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

Energy Efficiency Analysis of the SAARC Member States

15 February 2021

pwc

Content

1 Introduction

Basis of Analysis

Power sector of each SAARC member nation is unique in nature. The following fuel types are predominant:

- Thermal Power Plant using Coal, Lignite, or other liquid fuels
- Gas Turbine and Combined Cycle Power Plants using Natural Gas
- Hydro Power Plants
- Liquid or gas fuel-based Internal Combustion (IC) Engines

Apart from hydro based power plants, other renewable source of generation was not considered to avoid complexity in the study.

The specific generation type is selected for analysis based on the following prerequisite:

- ***Predominance in the generation mix***
- ***Type of fuel used for generation***

Electricity Generation from different sources (GWh)							
Country	Hydro Power	Thermal Power Plants			IC Engines	Import	Export
		Coal	Gas	Liquid Fuel			
Afghanistan#	786	-	152	-	42	4,986	-
Bangladesh#	725	1,230	48,306	11,426	2,022	6,786	-
Bhutan#	8,452	-	-	-	-	-	6,172
India#	155,769	994,197	48,443	199	-	5,794	9,368
Maldives²	-	-	-	-	704	-	-
Nepal#	4,476	-	-	-	-	2,582	-
Pakistan#	33,198	80,540			-	-	-
Sri Lanka#	5,149	4,764	-	1,886	-	-	-

**The red marked generation type is not selected for analysis*
 # 2019 figures, ²2018 figure

For example: In Afghanistan the share of installed capacity for Hydro and Thermal based power plant are almost equal but hydro power plants are selected due to high share in total generation mix.

Key Performance Indicators

Key Performance Indicators

It is a quantifiable or measurable value that demonstrates how effectively the plant, equipment or process is performing. KPIs can be financial and non-financial. The energy KPIs are mainly non-financial but have financial implications.

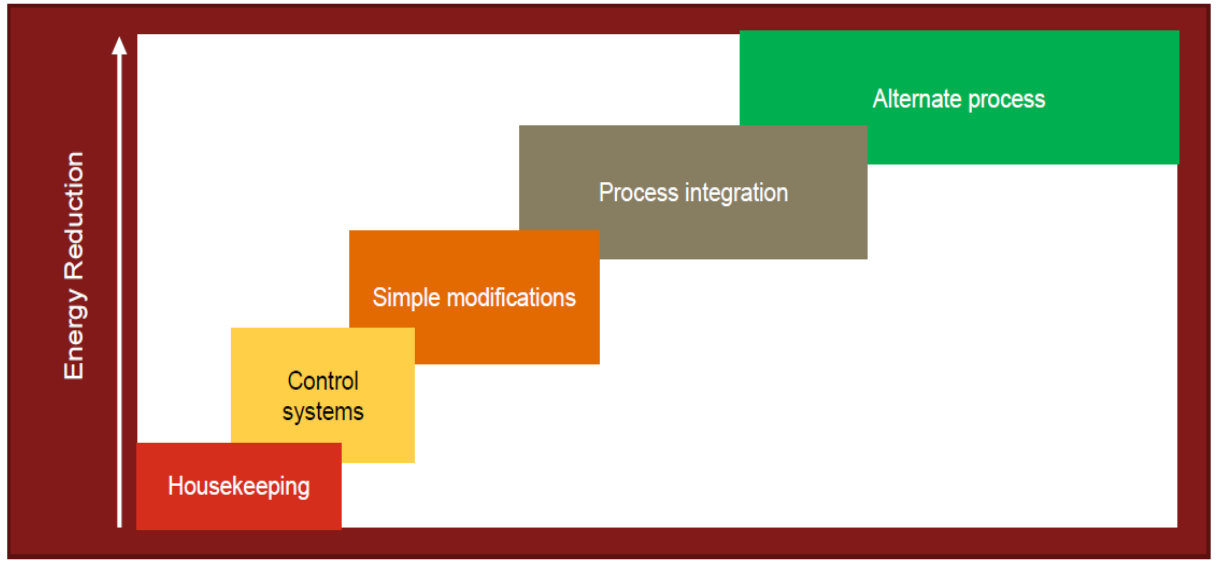
KPI's for the power plants vary based on the fuel and technology used. E.g. for thermal power plants:

- Boiler Thermal Efficiency
- Turbine Heat rate
- Auxiliary power consumption
- Turbine cylinder efficiency

These KPIs can further be subcategorized

Technical KPIs	Non-Technical KPIs
Copper loss	Collection efficiency
Dielectric losses	Theft level
Induction and radiation losses	Meter reading
Overloading & low voltage loss	Field vigilance
Unbalanced loading loss	Operational efficiency
Poor insulation loss	Maintenance practices

KPIs for auxiliary power consumption	Sub-Critical	Super Critical	Ultra-Super Critical
Feed Water System	32%	41%	42%
Cooling Water System	17%	15%	15%
Pollution Control System	13%	12%	11%
Combustion Air and Flue Gas	19%	16%	16%
Fuel Handling	05%	04%	04%
Other Loads	14%	12%	12%



This is only an illustrative list of KPIs, which may differ as per geographical conditions

Technical Losses: An illustrative

Thermal Power Plants

Boiler Thermal Efficiency

Dry Flue Gas Loss/Stack Loss	5 – 7%
Radiant Heat Losses	0.4 – 1%
Blowdown Heat Losses	0.5 – 1.5%
Heat loss due to soot formation	1 – 1.5%

