Energy Efficiency Improvements in Power Generation and Distribution Sectors of SAARC Countries

Importance of Energy Efficiency Improvements and Need for Study

15 February 2021
Content

1. Overview of Power Generation, Distribution & Losses

2. Importance of Energy Efficiency

3. Approach and Methodology
Overview of Power Generation & Distribution
## Overview of Energy Profile of SAARC Countries

<table>
<thead>
<tr>
<th>Country Name</th>
<th>Afghanistan</th>
<th>Bangladesh</th>
<th>Bhutan</th>
<th>India</th>
<th>Maldives</th>
<th>Nepal</th>
<th>Pakistan</th>
<th>Sri Lanka</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per Capita Energy Consumption (kWh/year)</strong></td>
<td>145</td>
<td>433</td>
<td>3126</td>
<td>935</td>
<td>1,064</td>
<td>229</td>
<td>557</td>
<td>616</td>
</tr>
<tr>
<td><strong>Total Installed Capacity (MW)</strong></td>
<td>520</td>
<td>22,562</td>
<td>2,326</td>
<td>371,054</td>
<td>251</td>
<td>1,020</td>
<td>35,972</td>
<td>4,046</td>
</tr>
<tr>
<td><strong>Total Generation (GWh/year)</strong></td>
<td>1285</td>
<td>70,533</td>
<td>6,172</td>
<td>1,389,121</td>
<td>704</td>
<td>2,548</td>
<td>128,564</td>
<td>15,985</td>
</tr>
</tbody>
</table>

Global average per capita: 3081 kWh/year

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Afghanistan

**Power Generation**
- Net installed capacity: 520 MW
  - Hydro Power Plants: 252 MW
  - Thermal Power Plant: 268 MW
- Total power generation: 1,285 GWh
- Total power import: 4,931 GWh
- Power importing countries: Uzbekistan, Tajikistan and Kyrgyzstan.

**Generation mix**
- Installed Capacity:
  - Hydropower: 13%
  - Thermal Power Sources: 39%
  - Distributed generators: 49%
- Generation mix:
  - Hydropower: 1%
  - Diesel: 17%
  - Fuel Oil: 2%
  - Import: 80%

**Power Distribution**
- Afghanistan’s transmission network: 1,905 km
- Transformer Capacity: 1,544 MVA
- Operating voltage level: 20/15/6 kV
- Distribution Zones: 10
- Distribution Network: 4, not synchronised with each other

**Distribution Losses**
- 2015: 37.9%
- 2016: 47%
- 2017: 48.6%
- 2018: 42.2%

*Net consumption is expected to grow ~45% in the coming decade*
Bangladesh

Power Generation

- Net Installed capacity: 22,562 MW
  - Gas Based GT units: 12,860 MW
  - Furnace oil based thermal power plant: 5,685 MW
  - Electricity import: 1,160 MW
  - Total domestic power generation: 70,533 GWh
  - Total electricity sale to utility: 61,836 GWh

Power Distribution

- Distribution Utilities: 6
- Total number of customers: 37.4 million.
- Distribution System Loss: 8.12%
- Transmission system loss: 11.96%
- Distribution Lines: 581,000 ckt. Km
- Grid Substation Capacity: 45,277 MVA

*Net consumption is expected to grow ~130% in the coming decade*
Bhutan

**Power Generation**
- Installed capacity: 2,326 MW (99% hydropower plant)
- Total power generation: 8,452 GWh

**Power Distribution**
- Domestic power consumption: 2,280 GWh
- Export of Power: 6,172 GWh
- Total Consumers: 192,859
- Total length of distribution lines: 1,709 ckt km
- Bhutan has 100% electrification rate in both rural and urban sector
- Peak Demand: 399 MW
- Losses in distribution network: 8%

**Generated Power**
- Hydropower: 99%
- Other: 1%

**Generation Mix**
- Domestic consumption: 34%
- Export: 66%

Data of year 2019

*Net consumption is expected to grow ~40% in the coming decade*
India

**Power Generation**

- Total installed capacity: 371,054 MW
- Thermal power plants: 200,705 MW
- Gas power plant: 24,937 MW
- Hydro Power plant: 45,399 MW
- Total electricity generation: 1,389,121 GWh
  - Thermal power plants: 986,591 GWh
  - Gas power plant: 50,208 GWh
  - Hydro Power plant: 134,894 GWh

