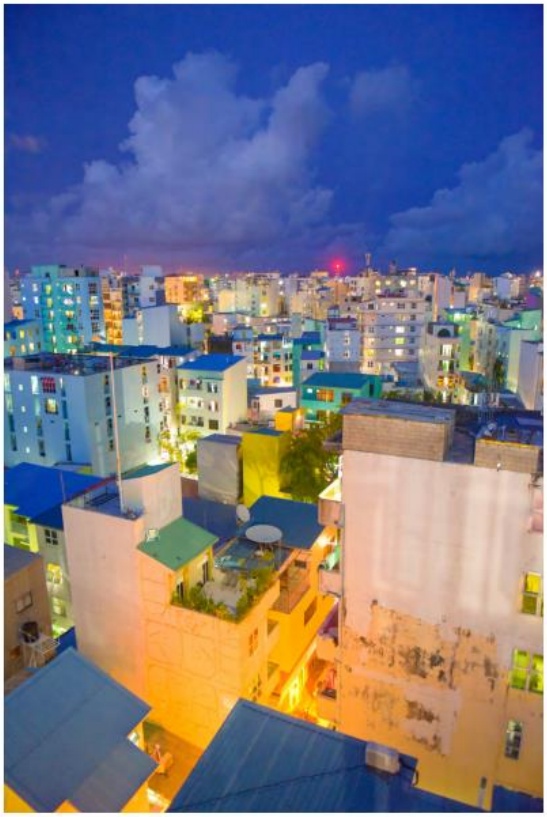


Figure 16 First prize winner Photograph Energy Efficiency Photography Competition

"Strengthening Low Carbon Energy Island Strategies (LCEI)" Project

The Project "Strengthening Low Carbon Energy Island Strategies Project (LCEI)", is designed with a goal of market transformation for energy efficient technologies in buildings and the built environment in the Maldives; and promotion of energy efficiency investments in buildings, The project will not only target energy efficient technologies, but will also promote emerging low carbon energy technologies for the building sector.

LCEI Project is implemented by Ministry of Environment and Energy (MEE) with support from UNEP and funded by the Government of Maldives and the Global

Environmental Facility (GEF). Purpose of the project is to reduce GHG emissions through introducing energy efficiency in buildings. The Government of the Republic of Maldives has received financial assistance from Global Environment Facility (GEF) supervised by the UNEP to reduce GHG emissions through energy efficiency in the domestic sector and intends to apply part of the proceeds of this grant to make eligible payments under the contract for the services of Communications and Knowledge Management Administrator for the Project Management Unit (PMU), established within the Ministry of Environment and Energy (MEE).

Under the "FahiAli" Program LED tube lights were distributed in households in Vilimalé.

Investment in energy efficiency and other low carbon energy technologies in the building sector of the Maldives are low. This is due to diffused responsibility for energy consumption over the lifetime of any given building. A detailed set of standards, appliances rating systems and novel incentive tools are required to give a boost to progressive developments. Key constraints include lack of awareness, classification of stakeholders, lack of resources in making decisions in order to participate in the process of global benchmarking system design, incapability to adequately analyze the requirement for local level policy interventions, and lack of capacity to collect local baseline data required for policy tools.

The existing policies and regulations lack provisions to encourage adoption of energy efficient design and the use or integration of efficient appliances, including incentives (or 'push') for existing building stocks to retrofit towards energy conservation and energy efficiency. The existing polices do not include energy efficiency guidelines or standards for building material and design, and building construction. Energy efficiency can be promoted under other names - good lighting, natural ventilation, preventing solar heat gain - to achieve EE outcomes. Although there is some awareness within the building design and construction industry of the basic design and construction methods for energy efficiency in buildings, there is room for substantial improvement through the preparation and implementation of guidelines, standards and possibly codes that focus

on energy efficiency measures including energy efficient construction materials for new construction.

3.6 Nepal

Sector Assessment

The Nepal Electricity System is a relatively smaller system with a peak generation capacity of around 800 MW. Hydroelectric power forms the main cornerstone of the electricity system in Nepal and also forms one of the foundations of the poverty reduction and economic growth strategy of Nepal. However, advances in this sector have been slow to materialize. The power sector is generally negatively affected by lack of investment in generation, transmission and distribution. Project development work has also been affected by the pace of development of the legal and regulatory frameworks within the country. Consequently, Nepal is also a country within and this has had negative implications for the economic growth of the country. (Asian Development Bank, 2013)

The 2014-15 demand figures put the peak load of Nepal's at 1291.1 MW which is significantly higher than the 2015 installed capacity figure even before factoring in load growth. To reduce the country's power shortfall, previous plan in Nepal have envisioned addition of 281 MW in new generation and initiating projects totally 1,743 MW. However, reasons for not being able meet targets have included:

- Inadequate infrastructure, including a lack of roads and transmission capacity
- Failing to restructure the electricity tariffs within the country;
- Local implementation issues

The projected demand for 2020 (dry peak) is indicated around 2200 MW. There is some activity in terms of addition of new generation but it does may not catch up with the growing demand Nepal may be required to import increasing amount of power from neighboring countries.

In addition to the installed capacity issue, the power deficit problem is exacerbated due to the seasonal nature of the hydroelectric power in the country. During the winter

season when the river flows dry up, the power output of the predominantly hydroelectric power system of Nepal falls leaving to seasonal load-shedding of as much as 12 hours in winter. However, Nepal does have interconnectors that allow the import of power from India with the import figure reaching around 27% of the annual consumption in 2015-16. Micro-hydels are significant in the Nepal system as shown in the figure that follows. The total deployment stood at 54 MW as of 2015-16.

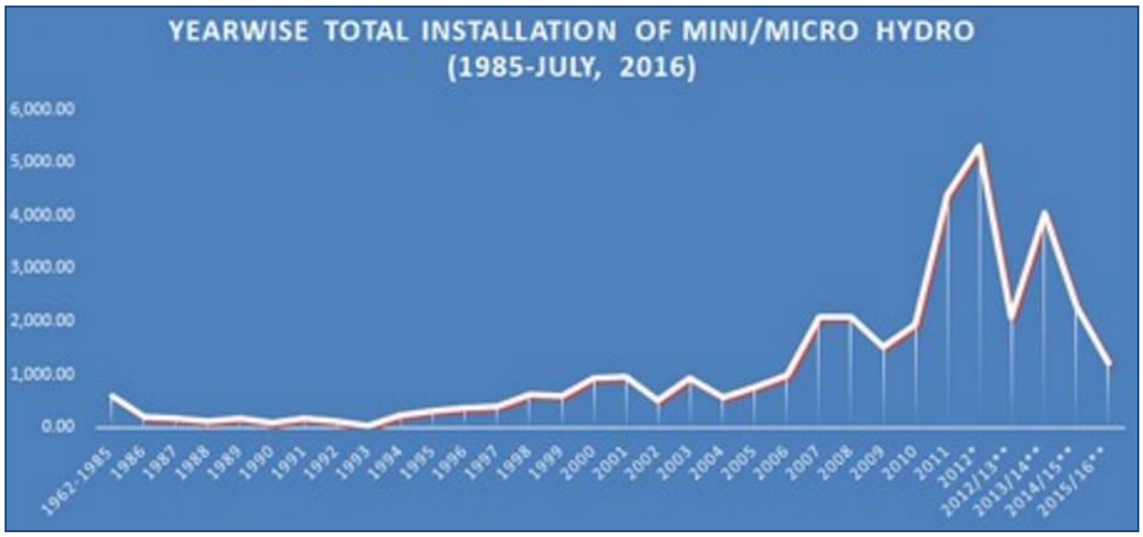


Figure 17 Installation of mini hydro in Nepal

Nepal is planning a long-term scale-up of its distributed solar deployment with over 100,000 systems planned for long-term deployment.

Apart from the generation sector, the transmission sector is also facing issues with power evacuation proving to be a bottleneck which the actual network expansions lagging considerable behind planned developments. Transmission bottlenecks have also led to dis-incentivizing Independent Power Producers. The cross-border interconnection with India is also limited with 2010 numbers suggesting that the interconnection link was limited to 150 MW. However, there have been plans to increase this connectivity to a higher capacity link on 400 kV; the execution of this link has however faced delays. According to the Nepal Energy Authority, the lack of transmission capacity in the country led to over 25 system collapses in 2010.

Going down to the distribution level, domestic consumers who make up about 95% of the customer base, account for about 42% of the energy sale whereas industrial

consumers who are only 2.3% of the base, account for about 48% of the sales. Key metrics of the sector as of 2014 shows that consumption access to electricity remained at a low 62% for the country (Sameer Ratna Shakya, 2015).

The overall T&D losses in Nepal have historically been quite high as shown in the figure that follows:

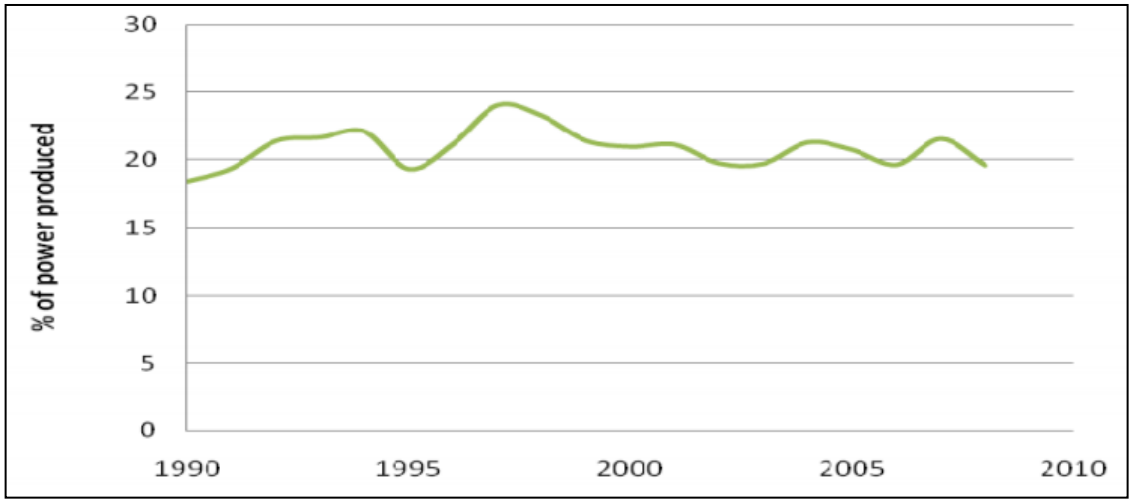


Figure 18 Electricity distribution losses (Nepal and Jamasb, 2011)

The losses have been a mixutre of technical as well as non-technical losses. The techinical losses are caused by an aging grid with overall low system reliability and lack of timely grid expansions. However, in recent years, the losses have been declining due to measures such as:

- Monitoring of distribution networks,
- Establishment of loss reduction committees,
- Legal measures taken in support of loss-reduction

It is important to note that previously the prices in the power sector in Nepal had remained supressed due to political interventions to keep energy affordable. This has also resulted in lower financial resources being available to the sector for expansion investment.

The Ministry of Energy in Nepal has started a restructuring program for NEA (Nepal Electrcicity A to improve its financial health. The measures taken in this regard include:

- Increasing NEA's share capital

- Writing off accumulated losses
- Other Financial Measures
- Allowing for an increase in the tariff

Together it is expected that these initiatives would improve the financial health of the NEA allowing it to make future investments in the energy sector. These initiatives along with the NEA's objective of attractive private sector investment improve the prospects for energy storage application in Nepal. On the issue of reform, the unbundling of the Nepal Energy Authority has also been progressing with the national transmission grid company being established in the 2014-15 timeframe.