Turbine Heat Rate

Losses due to part load operation	50 – 75 kcal
Condenser Losses	0.4 – 2.7 kcal
Loss due to improper control of steam temperature and pressure	0.3 – 0.7 kcal
Leakages in boiler and condensers	10 – 20 kcal

Auxiliary Power Consumption

Degradation of equipment	10 – 25%
Inefficient operation	Variable

Power Distribution

Technical losses

Network configuration – lengthy over-loaded feeders, equipment quality	1.5 – 1.75%
Lack of maintenance	0.75 – 1.25%

Non-technical losses

Connection management – unmetered/ghost connections	1.5 – 2%
Meter reading – faulty meter, meter inaccessibility	1 – 1.25%
Billing – not delivered, incorrect bill	0.5 – 1.5%
Field vigilance – Absence of field quality checks, limited or no field vigilance for power pilferage	0.2 – 0.5%
Collection & credit management - Limited avenues for collections, inadequate defaulter follow-ups	2 – 3%

A longlist of losses were created through desk research and primary consultations of all SAARC nations

2

EE Analysis Afghanistan

Afghanistan, story so far…

1960

Hydro Power Plant

Starting of building hydro based power plants in **Naghlu and Kajaki**

2008

Da Afghanistan Breshna Sherkat

DABS was formed to manage electric power generation, import, transmission and distribution throughout Afghanistan

2008

High voltage transmission line from Uzbekistan to Afghanistan

A 442 KM transmission line was constructed to import electricity from Uzbekistan to capital city Kabul.

2014

Afghanistan's' Energy Efficiency Policy

The Ministry of Energy and Water (MEW), prepared the Afghanistan Energy Efficiency Policy (AEEP) which aims to provide direction to the energy efficiency activities in the country.

2015

Paris Agreement

Landmark agreement between 195 countries to limit warming to **well below 2 degrees Celsius**

2015

Power Services Regulation Act

The law was prepared with the objective of improve the quantity and quality of energy service and Public access to the electricity energy services in exchange of a fair price.

2020

CASA-1000

This project was inaugurated in 2020. This transmission system will allow for the export of surplus hydroelectricity from Kyrgyzstan and Tajikistan to Afghanistan and Pakistan

2021 and beyond...

Expansion of distribution network to achieve government objective of power to all and expansion of generation with addition of renewable source of energy.

Technical Losses

Power Generation

Hydro Power Plant

Losses due to resistance in path of water:
Ageing leads to formation of algae, plantations and other resistance in the pathway of water.

Losses due Improper maintenance of equipment:
Due to financial constraints the replacement and maintenance of turbine bucket are not performed periodically

Power Distribution

Losses due to lengthy distribution lines:
The distribution network is still developing phase causing improper expansion of network.

Losses due use of inefficient transformers:
Use of more than 2-decade old transformers causes loss in network**.**

Losses due to improper monitoring:
No submetering at the feeder level causes huge unaccounted commercial losses.

Primary consultation: *Energy Services Regulatory Authority and various energy expert based in Afghanistan*
Secondary research: *Afghanistan Statistical Yearbook and studies by various multilateral and bilateral agencies*

Non-Technical Losses

Policy related issues

The government should form laws and regulations promoting for:

- Energy auditing of energy intensive sectors of the economy
- Expansion of efficient distribution network
- Smart metering and grid (to reduce the T&D losses)

Governance and administrative issue

- Government has not established any T&D loss reduction target for DISCOs.
- Afghanistan lacks timely amendment of law and regulations to curb energy losses
- Due to security reasons, field surveillance is hardly conducted by the utility officers, which leads to increase commercial losses.

Financial Constraints

- The DABS has nearly $ 135 million in debts. One of the major causes is high technical & commercial losses.
- In some geographies, the revenue collection efficiency is as low as 30-35%
- The power sector is depended on donor agencies for implementations of energy efficiency measures

Challenges and Barriers

Financial	***The power is supplied at a subsidized rate*** due to poor economic condition of Afghanistan, thus causing financial stress.
GRID	***The grid in Afghanistan runs asynchronously*** causing high T&D losses.
Focus	Afghanistan largely depends on financial aid from various agencies such as ADB, US-AID, The World Bank etc., for their development work. ***Focus is on development of basic infrastructure of the power system*** rather than implementing the energy efficiency measures in country.
Corruption	Afghanistan faces ***challenges of corruption***, which could affect the effective implementation of energy conservation program.
Policy Issue	The generation sector in Afghanistan is still in development stage and the technology used for installing generating units largely depends on the donor agency and government has **no policy for installing energy efficient system**
Security	The distribution companies have not invested in vigilance due to **security concerns**.
Promotion	The government has no policies for **promoting energy efficiency system** in the generation and distribution network.