**Power Distribution**

- Total consumers: > 200 million
- Connected load: 400 GW
- Distribution utilities: 73
  - Electricity departments: 13
  - Private DISCOMs: 17
  - Corporatized DISCOMs: 41 (+ 2 SEB)
- Power consumption: 1,267,526 GWh
- Power demand: 1,274,595 GWh

Data of year 2019

*Net consumption is expected to grow ~80% in the coming decade*
Maldives

Power Generation

- Total installed capacity: 251 MW
  - DG Sets: 240 MW
  - Renewables: 11 MW
- Electricity Generation Capacity of the greater Malé region (Malé, Villingili and Hulhumalé): 101 MW

Data of year 2018

Power Distribution

- DISCOMs: The State Electric Company Ltd (STELCO) and FENAKA Corporation Limited
- Operations
  - STELCO: 35 islands
- STELCO Consumer base: 40,000 customers.
- The T&D losses: 8%
- The other islands in Maldives have their own captive power generation and distribution network within the island and the same is not accounted by government.

Net consumption is expected to grow ~100% in the coming decade
• Total installed capacity: 1,020 MW
• Hydro power plant: 95%
• Others including renewables and oil-based DG sets: 5% (53 MW)
• NEA’s hydropower plants generation: 2,548.11 GWh
• IPP generation: 2,190 GWh
• Total Import: 37% of total power

• Total consumers: 3,909,641
• Total consumption: 6,306 GWh
• The NEA is responsible for planning, developing, implementing, and operating the distribution system in Nepal.
• Main load centre: Central zone (which includes Kathmandu Valley)

T&D loss (%) in different distribution zones

- Birahang: 12.2
- Janakpur: 23.4
- Hatauda: 8.4
- Kathmandu: 7.4
- Pokhara: 9.8
- Butwal: 12.4
- Nepalgunj: 11.6
- Atariya: 14.4
- Average: 11.3

Data of year 2019

Net consumption is expected to grow >200% in the coming decade
Pakistan

**Power Generation**

- Total installed capacity: 35,972 MW
  - Thermal Power plant (Gas based): 11,769 MW
  - Thermal Power Plant (HFO/Diesel as fuel): 5,887 MW
  - Hydro power plant: 9,730 MW
- Total power generation: 128,564 GWh
  - Thermal Power plant: 80,540 GWh
  - Hydro power plant: 33,198 GWh

**Power Distribution**

- Distribution companies: 11 (1 private & 10 government owned)
- The distribution companies (DISCO) fall under Pakistan Electric Power Company (PEPCO).
- Source of Power purchase:
  - Water and Power Development Authority (WAPDA),
  - PEPCO
  - Private Independent Power Producers (IPPs).

*Net consumption is expected to grow ~50% in the coming decade*
Sri Lanka

**Power Generation**

- Installed capacity: 4,046 MW
  - Thermal power plants (Oil based): 1,282 MW
  - Thermal Power plant (coal based): 900 MW
  - Hydro power plant: 1,809 MW
- Total electricity generation: 15,985 GWh
  - Thermal power plants (Oil based): 3,836 GWh
  - Thermal Power plant (coal based): 4,955 GWh
  - Hydro power plant: 6,553 GWh

**Power Distribution**

- The electricity distribution companies (DISCOMs)
  - Ceylon Electricity Board (CEB)
  - Lanka Electricity Company Pvt Ltd (LECO)
- Sri Lanka’s distribution losses has been substantially low due to strict monitoring.

**Installed Capacity**

- 34% Thermal
- 14% Hydropower
- 52% Renewable

**Generation Mix**

- 31% Thermal - Oil
- 41% Thermal - Coal
- 4% Hydro
- 24% RE (except mini hydro)

**T&D Losses (%)**

- Data of year 2019
- Net consumption is expected to grow ~70% in the coming decade
2

Need and Importance of Energy Efficiency
Need and Importance of Energy Efficiency in Power Generation and distribution for SAAARC Countries

SAARC comprise of some of the fastest growing economies in the world. With increasing economic activities in the region, the per capita electricity consumption of these countries is increasing at rapid rate.