However key issues in the sector with regards to attracting private investment which would also be relevant to the energy storage sector remain as follows:

- Inconsistent policies,
- Lack of comprehensive planning including development of long-term transmission expansion plans – however regional expertise may allow this to be rectified
- Financial limitations,
- NEA's credit and offtake risks,
- Difficulty in land acquisition (more relevant for pumped storage)
- Right-of-way issues (more relevant for pumped storage)

Energy Efficiency

Among all South Asian countries, Nepal has the lowest energy intensity i.e., about 1 TOE/$1,000 of GDP (IEA, 2012). Thus indicating a huge potential for energy efficiency. United Nations has warned that "energy efficiency efforts in the country are still at its infancy." Currently NEA is working on a "loss reduction" strategy to rehabilitat twenty seven feeders and distribution lines. It also has plans to install solar energy based street lights and replace incandescent bulbs with compact fluorescent lights. Nepal also has a variey of barriers in implementing energy efficiency that they have to overcome, such as "absence of a legal framework," "low levels of public awareness," and "lack of capable

human resources." In order to address these barriers and and to improve energy efficinecy an Energy Efficiency Strategy Nepal is in the process of formulation and an agency is also under consideration to institutionalize energy efficiency.

Policy Framework, Laws and Regulations

National Energy Strategy (NES)

To address the challenges as well as for the development and utilization of energy resources in sustainable manner National Energy Strategy (NES) was developed in 2013. It suggested for and highligted vast areas for need to improve energy efficiency such as electricity generation, transmission, and distribution, industrial processes, transport sector, buildings, lighting and domestic appliances.

Power intensive industries were bound to carry out a mandatory periodic energy audit, as one of the measures to bring the culture of energy conservation. Other industries may also be encouraged to adopt energy audits and energy conservation measures. Before that energy policy objectives were normally developed by the National Planning Commission, as a part of Five Year Plans. Electricity was exclusively dealt by the energy policy of the current three year Interim Plan. Though biomass is very important primary source of energy, targets for the its sustainable use are not discussed in this plan. Same is the case with the efficient usage of commercial energy sources. Similalry ther is no considertation of consumer side as the beneficiary of an energy policy.

Political government determines tariffs for electricity and petroleums. They are pushed to the bear minimum limit of procurement costs. Thus, the electricity bussiness is in loss and state has to balancethe loss through fiscal budget in the form of subsidy.

Biomass Energy Strategy (BEST)

The Alternative Energy Promotion Centre (AEPC) and the Nepal Energy Efficiency Program (NEEP) prepared a Biomass Energy Strategy (BEST) in 2017. The Biomass Energy Strategy delivers a distinguished understanding of the diversified situation of biomass energy in different parts of Nepal. It provides integrated solutions for the development of stable and sustainable supply and demand systems for biomass energy.

Energy Efficiency Strategy (EEST)

Since 2011 WECS is drafting an Energy Efficiency Strategy (EEST) supported by NEEP. The "efficient use of energy is a constituent of the national energy strategy of Nepal" is one of the objectives of this programme. Within this backdrop and the defined objective, WECS as an implementing agency for the component is to draft National Energy Efficiency Strategy of Nepal as a part of the "National Energy Strategy".

Institutionalizing Energy Efficiency

Nepal has been implementing energy efficiency measures for about two decades in different scales and at different levels, but as of today, does not have any nodal agency for addressing the issues of energy efficiency and leading the process of promoting and improving energy efficiency. The Ministry of Energy is currently working on the drafting of such a nodal government agency for energy efficiency that shall lead the initiation of a regulatory framework and facilitate the setting of energy efficiency promoting policies. Time to time various programs were launched and implemented for the promotion of energy efficiency. Nepal Energy Efficiency Programme initiated (NEEP) that was implemented by the Ministry of Energy, Government of Nepal with technical assistance provided by the GIZ, Germany acting on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ).

3.7 Pakistan

Sector Assessment

Pakistan has the second largest electricity demand in the SAARC region which is about 23.5 GW against an installed capacity of around 25 GW (Source: PPIB). However, the country faces frequent power outages with the actual demand that is met being lower than the 23.5 GW figure.

The power sector of Pakistan underwent a restructuring in 1998 where WAPDA, a vertically bundled utility was unbundled into Generating Companies (GENCOS), a Transmission Network Operator called the National Transmission and Despatch

Company (NTDC) and 10 distribution companies (DISCOs) covering the different geographical regions of the country.

The generation mix of the country which was originally predominantly hydro has been shifting across the years to a point where it becomes dominated by thermal plants which are a mix of GENCOs and independent power producers (IPPs). In recent years, a number of alternative renewable energy plants based on wind and solar have also been added to the system. The generation mix of the country as of June 2015 is shown in the figure that follows:

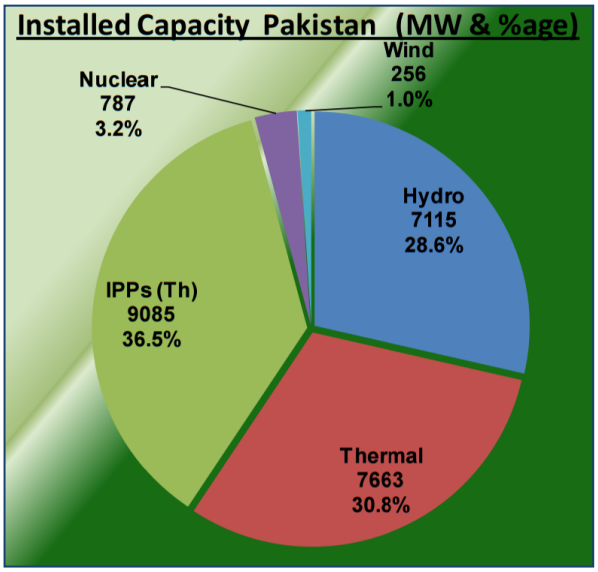


Figure 19 Installed Capacity Pakistan (NTDC, 2015)

The change in the power system of Pakistan has not only been in the energy mix but also in the composition of the consumption economic groups which has seen a rapid increase in the proportion of electricity that is consumed by the domestic sector as shown in the figure below:

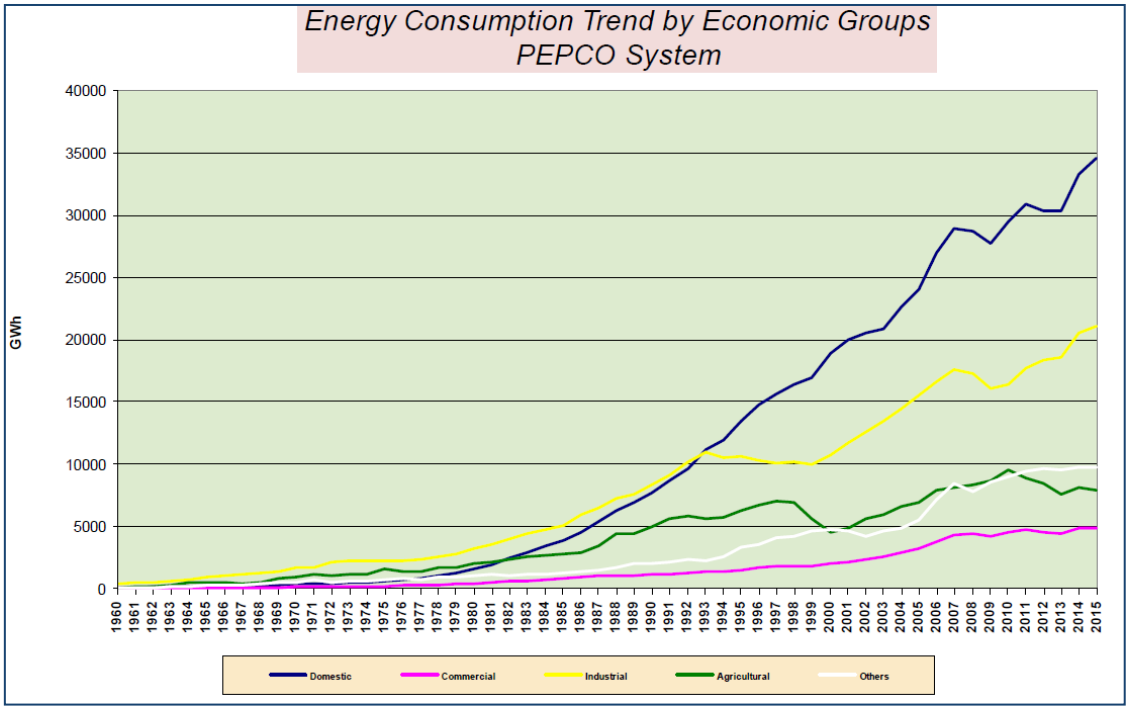


Figure 20 Energy consumption trend by economic groups (NTDC, 2015)

At least 51 million people in Pakistan have no access to electricity (World Energy Outlook 2016). Above 50 percent of rural population of Pakistan, is dependent on traditional biomass energies such as cow dung, firewood, waste etc. Burning of these fuels using inefficient stoves and poor ventilation causes serious health issues. In Pakistan yearly more than 50,000 premature deaths are estimated due to indoor air pollution, mainly women and children (WHO). Apart from this, wood burning is a major contributing factor in deforestation with a yearly rate of more than 2%. Progressive high distribution cost and the lower power generation capacity are the main causes of preventing the rural electrification.

Similarly in last decade electricity demand has also increased abnormally. Domestic sector is one of the major contributors to the increased demand. Installation of air-conditioning systems on large scale is one of the major reasons of this increase in demand, especially in urban cities and in the summer season.

Due to high supply demand gap in power sector, the country is facing severe daily blackouts. Extensive load shedding is affecting industry, commercial and social

institutions as well households, thus considerably hampering economic and social development.

Traditional energy sources that constitute a significant share of primary are not only neglected by policymakers in energy policies and planning in the country but they are not given any representation in the national statistics. Thus ignoring almost half of the rural households consumers are ignored in energy planning for supply of power.

Institutional arrangement in the Power Sector

Transmission and dispatch of electricity is mainly the responsibility of National Transmission and Dispatch Company (NTDC). Electricity is generation operates under one system and controlled by Pakistan Electric Power Company (PEPCO), whereby mainly hydel and some thermal generation is managed by state owned "Water and Power Development Authority" (WAPDA) and by several private power produces. Whereas distribution of electricity is managed by ten different distribution companies (Discos).

General government institutions in the electricity sector are:

- The Ministry of Energy (Power Division): responsible for the overall power sector development and policy regulation
    1. Water and Power Development Authority (WAPDA)
    2. Energy Efficiency & Conservation Authority (NEECA), previously National Energy Conversation Centre (ENERCON) has now recently being transformed
    3. Pakistan Council for Renewable Energy Technologies (PCRET)
    4. The Alternative Energy Development Board (AEDB)
    5. Alternative Energy Development Board (AEDB)
- National Power Control Centre: Responsible for managing the national grid and load shedding.
- National Cabinet Committee on Energy (CCE)
- National Electricity Power Regulatory Authority (NEPRA)
- Private Power Infrastructure Board (PPIB)
- Central Power Purchase Agency: The clearing house for the purchase and sale of electricity

National Energy Efficiency and Conservation Authority (NEECA)

National Energy Conservation Centre (ENERCON) which was previously responsible for EE & issues has been upgraded to Authority to be called the National Energy Efficiency and Conservation Authority (NEECA) through an act "National energy Conservation Act 2016" in June 2016. The Authority would serve as sole focal Federal authority for initiating, catalyzing, carrying out and coordinating the implementation of all energy conservation programs in all sectors of economy.