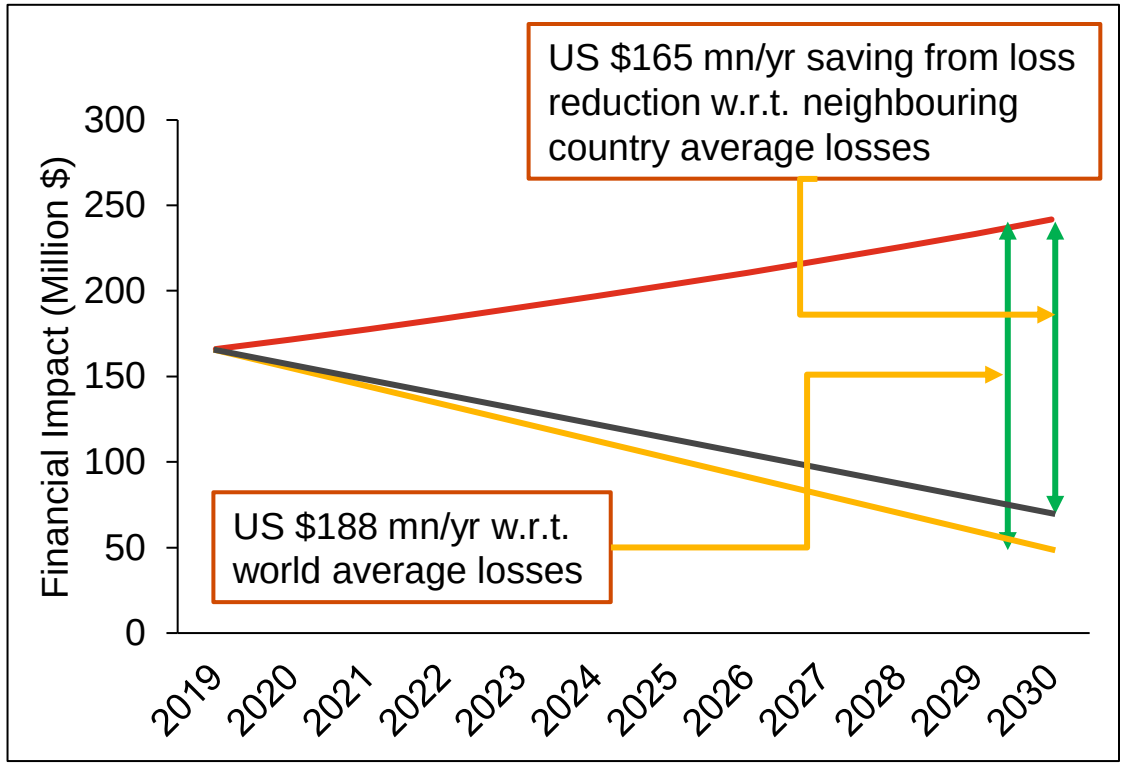
Future Challenges and Financial Impact of Losses

The growth of development of power generation and distribution sectors of ***Afghanistan is less*** as compared to growth in population, as a result the electrification rate is not improving.

Although there are measures being adopted continuously by government to establish peace in the country, but **security issues may still arise in the future**.

Financial impact of losses in power generation and distribution sector is compute based on international best practices and applicable to Afghanistan context:

- A technical efficiency improvement potential of about 6% exist in hydro power generation in Afghanistan.
- The financial loss due to high power distribution losses was analysed in two different scenarios:
  - T&D losses is improved to world average T&D loss i.e., 8.64%, leading to improvement by 33.56%.
  - T&D losses is improved to average T&D loss of neighbouring countries (similar geography) i.e., Iran, Turkmenistan, Uzbekistan and Tajikistan which is 12.75%, leading to improvement by 29.45%.



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EE Analysis Bangladesh

Bangladesh, story so far…

1995
National Energy Policy

Bangladesh has formed national energy policy to ensuring proper exploration, production, distribution and rational use of energy sources.

2008
Renewable Energy Policy of Bangladesh

The policy was formed to promote use of renewable source of energy and Enable, encourage and facilitate both public and private sector investment in renewable energy projects

2012
The Sustainable and Renewable Energy Development Authority Act

It aims to reduce global warming, environmental hazard risk and to ensure energy security by reducing dependency on fossil fuel through the use and expansion of Renewable Energy

2015
Paris Agreement

Landmark agreement between 195 countries to limit warming to **well below 2 degrees Celsius**

2016
Power Sector Master plan 2016-21

The plan aims to enhancement of imported energy infrastructure and its flexible operation and Improvement of human resources and mechanisms related to the stable supply of energy

2021
Power sector master plan 2021-26

It aims to reach capacity of 24,000 MW and improve the efficiency of generation and distribution network.

2021 and beyond...

Bangladesh look for improving efficiency of it's generation sector and strengthen the distribution network.

Technical Losses

Power Generation

Losses due to aging of gas power station:
Most power stations >two decades old

Gas based Thermal Power Plant (GT units)

Losses due to unavailability of HRSG:
4754 GWh per year : additional generation potential through use of HRSG

Loss due to high auxiliary power consumption

Thermal Power Plant (HFO, Gas and Coal as a fuel)

Losses due to improper monitoring of critical parameters: Estimated to be about 323 GWh

Losses due to improper operation and maintenance

Power Distribution

LV Line Losses: Loads scattered over large areas are fed by 11 kV and 420 V lines which are extended over long distances in the country.

Losses due to overloading and low voltage:
In some urban areas, the power network is stressed with overloading and leads to losses.

Losses due to improper planning of distribution network:
Due to rapid increase in consumer connections and unorganized growth of distribution network.