Key points for the need of EE in power generation and distribution are as follows:

1. SAARC countries still face acute shortage of electric power leading to frequent brown / black outs.
2. The power generation efficiencies in SAARC countries are still low as compared to western benchmarks.
3. Low adoption rate of new state-of-the-art low carbon technologies.
4. Major energy generation is through conventional source of energy, which causes pollution.
5. Highly unreliable and outdated distribution network hinders economic growth.
6. All the SAARC nations have specific NDC targets to be achieved as per Paris agreement.
7. The high electricity tariff affects the overall development progress of the SAARC nations.
8. Most of DISCOs in SAARC are financial stressed. EE can help in improving their condition.

<table>
<thead>
<tr>
<th>Countries</th>
<th>NDC Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>ND</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>15%</td>
</tr>
<tr>
<td>Bhutan</td>
<td>ND</td>
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<tr>
<td>India</td>
<td>35%</td>
</tr>
<tr>
<td>Maldives</td>
<td>26%</td>
</tr>
<tr>
<td>Nepal</td>
<td>ND</td>
</tr>
<tr>
<td>Pakistan</td>
<td>20%</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>20%</td>
</tr>
</tbody>
</table>

* ND – Not defined

3% of the world’s area
21% of the world’s population
4.21% of the world economy
### Need of the Study

<table>
<thead>
<tr>
<th><strong>Shortage</strong></th>
<th>Acute shortage of electric power leading to frequent brown/black outs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>Slow pace of adopting new technologies</td>
</tr>
<tr>
<td><strong>NDC</strong></td>
<td>Contribution in meeting NDC targets</td>
</tr>
<tr>
<td><strong>Gaps</strong></td>
<td>Need of a consolidated report on policy related gaps in SAARC nations</td>
</tr>
<tr>
<td><strong>Energy Source</strong></td>
<td>Huge dependency on conventional source of energy for power generation</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td>Understanding the technical and non technical inefficiencies in generation and distribution sector</td>
</tr>
<tr>
<td><strong>Challenges</strong></td>
<td>Shortlisting various challenges and barriers in adoption of energy efficiency measures in the sector</td>
</tr>
</tbody>
</table>
Afghanistan

Afghanistan has mainly hydro power and thermal power plants using oil as fuel. It imports as much as ~80% of the total power from Central Asian republic. The country’s distribution network is highly fragmented and consists of isolated grid systems.

Financial

- Inefficient operation causes rise in generation cost
- Huge foreign exchange spent on import of power
- Increase the revenue of DISCOs and hence they financial health
- Attract more industries and increase in government revenue

Consumer side

- Reduction in load shedding will help consumers
- Reduced losses will help DISCO to supply power at cheaper cost
- Will help industrial consumers for proper planning of their production schedules, increasing their production, and hence revenues

Social and Environmental

- Better access of quality power to more consumers
- Increased efficiency will lower greenhouse gas (GHG) emissions
- Reduction in use of Diesel Generators and hence lower sound and emission pollution
- More employment opportunities
- Increase in reliability of domestic generation network
Bangladesh

Natural gas based thermal plants form the main source of electricity generation in Bangladesh, followed by hydro power plants. Bangladesh’s imports around 1,160 MW, which is 6% of the total power installed capacity.

Financial

- Increase in generation cost and raise in tariff for end users.
- Import of fuel is done to meet power demand, leading to loss of foreign exchange.
- Load shedding due to demand and supply gap causes heavy losses to commercial and industrial consumers.

Consumer side

- Increase in load shedding affects quality of life.
- Industrial consumers are impacted in Bangladesh due to rise in electricity tariff.

Social and Environmental

- Bangladesh has almost 90% of power generation by conventional sources of energy, the rising inefficiencies in these plant cause greenhouse gas emissions (GHG).
- Bangladesh is facing shortage of gas and oil. An inefficient power system leads to increase use of precious natural resources.
Bhutan

Hydropower plants are the main source of on-grid power generation in Bhutan. In addition to hydro, diesel generators (for emergency purpose), wind power stations and solar home lighting system (off-grid) comprise the electricity generation ecosystem. It exports electricity to India.