National Energy Conservation Fund (ECF):

The Company is Limited by Guarantee not having share capital and is formed in 2012, not for profit with the main objective:

"Energy conservation through energy efficiency, use of alternative economical nonpolluting energy, better maintenance techniques for all types of vehicles, equipment, devices, machinery in use in Pakistan"

Pakistan Building Code 1986

Pakistan Building Code (Energy Provisions) – 2011, was promulgated vide an SRO in 2013, making it an integral part of Pakistan Building Code 1986.

En.lighten Project

On June 27, 2012 Pakistan become part of en.lighten "Global Efficient Lighting Partnership Program". En.lighten program was established by UNEP to speed up the process of global shift to environmental friendly and sustainable lighting systems through a coordinated global strategy and facilitating nations in gradual phase out of inefficient lamps. En.lighten Programme was established in 2011.

Pakistan's Energy Standards & Labeling Scheme

First time BRESL (Barrier Removal to the cost-effective development and implementation of Energy efficiency Standards and Labeling) laid the foundation for ES&L. This was a regional project, that was implemented by UNDP along with ENERCON being implementing Agency and it was funded by GEF. Implementation of BRESL started in Pakistan in January 2010 and completed in December 2014.

Aim of the project was to reduce annual growth rate of GHGs from thermal power generation with a target to accelerate the adaptation and implementation of Energy Standards and Labels (ES&L) in Asia, thus to bring about energy savings through using energy efficient appliances. Another target of the project was to facilitate harmonization of testing techniques, standards and labels for energy efficiency at regional level in Asia.

Six areas of intervention were included in the project, including compact fluorescent lamps (CFL), ballasts, motors, electric fans, refrigerators and air conditioners. Regional harmonization was among six member states including Bangladesh, China, Indonesia, Pakistan, Thailand and Vietnam, whereas for electric fans Pakistan was nominated as lead country.

In order to ensure effective implementation of the ES&L scheme, MOUs were then signed between PCSIR and PSQCA. JICA is providing assistance to develop Minimum Energy Performance Standards (MEPS) for the other three items, update these MEPS and to explore other areas of collaboration.

Figure 21 Pakistan Energy Label

Figure 22 Launching Seminar "Pakistan Energy Standards & Labeling Scheme" 24 May 2016

The Energy Standards & Labeling Scheme was formally launched on 26th May, 2016. The scheme is initially considering fans for energy labeling, on voluntary basis starting in May, 2016 and will continue for a period of two years. Accordingly it will be extended towards inclusion of Window Type & Split Air conditioners, Self- Ballasted Fluorescent Lamps (CFLs) and AC Induction Motors. Minimum performances Standard (MEPS) for these appliances are already developed.

Pakistan also has a "National Energy Efficiency and Conservation Awards 2015-16" in place for the industrial units and buildings that have taken special efforts in reducing energy intensities.

3.8 Sri Lanka

Sector Assessment

With the growth of the economy in Sri Lanka, electricity consumption has been increasing at a rate of 4.3% during the 2000-2014 period. Sri Lanka is one of the countries in the SAARC Region in which the supply of electricity exceeds the demand and the country has been successful in meeting domestic electricity need. Over the past decade,

the growth in installed capacity has been greater than the growth in the demand. The electrification of the country has also been to a greater extent than most of the other South Asian peers and as of 2014, stood at a very significant 98%. The evolution of the installed capacity compared to the demand of the network is shown in the figure below:

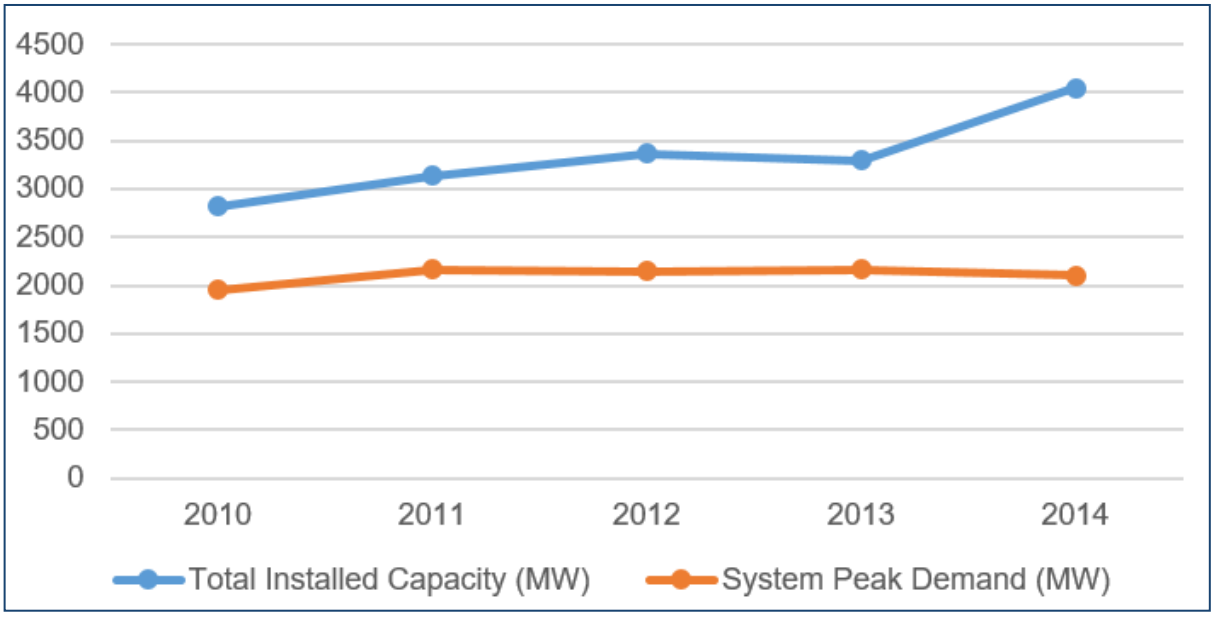


Figure 23 Installed capacity and demand evolution Sri Lanka (SEA, 2015)

The energy mix of the country has changed over the years; in the early 2000s the share of thermal power was on an increasing trend with smaller oil-based plants being added based on private investment which was quicker than the slower base-load plants (Asian Development Bank, 2015d). However, in recent years, renewable generation has increased and base load plants in the form of coal has been added. As of 2015, the energy mix for the electricity sector was as follows:

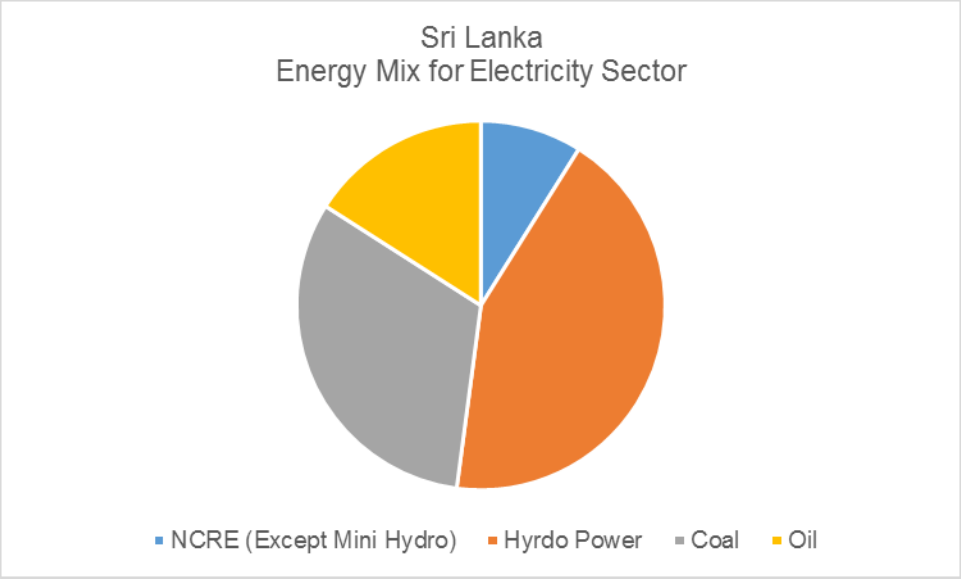


Figure 24 Sri Lanka Energy Mix.(CEB, 2014)

Despite the decrease in generation costs due to additional of base-load coal power and retiring of expensive oil-fired power plants over the last 3 years, tariffs is Sri Lanka, like several other SAARC Member States, do not properly reflect the true cost of the electricity service that is provided. The figure bellows shows how the level of difference between the costs and the tariffs has been rising which has potential impacts on the power sector financial stability.

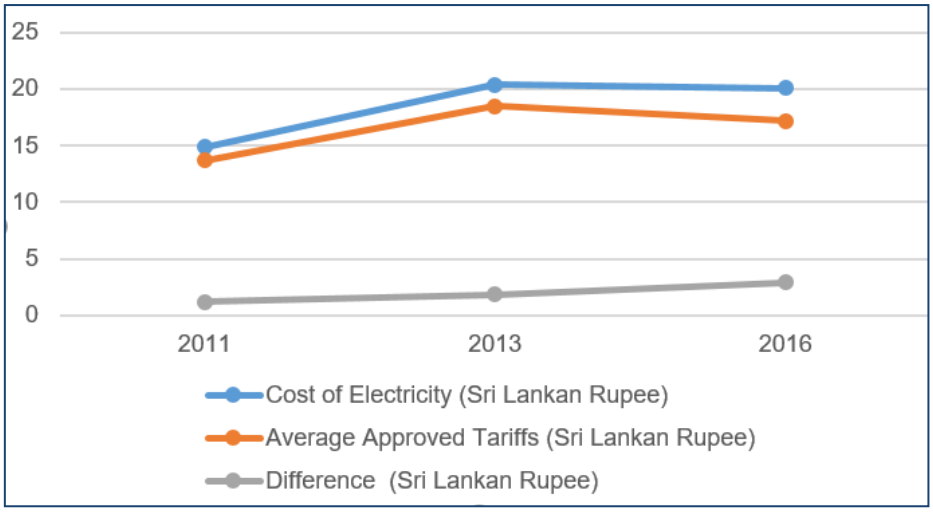


Figure 25 Analysis of tariffs (Asian Development Bank, 2015d)

Due to the insufficient cost recovery mechanisms through the tariffs, the power sector entities in the country have limited ability to generate new investments in generation, transmission and distribution elements of the power sector. In both the low-voltage and medium-voltage networks of the country, continued underinvestment has resulted in

The need for demand side management is very significant in Sri Lanka with nearly 40% difference between the peak and off-peak demands of the country, which provide a potential for electricity storage to bridge this gap and level off the peak.