Losses due to improper maintenance of transformers and lines

Primary consultation: *Bangladesh Power Development Board, Regional DISCOs and GENCOs and energy expert based in Bangladesh*
Secondary research: *BPDB Annual Reports, Energy Audit reports and analysis reports by various multilateral and bilateral agencies*

Non-Technical Losses

Policy Related Issues

- Absence of specific policies related to energy accounting and audit guidelines for DISCOs under The Sustainable and Renewable Energy Development Authority Act of Bangladesh
- No policies for modernization or scrapping of old power plants.
- More rationalisation of electricity tariff

Governance and Administrative issue

- Inability of state-owned DISCOs in implementation of energy conservation measures.
- Procurement of equipment are mainly by competitive bidding, leading to procurement of inefficient equipment.
- Major emphasis is given on expanding the distribution infrastructure rather than improving efficiency levels

Financial Constraints

- Continues financial loss to BPDB due to selling electricity at prices lower than the break-even point.
- Due to this the energy efficiency activities in power sector are kept on the lowest priority and more emphasis is given to running the system as a whole.

Social and Environmental issues

- Due to poverty, there is theft and unmetered connection which causes overloading of lines and increase in AT&C losses.
- In a democratic country like Bangladesh, it is challenging to penalize or remove the unauthorized connections by the DISCOs.

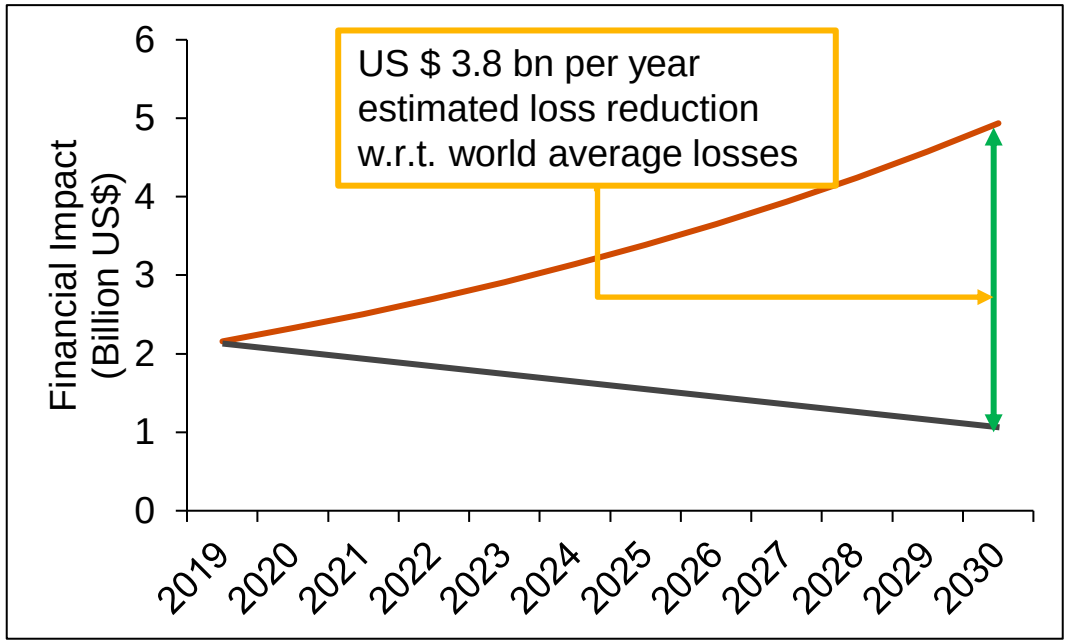
Challenges and Barriers

Financial	Bangladesh power sector ***faces huge financial deficit*** which is primarily due to **increasing fuel price**. This causes delay in funds allocation for energy efficiency measures.
Policy	No ***policy or incentives*** defined by govt. in EE for power sector such as **energy audits of power generators** and DISCOs. As a result, there is lack of motivation in the sector to implement energy efficiency measures.
Technology	Investment costs are high due to the ***lack of domestic market for energy efficiency equipment and technology***. Bangladesh should work towards better ecosystem for procurement/import of low carbon/energy efficient technologies.

Future Challenges and Financial Impact of Losses

- Timely, ***amendments and modifications in policies of government***, to attract private sector investment for energy efficiency.
- The country is ***shifting focus from gas to coal-based generation***. The plan should be focussed around the super-critical or ultra-super critical coal-based plants or towards investment in the alternative sources of energy.

- The generation sector can improve controllable losses by 22% of the total generation of electricity.
- Distribution sector T&D losses can be improved by 12.52% compared with world average, where T&D losses are nearly 8.64%.



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EE Analysis

Bhutan

Bhutan, story so far…

2001

Electricity Act of Bhutan

In 2001 government has notified electricity act to form guidelines and regulate the electricity sector of Bhutan

2002

Bhutan Power Corporation

It aim was to distribute electricity throughout the Country and also providing transmission access for generating stations for domestic supply as well as export.

2008

Druk Green Power Corporation

Three government owned hydropower plants were combined to form a single entity. It is a holding company to oversee and accelerate hydropower and alternative energy development

2015

Paris Agreement

Landmark agreement between 195 countries to limit warming to **well below 2 degrees Celsius**

2015

Power Services Regulation Act

The law was prepared with the objective of improve the quantity and quality of energy service and Public access to the electricity energy services in exchange of a fair price.

2021 and beyond...

Bhutan is targeting to increase it's share of other source of power generation, to reduce the reliability on hydro power plant.

Technical Losses

Power Generation

Hydro Power Plant

Losses due to resistance in path of water:

The frictional losses are estimated to be about 3%, due to various system resistance.

Mechanical losses between the turbine and generator systems:

Losses are in the range of 0.5 to 0.75 % and is causing a loss of 45 GWh

Turbine losses:

The losses in Bhutan is about 2-3% and is equivalent to a loss of 183 GWh.