**Financial**

- In-efficient distribution network leads to frequent overloading of lines and despite excess electricity available at GRID, load sheading may occur.

**Consumer side**

- The net export of electricity of Bhutan is ~70% of total generation and by saving energy in generation and distribution network, there will be direct increase in revenue by increase in exports.

**Social and Environmental**

- Efficient hydro power generation could help in increasing the generation with the same installed capacity. Thus, Bhutan may delay capacity addition of new hydro capacity in the country, which will prevent deforestation and land being converted into catchment areas.
India

India’s power sector is one of the most diversified in the world. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power to viable non-conventional sources such as wind, solar, and agricultural and domestic waste.

Financial

- Reduction in losses of DISCOM, can not improves its financial health, but also pass on the benefits to consumers (e.g. one of the Delhi DISCOMs)
- Fluctuation in voltage (bad power quality) causes industries to use power conditioning devices/equipment, thus leading to cost burden.

Consumer side

- By improving energy efficiency in power generation, country can export more power and earn a substantial amount of foreign exchange.
- Efficient power generation may lead to reduction of import of fossil fuels.
- Increase the profitability of power stations.

Social and Environmental

- With 2/3rd power generation by conventional sources, increased efficiency can lower GHG emissions in power generation.
- Efficiency improvement in the India’s power generation and distribution can assist in achieving the NDC targets.
Maldives being a collection of small islands, is heavily reliant on imported oil and diesel-based generators to meet its electricity demands. Majority of its islands have their own captive power generation and distribution systems.

**Financial**

- Cost of generation is highest among the SAARC nations.
- Country has no fossil fuel reserve and inefficiency increases foreign exchange outgo.
- Reduction in cost of generation, the hospitality industry can enhance profitability.

**Consumer side**

- Industries and commercial consumers have their own generation arrangements. If energy generation process is cheap, the consumers need not to maintain their DG sets.
- Efficient distribution network will increase the standard of living of people.

**Social and Environmental**

- In Maldives, 99% of power generation by DG sets, the rising inefficiencies in these plant causes emission of excess GHG.
Nepal

Nepal is predominantly dependant on hydropower for its electric power generation. Hydropower provides almost entire country’s electricity on the grid. The Nepal Electricity Authority (NEA) manages the entire distribution services and networks.

Financial

- A large part of total domestic electricity consumption is imported from India, which causes a foreign exchange loss.
- The reduction in T&D loss will increase the revenue of the utility and will help in strengthening their distribution network.

Consumer side

- Nepal has faced problem of load shedding during peak hours. Leading to use of expensive backup power supply.
- Efficient distribution network will help in reduction of cross-subsidy of tariff, helping the medium and high electricity consumers’ growth (as a result economy growth).

Social and Environmental

- The increased energy efficiency can help government in reducing the electricity tariff and increasing access to electricity, which will ultimately help in improving standard of living
Pakistan

In Pakistan, 31 thermal independent power producers (IPPs) with a total installed capacity of 12,427 MW, and 5 hydro IPPs with a total installed capacity of 213 MW are operational. The power distribution sector in Pakistan is catered by 11 distribution companies.

Financial

- Inefficient power plants lead to high import of gas and oil from gulf countries causing loss of foreign exchange.
- The inefficiencies in the plant lead to an increase in generation cost and raise in tariff for end users

Consumer side

- Pakistan, despite being power surplus, faces frequent load shedding in rural areas and areas with high power theft. The energy efficient system will minimize these load shedding and benefit the consumers.
- Commercial losses like theft and low collection efficiency is high in Pakistan causing high tariff for end consumers.

Social and Environmental

- The increased efficiency can lower greenhouse gas (GHG) emissions and other pollutants, as well as decrease water use per kWh of generation.
- A reliable power distribution system will create a sense of satisfaction among the society.
Sri Lanka

Ceylon Electricity Board (CEB) runs major power plants and followed by a few Private Power Producers (PPP). The major sources of power generation are coal, natural gas, oil, hydropower and renewables such as solar and wind. The thermal power accounts for the majority share in power generation in Sri Lanka and acts as base load.