The level of transmission and distribution losses of the country has also been on a general downward trajectory and is lower compared to some of the peer countries in the SAARC Region. The development of the T&D loss profile over time is shared in the figure the follows:

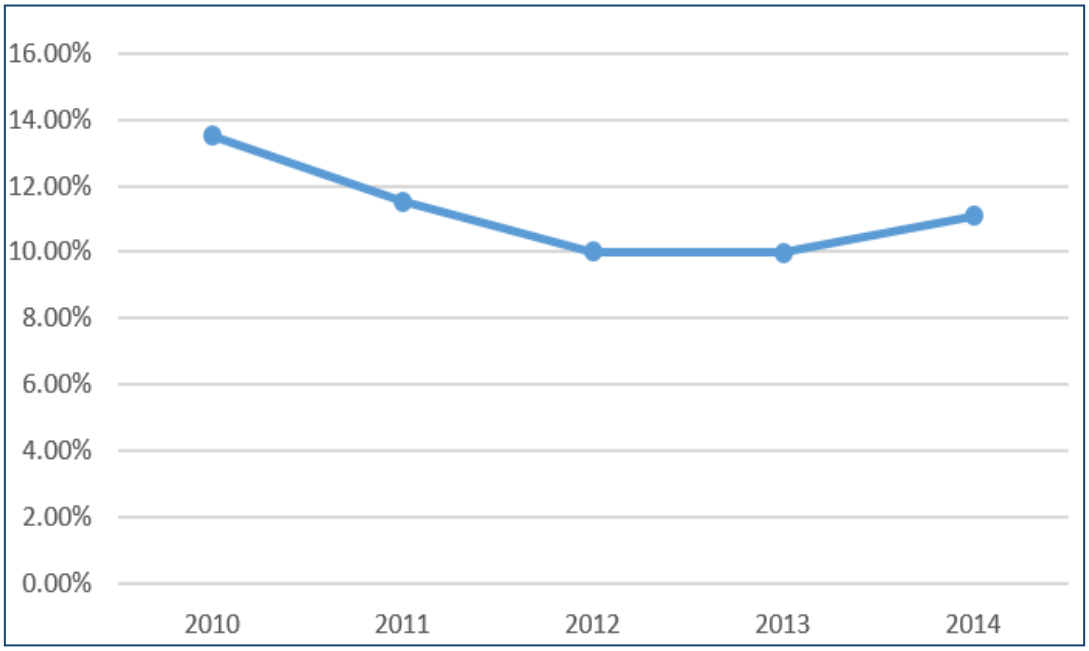


Figure 26 T&D Loss (Sri Lanka Sustainable Energy Authority, 2015)

The major underlying issues in the power sector of Sri Lanka are found to be as follows:

- Cost of generation being higher than the recovery though tariffs
- Decreased reliability of supply
- Increasing debt of the Ceylon Electricity board which increases credit risk for private sector investments and has reduced infrastructure investment capability

Progress on regulatory measures that would cover areas such as commercial and technical quality, continued development of grid codes and performance standards for the power sector has been slow. Although tariff reform in the country has progressed through fuel adjustment charging being done, these efforts need to be sustained to improve the economic regulation of the sector.

On the policy and institutional development side, the government formed the Sustainable Energy Authority in 2007 tasked with planning and policy for the energy sector and the entity has been playing a significant role in providing institutional frameworks for the development of the sector especially with regards to renewable energy.

Corporate reform of the Public Utilities Commission of Sri Lanka has also been slow and targets have been missed in recent years; however, the path of the reform appears to be heading in the correct direction.

Though end user energy demand has increased in almost all sub categories i.e., petroleum, Power, and biomass, the electricity demand growth was significantly low in comparison with previous years. In contrast to typical trends in a developing economy, total increase in power generation was only 4.2 percent, while the maximum demand recorded was with a 2.7 percent decrease. Domestic sector and commercial entities have the highest energy demand, with 48.44% of the overall energy demand in the country. Whereas the balance demand was shared by industrial and transport sectors; consuming 25.64% and 25.92% respectively.

Considering increasing trend of oil prices and major delays in execution of low cost power projects (including coal power plants and indigenous RE resources), strategies for demand side management have gained greater importance. Thus in light of the current situation, more investment to improve energy efficiency in all sub segments and at all levels along with development of renewable energy should be a priority in future planning. Apart from many long term economic, social and environmental benefits, it will counterbalance the short term adverse effects of delayed power projects.

In order to remain competitive in the global markets, Sri Lanka need to consider long term strategies for macro level applications, such as electrifying railway transport, improve mass transportation systems, and effective application of energy efficiency services in all other sectors of economy.

Globally Sri Lanka is among pioneers in various initiatives on energy efficiency and conservation. Thus Sri Lanka has vast experience to develop and deploy legal framework and execution of various energy efficiency interventions. Similar to international trend of energy efficiency evolution, legislation in Sri Lanka on energy efficiency is clearly connected to the oil crisis that was raised first time in 1970.

Energy Conservation Fund, Act No. 2 (1985), was the first piece of legislation, while the Sri Lanka Sustainable Energy Authority act No.35 (2007) was the second to follow. These legislations were mostly formulated to promote energy conservation culture and motivate end users to save energy, whereas in recent legislations more and deeper attention is given to implementation with comparatively more reliance on mandatory measures. Many success stories out while implementing energy efficiency and conservation programs in Sri Lanka, including popular efficient cook stoves and nationwide publicity campaigns, provided worthy experience along with huge economic benefits. Others valuable programs are utility driven CFL program that helped Sri Lanka in becoming among highly penetrated worldwide markets for CFLs.

Sri Lanka has been effective to access a variety of technologies on energy efficiency; those are arranged in a directory. Although not much research and development is taking place in the area of energy efficiency in Sri Lanka, yet efforts are underway indigenously.

4. INTERNATIONAL EXPERIENCE

Energy efficiency gained attention of the developed world and also some of the developing countries during the 1970s. It was realized without the energy efficiency improvements since the 1970s nations in the Organization for Economic Co-operation and Development would have used 49% more energy in 1998 than what they actually used. Under this study some of the specific policies and programs in the United States, China, Japan and Germany are evaluated and tried to show how they have saved a considerable amount of primary energy due to those policies.

A study conducted in 2016, involving 30 developing countries ranging from Bangladesh to Zambia; explained that higher energy efficiency improves total factor productivity in a large majority of the countries contrary to the belief among some policy makers that the economic output might suffer with energy efficiency interventions. Through appropriate policies and regulations and their successful implementation, the developing world will be able to harness higher economic returns. At the same time, in countries like Viet Nam where the government has been emphasizing energy efficiency and conservation polices in recent years, the implementation of such policies on the ground has been challenging (Luong 2015). Some of the challenges include (i) lack of information and data to establish benchmarks and to measure improvements, (ii) lack of readily available expertise locally and inadequate support for international expertise, and (iii) inadequate follow-up government support, which is critical for implementation success. In many countries, even though market instruments and economic incentives have a significant role to play in energy efficiency interventions, particularly in subsectors such as building construction, regulations are increasingly used where the market tends to fail. Building codes and appliance labeling are some of the examples where regulations play a key role. Moreover, in all the countries, private sector involvement through mechanisms such as the use of energy service companies is critical to further energy efficiency interventions since government budget is always constrained by other priorities (World Energy Council 2013).

4.1 Summary of Global Energy Efficiency

A wide range of policy measures to implement energy efficiency are adopted by majority of developed nations and a considerable number of developing nations. Broadly, adaptation of these policies depends on suitability to national circumstances and to address numerous political goals.

In order to meet the challenge of global warming and climate change impacts, a large number of nations have adopted ambitious energy efficiency programs. Energy efficiency facilitates nations to relieve the financial burden of importing oil on their trade balance as well as improvement in energy security. Energy efficiency has proved as best strategy in improving the competitiveness among industry, through energy cost reduction and economic growth stimulation and creating jobs with the investments being generated.

Energy efficiency plays an important role to reduce investment in energy, thus helping emerging economies to get most out of existing resources to improve energy access. There are two benefits of improving electrical energy efficiency. One benefit is that with the same electricity generation capacity more customers, thus increasing electricity access to more people, being a major challenge in many African and Asian countries. Other benefit is to slower down power demand growth, thus less investment is needed to expand electricity generation capacity. Other benefits of energy efficiency include reduction in the impact of oil price volatility on the balance between import and export and on subsidies, in case of subsidized rates. Energy efficiency is now equally a concerned for energy producing countries, since they also have realized that by not using efficiently, they are wasting valuable resources.

4.2 Global Energy Efficiency Status

As of 2016, world is continuously improving outcome from energy use. Global energy intensity primary energy demand/GDP has fallen by 1.8%. Since last six years, energy intensity on average has declined annually by 2.1%, with a considerable increase if compared with the average rate of 1.3% during 1970 to 2010. Improvement in energy

intensity varies vastly country to country and region to region, while China has the most significant impact on worldwide trends. Thus avoiding large quantity of energy consumption, generate considerable financial savings at consumer end and controlling growth in greenhouse gas emissions. Apart from these positive impacts, there is lot more potential for further improvements. Role of policy has a mixed trend, and further implementation of policies has been slowing down. With such pace of policy implementation, present level of energy efficiency achievement will quickly disappear.

According to an estimate, without efforts towards improvements in energy efficiency since last couple of decades, the global energy consumption would have been higher by 12% than that of existing. It is assumed that without use of energy efficiency applications, overall global energy consumption would have had an upward trend. Rather due to energy efficiency it is considered that by 2007 total energy consumption has reached to its peak.

Energy intensity reduction has a major role in in stabilizing global energy related greenhouse gas emissions. Lower energy intensity mostly resulting in efficiency improvements, in combination with the rapidly shifting to REs and other low carbon sources are contributing at large to counterbalance the impact of growth in GDP on emissions.

In similar manner developed world has been benefitted allot from energy efficiency in terms of improving energy security. With the efficiency improvements, in last couple of decades many countries have reduced their additional expenditure on energy imports. For example in Japan, has reduced their oil imports by about 20% and gas imports 23% just by improving energy efficiency. Similarly Germany and the United Kingdom, achieved significant amount of savings in gas imports from Russia. Energy efficiency is also quite helpful in reducing daily peak demand has, thus improving short-term energy security. That’s the reason United Kingdom and France have suppressed the daily additional supply of 240 million cubic metres that would had needed during periods of peak demand. This is five times more than that of daily withdrawal capacity one of the largest gas storage site in UK, so as to maintain existing levels of short term security.

Alone improvements in Energy efficiency in domestic sector has helped in global energy savings by 10 – 30% in annual energy spending. For example, on average, domestic sector in China has reduced its energy consumption by 25% through efficiency implementation. Policy actions and technological advancements have played an excellent role in bringing continuous improvement in energy efficiency in buildings. Building envelope remained primary focus of policies, instead of heating and cooling appliances. There is significant potential in achieving more savings in energy usage through developing and/ or strengthening energy efficiency standards.

Internationally energy efficiency investment has crossed the figure of USD 231 billion, i.e., an increase of 9% alone in 2016, with an upward trend. China and Europe are biggest shareholders in global investment with a share of 24% and 30% respectively. Sector wise building sector is dominating energy efficiency investment, being responsible for 58% of the world total that goes mainly to building envelopes, lighting and appliances.

Globally market for energy service companies (ESCO) is expanding speedily. China having strong government incentives, is leading as the largest market for ESCO, with over 60 percent of the global revenues. The US and Europe are the next two major ESCO markets with 20% and 10% of the global revenues, respectively. Globally more than one million people are employed by ESCOs.

Many countries have energy efficiency is now a tradable commodity. For example in France and Italy, energy savings are traded in the form of white certificates. It is expected that digital technology would enhance the capability for energy efficiency so that it can participate in electricity markets.

Another avenue is that in many countries, household devices are connected to networks and other devices, providing more accurate control of consumption hence generating new ways for energy savings. Worldwide four billion connected devices were recorded in 2016 being in use in households and it is expected that this number, would triple by 2020. Half a billion smart meters that can track and display electricity use in real time, are either installed or in process of installation. These smart meters along with other

many benefits can supplement connected devices that allow consumers to modify consumption in accordance with price variation.

According to EIA's Marker report of energy efficiency 2017, overall policy progress has slowed down since 2009. The IEA "Efficiency Policy Progress Index" (EPPI), that measures changes in the coverage and strength of mandatory energy efficiency policies since 2000, has increased by half a point in 2016, in comparison to an average increase of about 0.75 since 2010. The reason for this slower rate in the EPPI is that very few new policies are coming into force. In recent years China, having an EPPI of 10.9 points during 2016, is the global leader for implementation of mandatory efficiency policies.

Stronger policy formulation and implementation is a must to maintain and accelerate present level energy efficiency achievements. Governments essentially need to realize the importance to develop and implement more ambitious policies. Expansion in energy efficiency policies and their coverage during 2015-2016 is given below (Table 2).