Power Distribution

Losses due to lengthy distribution lines:

Bhutan has large scale Rural Electrification programme, which has resulted in lengthy lines of low voltage, leading to losses in the distribution lines**.**

Losses due to ageing infrastructure:

The power distribution network is quite old and many lines, transformers and substations are built in the 1980's which needs upgradation.

Primary consultation: *Officials of Druk Green Power Corporation Limited and various energy expert based in Bhutan*
Secondary research: *Bhutan Power Corporation Limited and Bhutan Electricity authority annual report and reports by various multilateral and bilateral agencies*

Non-Technical Losses

Policy Related Issues

- Provision of Energy Audit in electricity policy
- In Electricity Act policy can be included against inaction by supervisor/investigating officer if any irregularities are found in the process

Governance and Administrative issue

- The power generation plants quite often see downtime. This could be attributed to improper maintenance and operation practices
- Public utilities should integrate most energy efficient equipment as a clause during procurement process.

Social and Environmental issues

- Due to government plan of rural electrification, electricity in remote hilly areas has to be provided which causes raise in T&D losses.

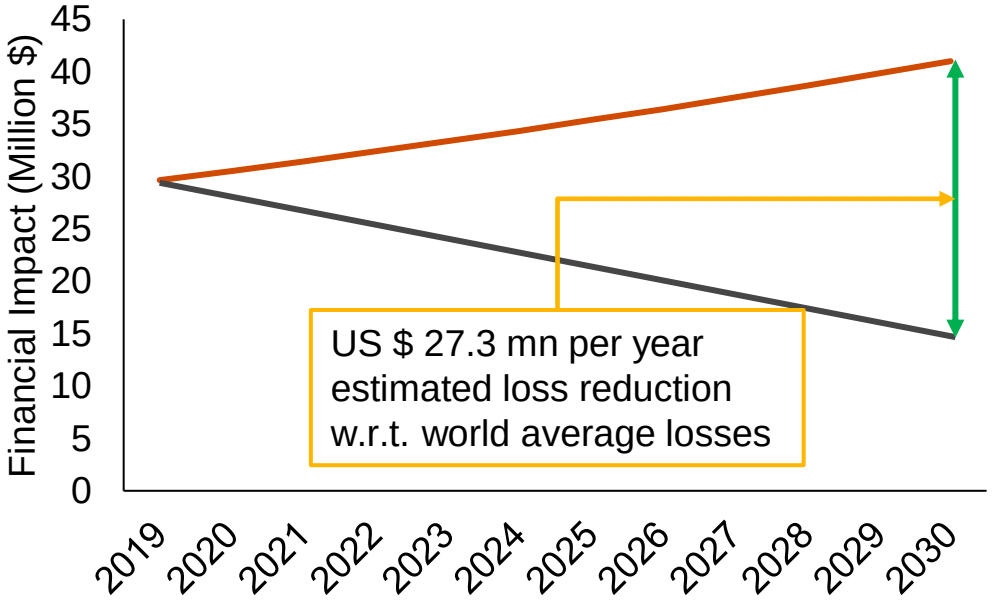
Challenges and Barriers

Financial	Bhutan being a developing nation is largely ***dependent on financial aid from neighbouring countries and financial institutions such as ADB***, The World bank for implementing projects.
Payback	Power generation in Bhutan is ***largely dependent on hydro power***, which is not expensive. However, due to low cost of generation, **the payback of energy efficiency measures is less attractive** (payback >3 years).
Technological	The size of energy efficiency market is **too small**, and Bhutan is already carbon neutral country. As a result, the ***penetration of new efficient technologies is very low*** in Bhutan.
Policy Issue	Power sector is **managed by government agencies** ***needs strong policy push to implement energy efficiency***.

Future Challenges and Financial Impact of Losses

- Major share of power is exported to neighbouring countries, ***a long-term stable cross-border energy policy is important***, ***otherwise it may endanger the investment done by utilities*** in implementing energy saving measures in generation sector of Bhutan.
- ***Due to global warming and climate change***, there are frequent rainfall variation affecting output of hydropower generation.

Distribution sector T&D losses can be improved by 2.36% compared with world average where T&D losses are nearly 8.64%



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EE Analysis India

India, story so far…

2001
Energy Conservation Act

It provided an enabling framework for accelerated and more efficient development of the power sector.

2002
Bureau of Energy Efficiency

The aim of BEE is to develop programs which will increase the conservation and efficient use of energy in India

2008
Perform Achieve and Trade (PAT)

It is a market-based compliance mechanism to accelerate improvements in energy efficiency in energy intensive industries. This includes thermal power plants as one of the designated consumers.

2015
Paris Agreement

Landmark agreement between 195 countries to limit warming to **well below 2 degrees Celsius**

2016
Perform Achieve and Trade (PAT) II

This cycle has included DISCOMs as one of the DCs, which will help in reducing the losses in DISCOMs

2017
Demand Side Management

This program aims in building capacity of DISCOMs in energy efficiency and demand management.

2021 and beyond...

India aim to reduce its carbon footprint by 30 to 35 % by 2030. This will be achieved by improving efficiency level of generating plants and DISCOMs

Technical Losses

Power Generation

Thermal Power Plant

Losses due to improper monitoring of critical parameters:

In India, it is estimated that about 54,423 GWh per year are lost due to this inefficiency.