Financial

- Energy efficiency measure can help in reducing the financial burden for end consumers.
- The fuel used in power plants are imported, inefficiency in these plants increase burden on country economy.

Consumer side

- Sri Lanka has gap in demand and supply, there is frequent load shedding (2019 & 2020 Sri Lanka electricity crisis).
- The better and reliable distribution system will help industrial consumers for proper planning of their production schedule.

Social and Environmental

- Sri Lanka has coal as well has oil-based power generation, the rising inefficiencies in these plant cause consumptions of more fuel and emission of excess GHG.
Scope of Study And Methodology
Objective and Scope of the Study

**Objectives**

1. Assessment of technical and non-technical inefficiencies of generation and distribution sector
2. Assessment of challenges, benefits and requirements for implementing energy efficiency improvement
3. Assessment of viable and proven solutions and best practices of other countries
4. Preparation of report, which will steer the generation companies and distribution utilities towards higher efficiency.

**Scope of the Study**

Identification of EE options in SAARC power systems
- Primary data collection
- Desk research of existing benchmarks
- Identify Energy Efficiency options

Challenges and barriers to implementation
- Desk research of legislative and business policies in power sector of SAARC nations
- Assessement of country wise barriers

Area wise benefits of implementing EE options
- Technical benefits
- Financial benefits
- Environmental benefits

Recommendations
- Recommendations on energy efficiency improvements
Approach and Methodology

Our approach was based on our understanding on development of a high-level analysis to support setting a path for the energy efficiency in power generation and distribution sector of SAARC nations.

Consultative approach
Communication and cooperation with the key stakeholders was adopted to understand the present scenario and corrective actions required.

Team of world-class experts
The project was implemented by a team of professionals with international experience in energy efficiency in power generation and distribution sector.

Understanding of local context
In order to provide a value added we have consulted local stakeholders of each country to get the actual insight of the sector.

Focus on quality and data collection
We have adopted quality assurance procedures to make sure that all our deliverables and recommendations meet the highest standards. To the extent possible.

Key components of the assignment comprise of the following interconnected tasks

<table>
<thead>
<tr>
<th>Step I</th>
<th>Step II</th>
<th>Step III</th>
<th>Step IV</th>
<th>Step V</th>
<th>Step VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Research and Stakeholder Identification</td>
<td>Development of structured questionnaire</td>
<td>Primary research through interviews</td>
<td>International benchmarking for best practices</td>
<td>Data analysis and drawing conclusions</td>
<td>Draft and final report of the study for evaluation</td>
</tr>
</tbody>
</table>
### Step 1: Stakeholder identification and secondary research
- Conducted a comprehensive desk review
- **Identification of key stakeholders**
- Classification of stakeholders as regulator, policy maker, power generation, power distribution, OEMs & consultants and sector experts.

### Step 2: Development of structured questionnaire
- Developed questionnaire in two parts:
  - structured to obtain specific **quantitative information**
  - a semi/unstructured part to collate **qualitative information** usually not present in available dataset.
- A different questionnaire was developed for **each category of stakeholders**

### Step 3: Development of semi/unstructured questionnaire
- A different questionnaire was developed for each category of stakeholders

### Step 4: Primary research through interviews
- Conducted interviews, **nearly 25 stakeholders of different country**
- Purpose of these interviews was be **three-fold** to collect data, to gauge the efforts done on promotion of energy efficiency and to understand outlook of energy efficiency in PGD sector in near-term and long-term as per the stakeholder

### Step 4: International benchmarking for best practices
- Scouted for **nationally and internationally best available practices and technologies** for power generation and distribution.
  - Secondary desk research
  - Consulting sector experts within SAARC
  - Leverage expertise within PwC network.

### Step 5: Data analysis and drawing conclusions
- Draw learning from EE activities within SAARC member countries and suggest potential steps for quick adoption
- Draw learnings from international benchmark study from potential countries with similar attributes.
- The learnings will be localized and customized to meet SAARC member country’s context.

### Step 4: Draft and final report of the study for evaluation
- The draft report presents options and recommendations. In addition, the report covers a situational analysis of various recommendations to **show impact v/s implementation effort**.
- Organize a webinar **inviting all relevant public and private stakeholders**.
Thank you