Table 2 Selective energy efficiency policies (Source: World Energy Outlook 2016)

Region	Sector	New policy measure
China	General	Improve energy intensity by 15% by 2020 compared with 2015 (13th Five-Year Plan). Circular Economy Promotion Plan supporting industrial parks and waste recycling.
	Industry	Planned closure of 100-150 Mt of inefficient steel capacity within five years.
United States	Buildings	Energy conservation standards for air conditioners, heat pumps, walk-in coolers and freezers, residential boilers, battery chargers and dehumidifiers.
	Industry	Introduction of energy conservation standards for clean-water pumps.
European Union	General	Germany: Competitive tenders for electricity saving projects, support for efficient cross-cutting technologies and waste-heat recovery. Poland: New act on energy efficiency including obligatory energy audits and a modification of the efficiency certificates system.
	Buildings	Proposal to revise the EU Directive on energy labelling of consumer appliances.
India	Transport	Plans to implement a "green tax" of 1% on small petrol, LPG and CNG cars, 2.5% on certain diesel cars and 4% on larger cars and SUVs.
	Buildings	National Energy Efficient Fan Programme to distribute efficient ceiling fans.
Middle East	Buildings	United Arab Emirates (Dubai): Plan to introduce energy efficiency ranking of buildings and MEPS for retrofits.

4.3 Status of Existing Energy Policies Measures

4.3.1 China

Since 2006, China remained the world's largest GHG emitter. China has continued its long-standing efforts to improve the efficient use of energy in its economy. Under the Copenhagen Accord of 2009, China assured reduction in its emissions intensity up to 40-45 percent by 2020, from 2005 levels. As part of the 13th Five Year Plan, China set the goal of achieving energy intensity improvements of 15% within five years from 2015, slightly below the target over the previous five years of 16%. During a joint announcement in Beijing with US during 2014, two new goals were announced by China, including increase in its share of non-fossil sources to 20 percent and peaking of GHG emissions by around 2030 simultaneously.

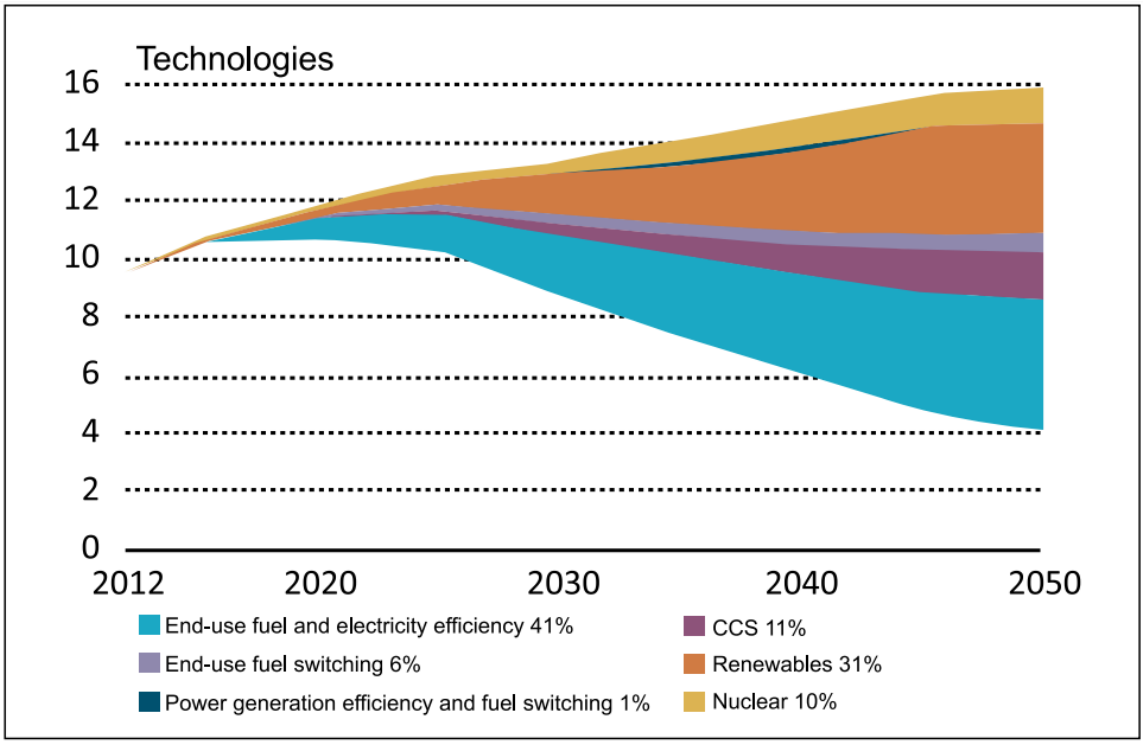


Figure 27 Contributions to China's emissions reductions

The same two goals along with another goal to reduce carbon intensity by 60-65 % below 2005 levels were later to the new international climate agreement, concluded in Paris in 2015. (Beijia Huang 2016)

4.3.1.1 Current status of energy efficiency in China

4.3.1.1.1 Energy intensity

China has successfully delinked its energy consumption from economic growth. From 1980 to 2017, while China's economy increased 25-fold, energy consumption increased only 6-fold. In the China, energy intensity has fallen by 5.2 % that reflects strong economic growth with lowest raise in energy demand. Taking in to consideration the Chinese economic size and energy consumption its greater impact on global energy intensity trends is very obvious. Fall in global intensity without China would have been very small, and this Chinese contribution is the best achievements in global energy

intensity reduction. Energy intensity in China has been reduced tremendously after 1990, with about 60 % reductions in 2016 (Figure 28).

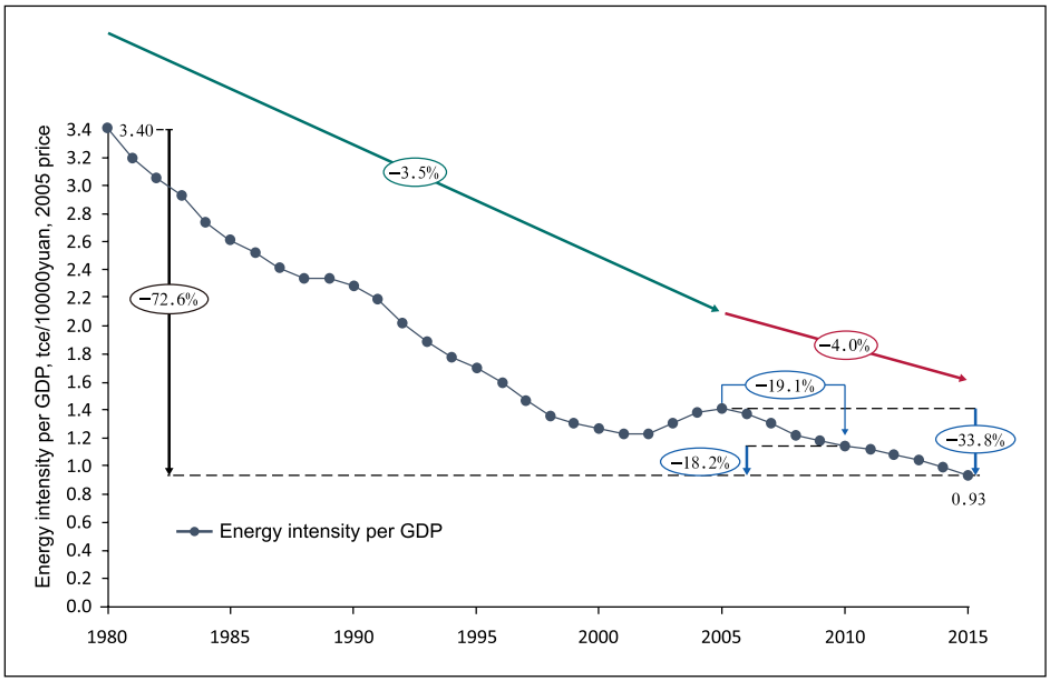


Figure 28 Trends in China's energy intensity per GDP over 1980-2015 (Source: China Energy Statistics Year Book 2015)

4.3.1.1.2 Overall energy efficiency policy framework

Out of entire global energy savings over the past twenty years; China is responsible for more than half of it that reflects the government level policy priorities. Sustainable development, energy conservation and climate change began to be incorporated into China's national strategic planning in the mid-2000s in a number of ways (Zou Ji, et al., 2016):

- For the first time, in the Eleventh Five Year Plan 2006, mandatory energy saving and emissions reduction targets were set.
- Environmental conservation and energy & resource efficiency were first time linked clearly with the economic development in a report to the seventeenth National Congress of the Communist Party of China, 2007.

- An active response to climate change was incorporated in the Twelfth Five Year Plan 2010, which also included the promotion of green and low carbon technologies development.
- Integration of climate change and sustainability with in all aspects of economic, social, cultural and political planning was advocated in the Report of the 18th National Congress of the CPC during 2011.
- During 2015, energy savings and environmental conservation and regeneration were regarded as part of China's fundamental development policies, published by the Politburo of the CPC Central Committee in Opinions on Accelerating the Building of Ecological Civilization. The Opinion also promoted the advancement of an 'ecological civilization' with ecological progress and innovation as pillars of development.
- China's Intended Nationally Determined Contribution, submitted to the UNFCCC Secretariat during June 2015, sets an efficiency target for newly constructed coal power stations at an average coal consumption of around 300 grams per kilowatt hour; improving energy efficiency is also indicated as one of the major initiatives in developing low-carbon industrial sectors (Category 4) and in promoting energy saving buildings, transportation systems, urban infrastructure, etc. (Category 5).

A detailed policy framework up to 2030, to improve energy efficiency has already been established by China. The latest 13th Five Year Plan targeting a reduction of 15% in energy intensity and to reduce carbon intensity 18% below 2015 levels by 2020. It also imposes a complete limit on energy usage at Five billion tons equivalent of standard coal.

Referring National Plan on Climate Change 2014; China has developed a Work-Plan to control GHG emissions during the time slot of 12th FYP that was later on incorporated into sector development plans, climate change plans and energy conservation plans in all sectors of the economy and also in to a plan for promoting Carbon, Capture & Storage (CCS) experimentation and demonstration (Figure 29). These plans comprises of sector specific interventions, including subsidies and mandatory indexes for the implementation and accomplishment of national level targets as per National Plan.