Losses due to excess auxiliary power consumption:

The auxiliary power consumption in Indian plants is about 08 – 15 % of total generation.

Losses due to improper operation and maintenance

Gas based Thermal Power Plant (GT units)

Losses due to part load operation:

The gas power plants in India are used for meeting the instant peak demand, So these plants face issue of low plant load factor (PLF)

Losses due to improper operation and maintenance

Hydro Power Plant

- **Losses due to resistance in pathways**
- **Losses in turbine and other mechanical losses**

Primary consultation: *NTPC, NLC, MahaGenco, BEE, State DISCOMs and* ***other*** *energy expert based in India*
Secondary research: *CEA Annual Reports, Energy Audit reports and analysis reports by various multilateral and bilateral agencies*

Technical Losses

Power Distribution

Losses in rural distribution segment in India:

Rural areas in India have losses due to wide spreading of network in large areas with long lines,, large number of subsidized customers.

Losses due to operational issues:

DISCOs do not have proper load monitoring and control mechanisms, which results into haphazard control of the demand and leads to losses

Losses due to various technological issues:

Issues like no real time monitoring, manual readings, electromechanical meters contribute to these losses.

Loss due to administration:

There are still unmetered supply to consumers causing commercial loss to DISCOs.

Non-Technical Losses

Policy Related Issues

- Improvement in National Electricity Policy
- In PAT scheme on BEE Accredited Energy Auditor firm should not be appointed by DC itself, either BEE or SDA should take that responsibility and training of plant personnel must be an integral part of the PAT energy audit process by the energy auditors.

Governance and Administrative issue

- Approach of sector stakeholders towards energy efficiency improvement.
- Addition of renewable energy has affected PLF of conventional plants.
- Inaction against the defaulter

Financial Constraints

- Outstanding dues from DISCOs to power generators at the end of June 2020 stood at ₹100.3 billion.
- A signification financial challenge is faced by DESCOs due to low collection and high cost of power procurement.

Social and Environmental issues

- Due to poverty, there is theft and unmetered connection, which causes overloading of lines and increase in AT&C losses.
- In the tariff, there is flat rates or zero tariff for agricultural and below poverty line consumers, which leads to misuse by consumers and ultimately causes overloading.

Challenges and Barriers

Financial	DISCO has faced issue of high commercial losses and operation inefficiencies, which had affected their financial stability. DISCOs often to ***not have financial resources to invest for energy efficiency improvement***.
Payback	India thermal power stations are currently ***running at low PLF***, the payback of the energy efficiency options is longer than usual, and project is unviable in some cases.
Investment	The ***cost recovery from utilities is a tough task*** for ESCOs working on energy efficiency measures, which demotivate them for any future investment.
Implementation	Experience in ***implementation of EE measures in DICOMs and hydro power generation is in early stages***. This prevents the DISCOs in implementing the energy conservation measures (ECMs) in their utilities.
Monitoring	PAT (Perform Achieve Trade) scheme by Bureau of Energy Efficiency (BEE) needs to be more vigilant. The data submitted by utilities should be ***cross-checked for establishing actual energy efficiency measures adopted by the utilities***.
Commercial losses	***Electricity theft and low collection efficiency*** in DISCOs cause overloading of lines and transformers. In this scenario, proper planning for loss reduction becomes difficult as line loading cannot be determined properly.
Loss accounting	Presently, ***energy losses in hydropower generation plants in India are not accounted*** by any agency. Thus, there is no urgency towards implementation of energy efficiency in their plants.

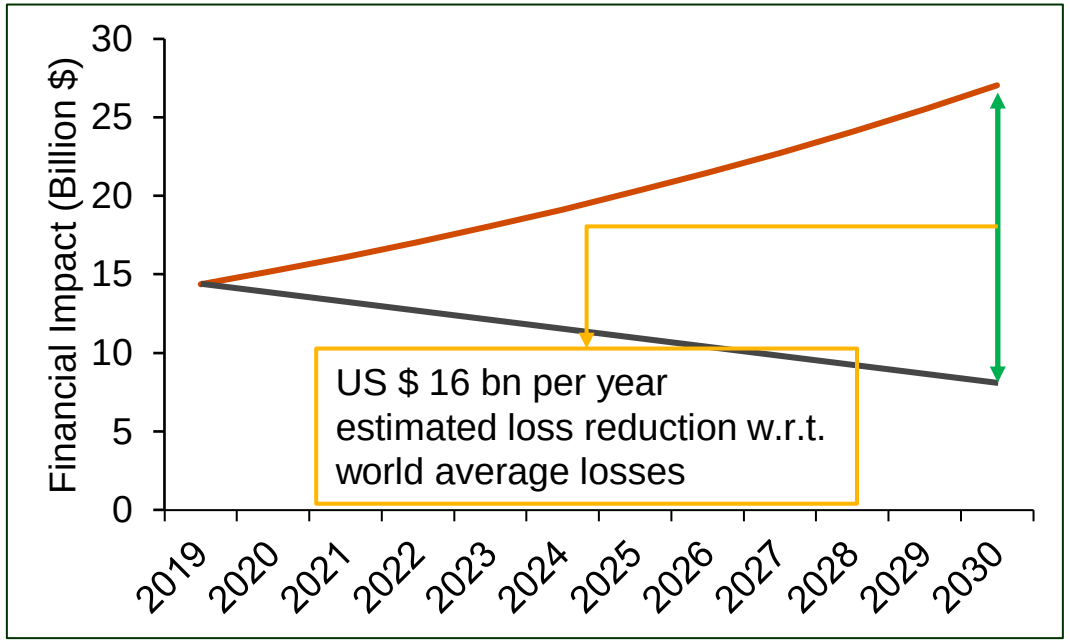
Future Challenges and Financial Impact of Losses

The ***shift in power generation mix towards renewable could endanger investment*** done by private players in implementation of energy efficiency measures in **conventional power plants**.