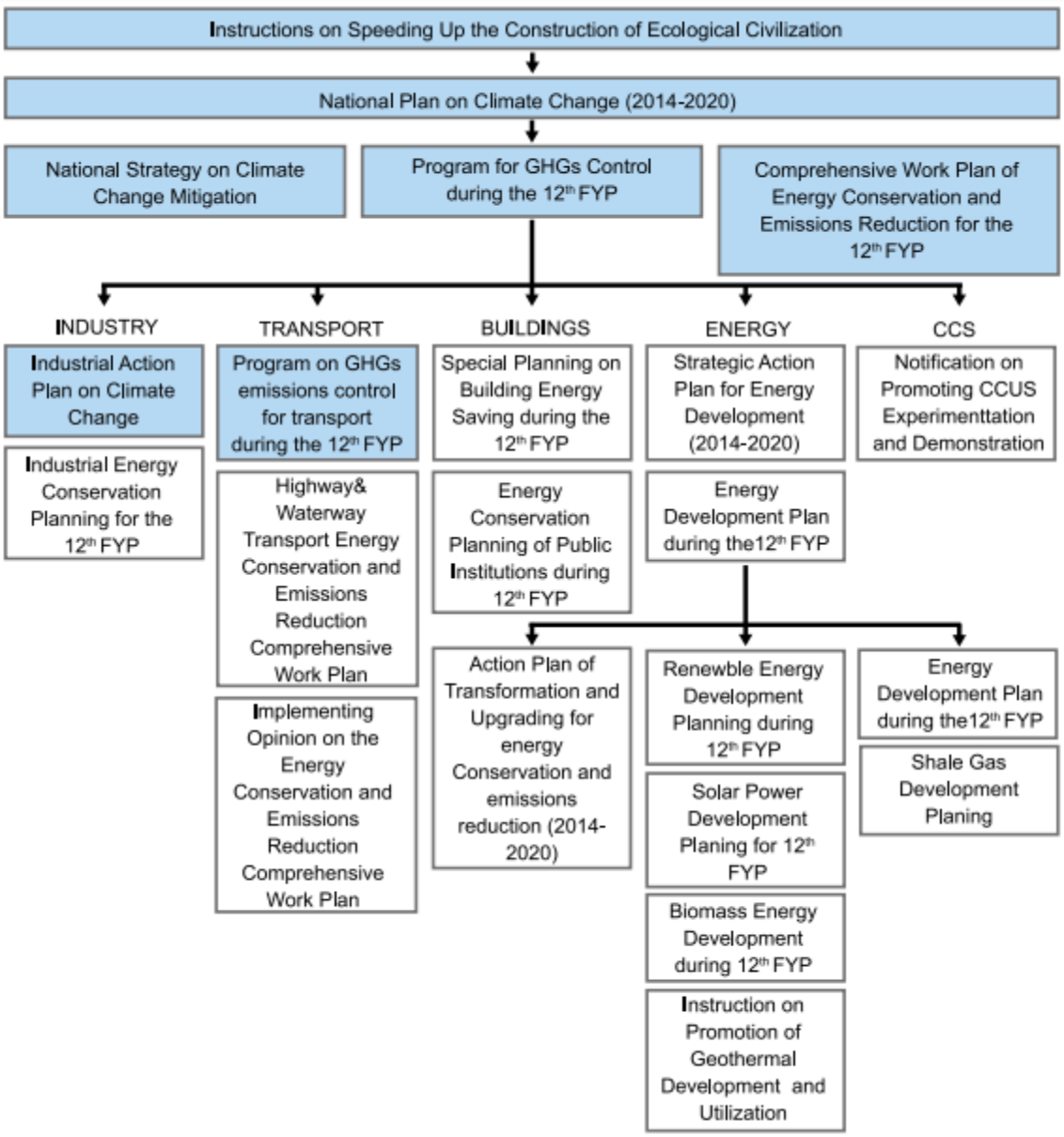


Figure 29 China's planning system on Energy Conservation and GHG emissions control (Source: Zou Ji, Fu Sha et al. 2016)

Relating to low carbon development, including energy conservation and RE laws, China has passed more than 30 laws and 90 regulations. In China the most common tool for energy conservation and climate change policy is Executive order. Mandatory standards and/or various required actions related to industrial sector, transportation, buildings and public procurements were executed through executive orders. Economic incentive is another tool being used by Chinese government through pricing systems and fiscal

support. Emission trading schemes were launched in in seven pilot regions, including Shanghai and Beijing. They were launched in 2013 and 2014, with total trading volumes of 40 million tonnes of CO_2 by the end of August of 2015. The government is also formulating an overall plan to implement a carbon-trading system which is expected to launch in 2018.

Energy Efficiency Standards and Labeling

National Development and Reform Commission (NDRC), the "Administration of Quality Supervision, Inspection and Quarantine" (AQSIQ), and the Standardization Administration collectively implemented the "One Hundred Energy Efficiency Standard Promotion Programme". AQSIQ is responsible to enforce inspections for energy efficiency labeling of project related products.

By September 2015, seventy mandatory energy efficiency standards and 105 compulsory energy consumption standards were published. For high consumption industries these standards included "limiting unit product energy consumption", and energy capacity and efficiency of end products.

In addition, various Ministries issue standards for industries that fall into their area of responsibility. For example, the Ministry of Housing and Urban Rural Development developed and approved Energy Capacity and Efficiency Standards for Buildings and Regulation on town level energy saving technologies for heating systems.

Table 3 Main features of energy conservation policies developed during Twelfth FYP

Sector	Policy	Policy instrument
Framework policy	Twelfth FYP Energy Conservation Target Responsibility System	Regulation
	Ten Thousand Enterprise Energy Conservation Programme	Regulation
Industry	Obsolete Capacity Retirement Programme	Regulation
	Energy Conservation Technology Fund	Incentive
	Differential Electricity Pricing	Economic instrument
	Small Business Closure Programme	Regulation
Building	Building Energy Efficiency Standards	Regulation
	Retrofitting Existing Residential Buildings	Investment
	Retrofitting Public Buildings	Investment
	Integrated Renewable Energy	Incentive
	Promotion of Green Buildings	Incentive
	Energy-Efficient Product Discount Scheme	Incentive
	Incandescent Lighting Phasing Out Programme	Regulation
	Differential Electricity Pricing	Economic instrument
	Ten Thousand Enterprise Energy Conservation Programme	Regulation
	Development of the Energy Services Industry	Incentive
	National Energy Conservation Campaign	Education
Transport	Commercial Vehicle Fuel Standards	Regulation
	Road Passenger Transport Capacity Control	Regulation
	Thousand Enterprise Low-Carbon Programme (transport)	Voluntary agreement
	Transport Energy Conservation Fund	Incentive
	Transport Energy Conservation Demonstration Projects	Investment
	Low-Carbon Transport System Development Programme (pilot)	Incentive
	Ten Thousand Enterprise Energy Conservation Programme	Regulation
	Energy-Efficient Product Discount Scheme	Incentive
Public	Public Sector Key Energy Conservation Projects	Investment
	City Green Lighting Project	Investment
	Compulsory Government Procurement of Energy-Saving Products	Procurement
	National Energy Conservation Campaign	Education

Buildings

The buildings sector is responsible for around 25% of the overall Chinese energy consumption that due rapid urbanization and raise in per capita income is expected increase up to 35% by 2020. The General Office of the State Council issued the Action Plan for Green Buildings in January 2013, which was jointly drafted by NDRC and the Ministry of Housing and Urban-Rural Development. The Ministry also issued the Special Blueprint of Conserving Energy in the Building Sector during the Twelfth FYP Period, which covers all public buildings operated by all levels of government. Some of the specific key measure implemented by China to control energy consumption in buildings

includes energy building codes, retrofitting in existing buildings, energy standards and labeling of appliance, and subsidies for energy efficient and RE appliances (Lo, 2013).

Energy Building Codes

Ministry of Construction (now the Ministry of Housing and Urban–Rural Development, MOHURD) issued Energy building codes (EBC) in 1986 for residential buildings cold northern regions of China. In 2000, EBC were extended to other regions where energy is more likely to be used for cooling purposes in summer season. These codes set national standards for design & building envelope materials as well as the heating, ventilating and cooling systems (HVAC). The enforcement of EBCs has greatly improved since 2006. The compliance rate increased with building energy codes improved by 40%, in 2010 from 2005 values. According to very recent inspection outcomes, reveal that in urban new buildings, compliance rate has been reached to 100% level.

Appliance energy standards and labeling

Electric appliances consume large amounts of energy. China's voluntary energy labeling system covering 40 products was launched in 1998 and became mandatory in 2005. The 5-tier labeling program which ranks appliances from 1 (internationally leading in efficiency) to 5 (barely meeting the energy standards) is called the China Energy Label. It was launched in 2004 and is now managed by the China Energy Label Centre under the China National Institute of Standardization. China has also set up specific programs to phase out outdated, inefficient applicants. For example, China launched the Incandescent Lighting Phasing-out Programme in October 2012 with bans on importing and selling traditional light bulbs over 100W. China also has multiple subsidy programs for a variety of energy efficient appliances (Table 4)

Table 4 Chinese Energy efficient Product discount scheme

Item	Year	Subsidy (RMB/unit)
Light bulbs	2008	30%–50%
Air-conditioners	2009	300–650(USD 45-98)
Flat-panel TVs	2012	100–400(USD 15-60)
Washing machines	2012	70–260(USD 10.5-39)
Water heaters	2012	100–550(USD 15-83)
Refrigerators	2012	70–400(USD 10.5-60)
Desktop PCs	2012	260(USD 39)

Subsidies for solar hot water have helped China grow into the world's largest market. The annual growth rate for the adoption of solar water heaters from 2000 to 2009 was already 21% without government subsidies. A rural subsidy program was launched by MOF in April 2009 followed by an urban scheme in 2012. The rural program provided up to 13% of the product price capped at 5000 CNY (USD 752) per unit for solar water heaters while the urban one offered up to 550 CNY (USD 82) per installation (Lo, 2013). China accounted for 70% of the world's installed capacity of 374.7GWth in 2013 (Mauthner et al. 2015)

4.3.2 United States of America

Having 19% of world consumption, US constitutes as the second-largest energy market after China during 2011 (Figure 30). While for proven oil reserves US ranks 13th and for natural gas reserves 4th. US still meet 60% of its domestic oil and 13% of gas demand, from international market. Buildings dominates US energy sector, responsible for 41% of overall national consumption, whereas out of this consumption residential buildings are responsible for more than half of this share.

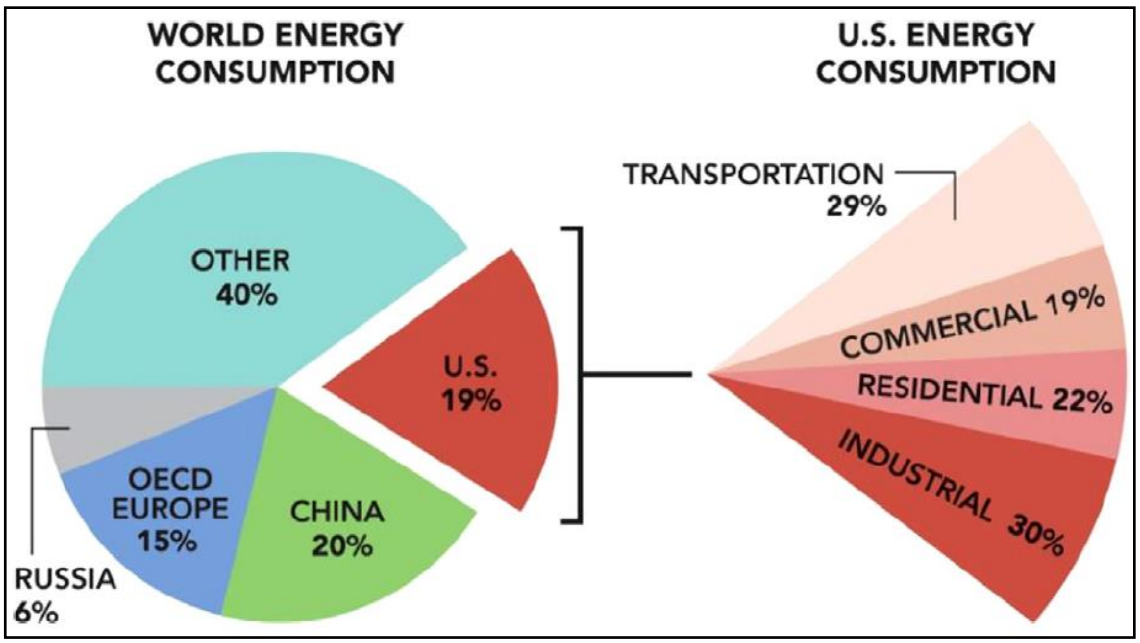


Figure 30 US share of world energy market and energy consumption of residential sector in US

Building energy policies in the US have been developed and implemented both at federal level and the state level. Mainly federal government is mandated to set standards for appliances and equipment, requires labeling and provides financial incentives. Whereas the state governments create their own Building Energy Codes (BEC); with few of them also have incentive programs in place. Federal government only supports states by providing technical assistance in implementation, adoption and enforcing BECs.

These BECs, are apply model codes developed by by the International Energy Conservation Code (IECC) along with the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE. Local climate and environment determines Codes' stringency as well as interests of local stakeholders. In majority of states BECs are obligatory while some have tightened their regulations. According to US federal policy, new building's energy demand has to be decreased by 70% with a potential to reduce GHG up similar percentage in 2020.

During 1999 U.S. Environmental Protection Agency (EPA) organized Home Performance with ENERGY STAR Program (HPwES). Department of Energy and US EPA jointly offered ENERGY STAR with the focus on appliances performance. Along with aiming energy conservation, HPwES ensures contractor's' energy audits should result in real

improvement in the energy efficiency and comfort of households. The policy anticipates attaining at least 20% savings in energy consumptions. The program provides technical support as well as assistance to NGOs, state energy offices and utilities public benefit funds, etc.

HPwES only evaluates processed, whereas ENERGY STAR Programs mainly on products such as domestic appliances etc. By 2012 ENERGY STAR label was earned by more than 1.4 million new homes. During these two decades, about 27,000 builder helped homeowners in USA to save $4 billion on their energy bills.

LEED is another prominent federal energy policy developed by the U.S. Green Building Council (USGBC). It is a set of rating systems to address green buildings' design, construction, operation, and maintenance of homes and neighborhoods. LEED was initiated to facilitate building owners and operators to use resources efficiently and be environmentally responsible.

US energy consumption increased by 26 % during 1980 to 2014, while over the same period, US GDP increased about 149 %, meaning that energy intensity improved by 50 %, declined to 6.1 in 2014 from 12.1 thousand Btus per US dollar in 1980. Energy efficiency was the major contributor to this improvement of average 2 % annually. While another factor partly responsible for these efficiency gains were the US economy shifts away from few energy intensive segments such as heavy manufacturing. It can be conservatively estimated that 60% of this energy intensity improvement was due to efficiency improvements and 40 % due to structural shifts. Energy efficiency savings in 2014 were around 58 quadrillion Btus (1 quadrillion = 10^{15}), worth $800 billion (based on the average energy price during 2014) i.e., about $2,500 per capita.

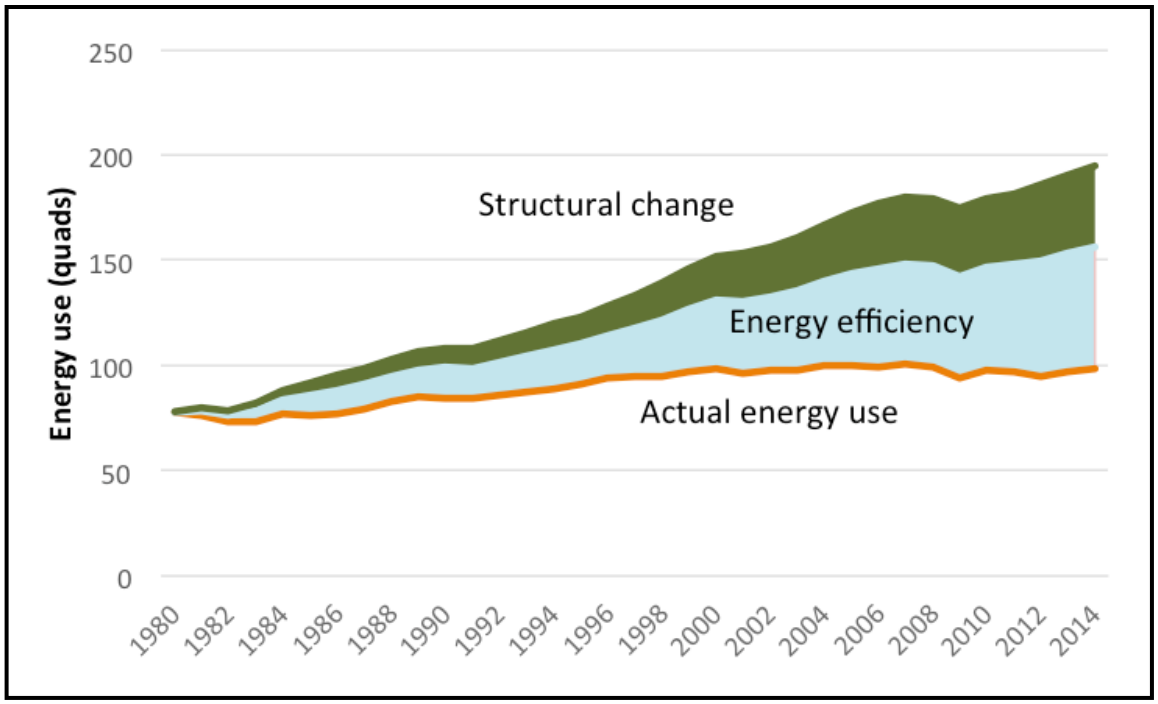


Figure 31 US Energy consumption (1980–2014): actual and estimated structural and efficiency impacts. (Source: EIA 2015)

Additionally, energy efficiency savings have contributed to US energy security and improved its environment over the past 35 years. For instance petroleum imports in 1983 accounted for 33% of US crude oil consumption, declined to 44% in 2014. Among other contributors to this decline such as the Great Recession of 2007–2010 and growth in domestic energy production; energy efficiency improvements particularly vehicle fuel economy was the prominent one. Energy consumption reduction is directly linked with emissions reduction such as combustion by products including CO_2, SO_2 and NO_x, mercury and other toxic metals.

By 2014, CO_2 emissions in US were 5,404 million metric tons, meaning that 10% lower from 2005 levels. Energy efficiency has major role in US plans to reduce emissions level in 2020 to 17% lower 2005 levels.

BUILDINGS AND EQUIPMENT

According to US Energy Information Administration estimations during 2014, the buildings sector was responsible for around 41% of its total energy consumption comprising lighting, heating, cooling, hot water, and various types of appliances and

equipment. During the past 35 years there have been substantial improvements in US building energy efficiency having summarized key trends separately for the residential and commercial sectors.

Residential

Total energy consumption in residential sector increased by 37% between 1980 and 2014 from 15.8 quads to 21.5 respectively (EIA 2015). Half of this raise in consumption is due to the increase in the number of households, whereas other contributors include growing household size (space per single family household) with an increase of about 23%. On the other hand, energy efficiency has helped reduce the consumption increase.

4.3.3 Germany

Germany is the fourth largest economy on the map of world. Germany is among largest consumers of energy in Europe, and ranked on eighth position in the world. Germany has limited energy resources, therefore to fulfill its energy needs it is completely dependent on imports (with 96% share of oil and 87% natural gas).

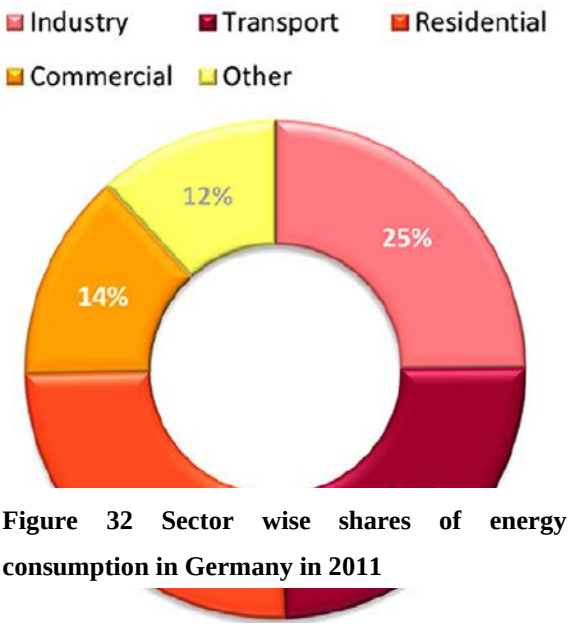


Figure 32 Sector wise shares of energy consumption in Germany in 2011

Germany is ranked as global leader in energy efficiency leader, and with decrease in its fossil fuels consumption and expanding renewable resources it may adapt its energy sector to current environmental obligations and standards. In Germany about 18 million residential buildings account for about a quarter of Germany's total final energy consumption (Figure 32).

General trend in energy consumption in households of Germany has been decreasing during last two decade. Housing energy demand diminished by 14% in 2011, mostly in response to fossil fuel depletion (Figure 33Figure 32).

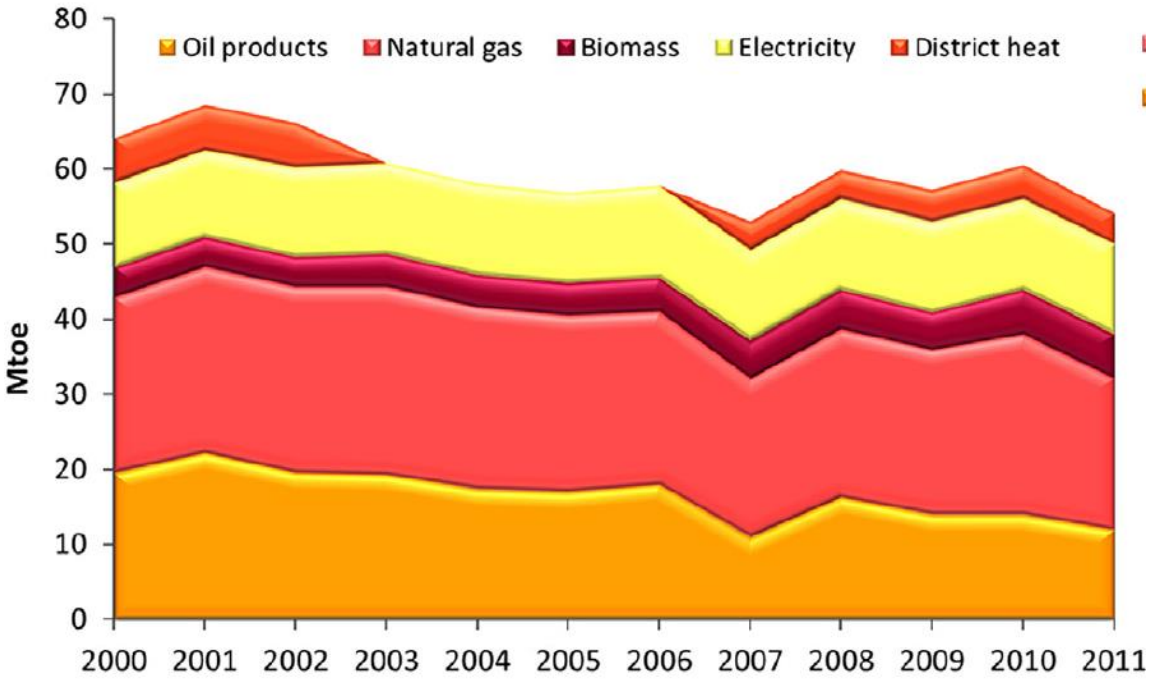


Figure 33 Germany's residential-sector energy consumption by energy source

In Germany biomass and district heating are minor sources that account for a total of about 18% share in energy supply. Like the other developed countries, coal is insignificant (2% of TFC). Although Germany finished last decade with the successful implementation of modern renewable energy measures, is the sector still has a long way to go to surpass powerful fossil fuel rivals (1.8% of TFC).

Germany's overall CO_2 emissions dipped sharply by more than 20% during the last forty years, but the country still accounts for 2.5% of the world emissions. Alongside the other sectors' trends, the residential sector contributed effectively to emissions mitigation, and the direct CO_2 emissions from residential buildings stood at 89 Mt in 2011, which is 30% less than it was in the 1990s.