The government is introducing reforms in power sector and one of the major reforms is gradual privatization of utilities. Due to this uncertainty, ***the public distribution companies may be rebellious in implementing EE measures.***

The financial impact of losses in generation and distribution sector is compute based on international best practices and applicable to India context:

- The generation sector can improve controllable losses by 7% of the total generation of electricity.
- Distribution sector T&D losses can be improved by 12.4% compared with world average, where T&D losses are nearly 8.64%.



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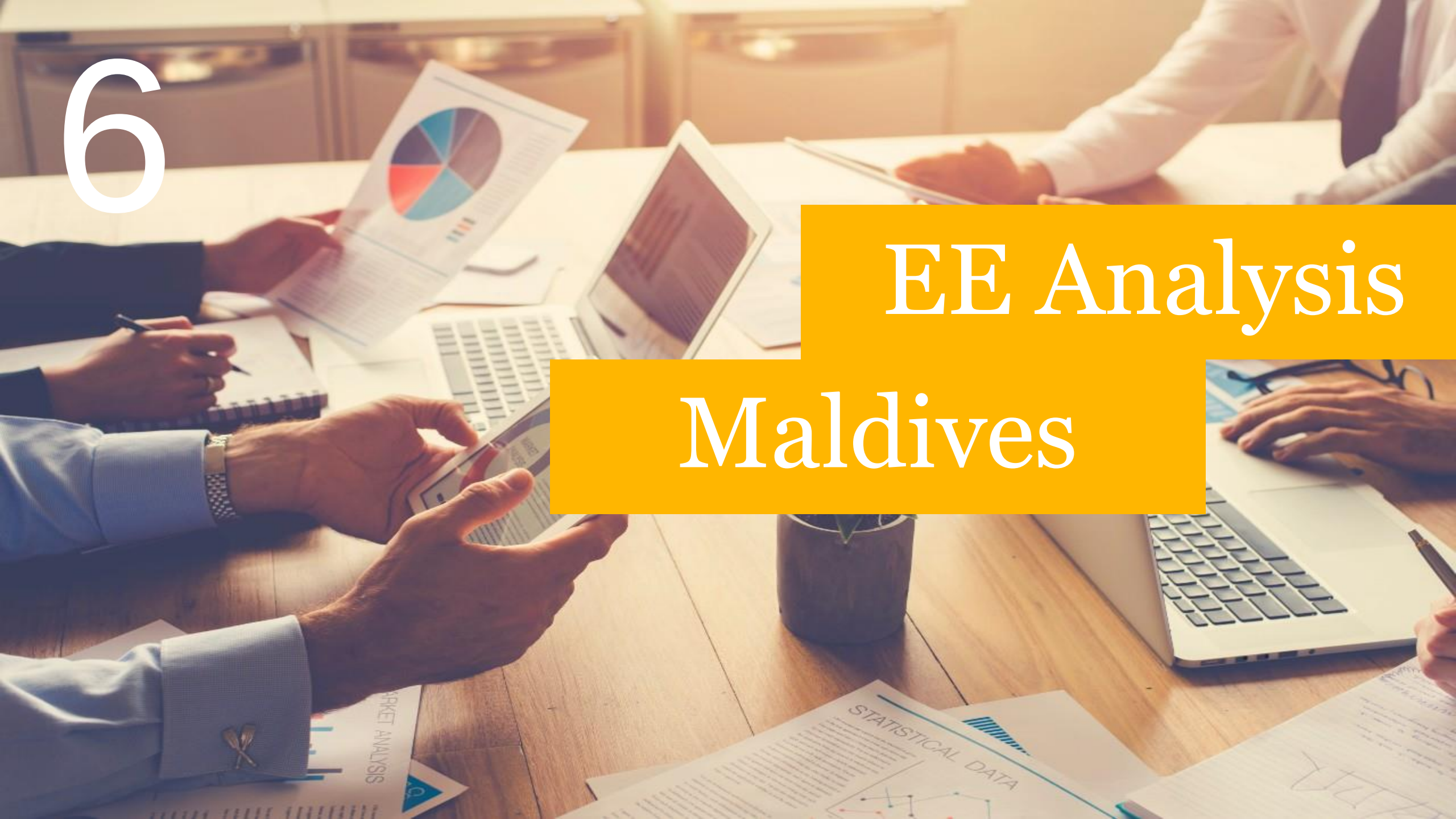
EE Analysis

Maldives



Maldives, story so far…

1997

STELCO

STELCO was formed to cater the electricity demand of Male and nearby islands.

2012

Fenaka Corporation Limited

Its aim is to ensure sustainable primary services to the populace in the regions of the country other than Male'; supply of clean water, sewerage and electricity, and to establish an environment friendly waste management system

2015

Paris Agreement

Landmark agreement between 195 countries to limit warming to **well below 2 degrees Celsius**

2020

Unified Grid

This program aims is to ensure power security to the capital region of Male and to connect three islands into a unified GRID.