Germany is among the world leaders in terms of strict energy efficiency policies. In 2010, the government set an ambitious target or an 80% decrease in the primary energy demand as well as CO_2 emissions (compared with 1990 level) for the buildings sector by

2050. The government has also employed financial incentives, offering grants and low-interest loans for energy efficiency activities. For example, the cost of thermal renovation of existing dwellings can be returned through the value of energy saved for space and water heating In Germany, BEC specifications are determined at national level by means of the Energy Saving Act (EnEG) and the Energy Saving Ordinance (EnEV). Energy requirements in the German BEC are stricter, comparing with other countries because the BECs have been strengthened five times over the past three decades. Recent amendments to the Energy Saving Ordinance in 2009 raised the minimum energy performance requirements for new and existing buildings by 30% on average. The German BEC includes minimum energy performance requirements (MEPs) and energy certificates. However, the 2010 redefinition sets a new target for new buildings to be at "nearly-zero energy" performance by the end of 2020, which can have a considerable effect on Germany energy saving objectives.

A Top Runner Initiative on national level for residential appliances was launched in 2016 under the National Energy Efficiency Action Plan. Another program was launched to fund pilot projects on smart grid so as to reduce waste heat in commercial and industrial sectors. The purpose is to encourage energy efficiency improvements in the industry and services sectors at system level and a green paper on energy efficiency.

Green paper on energy efficiency

Interactions among energy efficiency, RE energy and power market is under considerations by policy makers; especially in nations having ambitious targets for energy efficiency and emissions reduction. Germany is considered one of such countries that is pursuing policies to reduce its primary energy demand, improve overall system efficiency and increase RE supply. Germany released a Green Paper in September 2016 on Energy Efficiency with a focus on how to enhance sector wise energy efficiency and cost effectiveness of renewable energies. This paper was based on three principles:

- Reducing demand in all sectors ("Energy Efficiency First"). Increasing investment in energy efficiency technologies to halve energy demand by 2050 and using renewable energy to cover remaining demand.

- Direct use of renewable energy. Increasing the use of renewable energy, such as solar thermal, geothermal, waste heat and bioenergy for heating, building air conditioning and hot water.
- Renewable power is used efficiently for heat, transport and industry ("sector coupling"). The demand for energy that remains, despite efficiency measures and direct use of renewable energy, is covered by power from the wind and sun, primarily in technologies that replace fossil fuels with a small amount of power, or convert power into other energy sources such as hydrogen.

These principles also supported market design reform strategy of Germany "Power 2030"along with a combined aim to expand the efficient use of RE sources in the transport and industrial sectors.

5. PLAN OF ACTION FOR IMPLEMENTATION OF SUITABLE EE POLICIES AND MEASURES IN SAARC MEMBER STATES

5.1 Conclusion

In order to meet multidimensional policy objectives, energy efficiency is a win-win opportunity, in terms of energy security, competitiveness, reduction in investment in power generation projects to cater for increasing demand in developing countries, and to address issues of climate change & local pollution. Apart from consumer end reduction in energy bills, it also reduces consumer vulnerability to supply interruptions and price variations. I also help improve economic competitiveness with in the industry through reduction in production costs. It can contribute to alleviate poverty or improve quality of life in developing nations, especially vulnerable part of the communities. Energy efficient entities, whether it is an industrial unit, a commercial building or a single house, it always will have a higher monetary value and improved working as well as living conditions. Although the whole society gets benefited, yet market, financial and institutional barriers are often considered main barriers in implementing energy efficiency initiatives.

To reinforce the institutional framework for energy efficiency, adoption of laws related to energy efficiency is highly important and a growing trend in developed world. Establishing of agencies specific to energy efficiency, are increasingly recognized as compulsory tool to support implementation of policies. Most of the SAARC Member States have adopted various national level energy efficiency programs with quantitative targets.

In lowering energy consumption of specific appliances, regulations are equally used due to their proven effectiveness. Regulations are also helpful in speeding up the market diffusion of efficient appliances, equipment and energy savings practices.

Economic incentives are also very helpful to encourage investments in efficient appliances, buildings and industrial processes because of lowering investment cost. Due to limitation of public funding, participation of the private sector is highly desirous to invest in energy efficiency. Obligatory energy savings is an innovative technique, where

energy companies are legally bound to undertake energy efficiency approaches with their customers.

Coming to SAARC region, through some implementation of similar mentioned initiatives, regional primary energy intensity is showing decreasing trend, yet there is long way to go as there is a huge potential to show prominent improvements in the energy efficiency and conservation situation as whole and bring significant decrease in oil imports.

5.2 Recommendations

Based on the analysis and observation of the energy efficiency status in SAARC Member States, and evaluating their policy regime, some recommendations are proposed. These recommendations are expected to facilitate Member States boost their energy-efficiency policies and help in achieving their targets for effective implementation of energy efficiency programs. These recommendations are based on the rich experience of advanced nations such China, USA, Germany etc., international organizations and also SAARC Member States whom in have been successful in policy implementation in various segments of bringing energy efficiency in to their systems:

5.2.1 Adjust Energy prices linked with actual costs, while incentivize consumers for energy efficiency investments

In order to give clear picture to consumers and keep them part of real situation, Member States with subsidized energy prices should adjusted local energy price gradually to the real cost. It is important to share that few of SAARC Member States are convinced on it, and they have successfully deregulated their domestic energy price.

This is a slow process to be adopted through variety of strategies bring up price reform. One way could be forming a regulatory commission for pricing that can openly link the actual revenue to expenditures and through 'safety nets' protect the economically deprived segment of population.

So Member States already having higher energy prices, find difficulty to provide incentive pricing signals for investments in energy efficiency, can avoid price fluctuation by providing long term signals for consumers and investors to avoid price fluctuations.

5.2.2 Mass awareness campaigns to keep consumer well informed

To achieve consolidated and effective results in energy efficiency implementation, timely, simple and collective dissemination of information should be the top priority of the implementing agency. Governments should launch awareness campaigns and develop local information centers easily accessible to consumers.

Governments should also improve level of information to households on possible interventions according to their convenience, and facilitate consumers' initiations through sharing updated lists of service and appliance providers, such as efficient appliances available in the market, energy audits, ESCOs etc.

Governments should support and provide smart meter smart billing and in house display along with software applications on their phone being highly p otential approach towards saving energy, since it motivate consumers have a check and control on its electricity use, hence resulting in reduction in consumption.

Voluntary agreements and sectoral benchmarking should be promoted; they have proved very effective in many advanced nations, in terms of energy efficiency applications in commercial buildings.

5.2.3 Support Consumers' investments through various financing tools

Governments should devise simplified and easy financial support schemes and centralize information on existing processes. Economic incentives may be linked to various energy or environment funds from variety of other sources such as dedicated taxes, banking system, or financing institutions, instead of public budget alone.

Private should be encouraged to invest in energy efficiency so as to facilitate developing intermediate third parties including ESCOs, utilities and installers. They play a multiplying role to fill the financing gap to execute projects. Energy companies being investors should be obligated to implement energy efficiency could be another good too to finance energy saving measures. Similarly loans with lower interest rates and longer lending period with affordable monthly repayment plans need to be encouraged for implementation of large

scale building interventions including diffusion of large and costly appliance and equipment like solar photovoltaic and solar heaters.

In rural area, micro financing could be a highly effective tool to promote energy efficient equipment such as cooking stove and to subsidize biogas plants.

5.2.4 Quality control of energy efficient appliances and services

Quality check and control of both locally produced as well as imported products should be prime responsibility of governments, in particular domestic appliances including CFLs, Fans, Washing Machines, Refrigerators, Air conditioners, as well as installations techniques. This can be achieved through certification and standardization of appliances & equipment, the installers, and auditors. Moreover, regional approach is needed to be promoted and adopted for harmonization of testing procedures. Quality labels for appliances, equipment and services should be encouraged through public incentives.

5.2.5 Enforcement of regulations and regular monitoring during implementation

To promote energy efficiency, regulations are a powerful instrument. Yet their impact is dependent on effective implementation and proper compliance. Effectiveness of a policy and a program must be evaluated during execution and post implementation. Otherwise, noncompliance will impact the actual energy savings significantly. Related penalties should be well defined that can serve as productive disincentives in case of noncompliance.

In order to stimulate technical progress and to ensure a stable improvement in energy efficiency Labeling programs and standardization schemes must be revised and upgraded on regular basis. Though practically this process could be reasonably long and causes delay. In order to guarantee their regular updating, revisions in Minimum Energy Performance Standard (MEPS) should be embedded within the regulations.

5.2.6 Change in human Behaviors should be equally focused as technological advancement

Thanks to research and innovation in promoting technologies and services that facilitate efficient energy consumption behaviors such as awareness on specific fuel consumption, Air conditioner temperature control, level of vehicle tyre pressure etc.

Governments must promote the dissemination of technologies to limit the impact of inefficient behaviors by introducing speed limiters, sensor for lighting, auto set mode programs to save energy in appliance.

Being aware of how energy is used is one of the best approaches to be energy efficient. In result to make conscious decisions, energy efficiency can be achieved through energy conservation. Various studies have revealed that just by modifying behavior of consumer towards efficient electricity use, SAARC Member States can save 8-12 % of electrical energy per month for a common household.

Almost all SAARC Member States are struggling hard in this aspect through media campaigns, community projects, awareness workshops, involving educational level programs, but it is observed that none has achieved the desired levels in changing the consumer behavior. It needs some consolidated program with consistency and continuity. And that obviously involves relatively higher financial inputs. It is proposed that the basic key towards successful energy efficiency plan in place is to change mind of the people. It starts with energy conservation and later on can easily shift to energy efficiency interventions as well. It is recommended that SAARC Members States should bring aggressions and innovation in

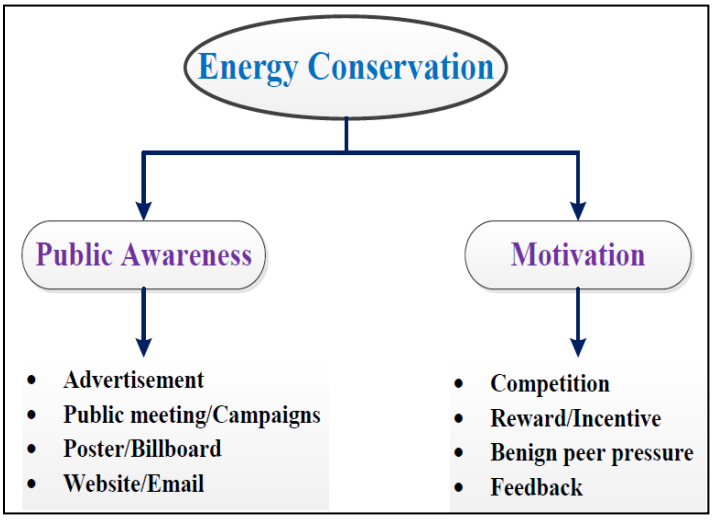


Figure 34 Effective factors of Energy Conservation

their public awareness approaches, while SEC should also proposes a regional awareness plan along with an aggressive media campaign.

5.2.7 To check the genuine effect of policies relevant to energy efficiency, Monitoring accomplishments and the effects of measures is compulsory

They should include:

- Collection of end-use data.
- In order to monitor yearly basis progress, energy-efficiency indicators need to be developed.
- To improve measures, how effective they are, measure evaluation is to be carried out based on different criteria (e.g. cost adequacy, economic impacts, bounce back effects, free rider effects).
- Promotion and utilization of institutionalized methods for estimating energy savings.
- Enhancing monitoring reporting and verification for global financing.

5.2.8 Global and regional collaboration ought to be improved

The advancement of international standards could improve universal and territorial collaboration in addition to regional testing and harmonization facilities and accreditations.

Nations should keep on exchanging their trial with a specific end goal to benchmark arrangements and recognize best practices.

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