2021 and beyond...

Maldives aim to reduce dependency of diesel-based power generation and shift to more renewable source of energy.

Technical Losses

Power Generation

Diesel Engines

Losses due to unsteady and unbalanced load:
Due to frequent demand fluctuation, there is continues variation in the loading of DG set causes underloading and overloading.

Losses due to low power factor:
Low power factor causes the generator to require high excitation currents, which results in increased losses.

Losses due to inefficient operational practices

Power Distribution

Losses due to overloading of transformers:
The transformers are more than 70% loaded causing losses in transformer in STELCO supply area.

Losses due to ageing infrastructure:
The 11 kV lines in Malè are overloaded due to increasing peak load demand.

***Primary consultation**: Various energy experts based in Maldives.*
***Secondary research:** Island Electricity Data Book, Ministry of Environment And Energy and analysis reports by various multilateral and bilateral agencies*

Non-Technical Losses

Policy Related Issues

- Maldives does not have policies related to energy efficiency in power generation and distribution sector.
- There is no mandate for energy audit of power generation and distribution network.

Governance and Administrative issue

- The government has very less control on power system of private islands and resorts, which hinder the implementation of energy efficiency measures.
- The delay in feasibility study of interconnection of distribution network within the neighboring islands and identifying other cheap source of generation has caused huge loss in the power sector of Maldives.

Financial Constraints

- Maldives state utilities are under immense financial strain due to variable cost of diesel and less frequent tariff revision.
- The power sector of Maldives is mainly dependent on donor agencies for development of its power infrastructure.

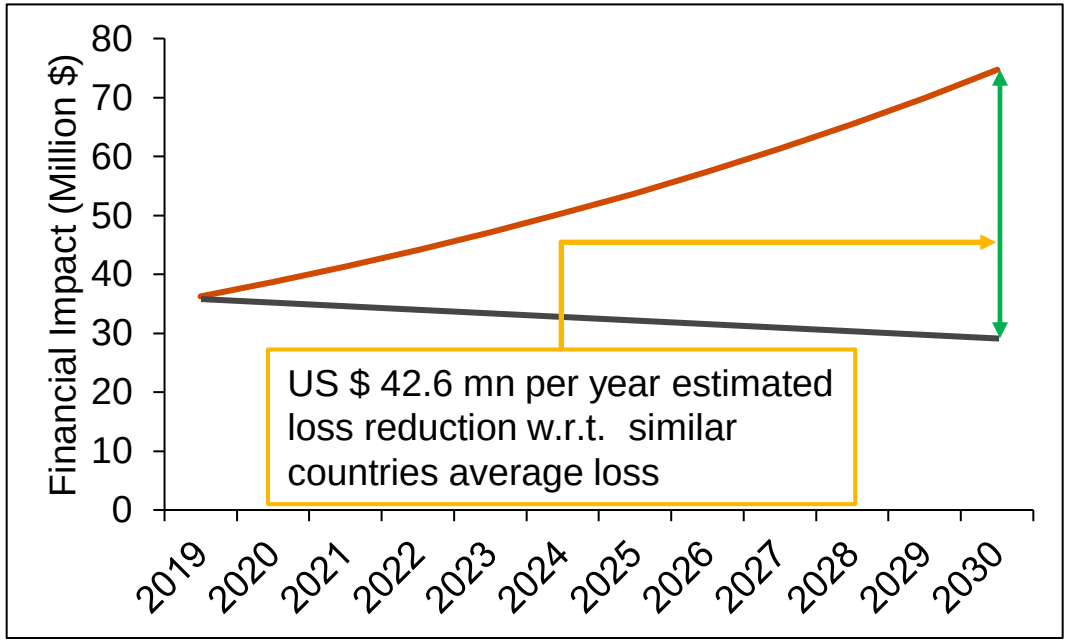
Challenges and Barriers

Implementation	Maldives power sector **is highly scattered**, state owned SETLCO owns power distribution and generation sector for Male and neighbouring islands. Due to ***non-availability of single utility, it becomes difficult to implement EE measures***.
Guidelines	Maldives mostly depends on donor agencies for development of power sector infrastructure, so ***government has no regulations to restrict energy inefficient units*** to be installed.
Geography	Due to geographical condition of the country, ***it is non-viable to install other source of generation*** like gas or coal-based power units.
Policy	Maldives has ***no regulatory policy***, which bind the independent islands to implement energy efficiency measures in their jurisdiction.
Market	***The size of energy efficiency market is too small***, and the geography of small islands is difficult. As a result, the penetration of new efficient technologies is very low in Maldives.

Future Challenges and Financial Impact of Losses

- The government to ***plan judiciously to shift to renewables*** in short term. It may occur that the investment in energy efficiency in DG sets will not live its payback period.
- ***Space availability*** is a major issue for small islands. Power distribution infrastructure revamp for improving energy efficiency may see this as a major challenge.

- The generation sector can improve controllable losses by 6%.
- Distribution sector T&D losses can be improved by 2% compared with average T&D losses of 6% of similar countries.



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EE Analysis

Nepal

Nepal, story so far…

1984

Nepal Electricity Authority Act

This act leads to formation of Nepal electricity authority, which now controls and maintain the generation, distribution, transmission and import of electricity in Nepal.

2001

The Hydropower Development Policy

The aim is to generate electricity at low cost by utilizing the water resources available in the country and to develop hydropower as an exportable commodity

2002

Electricity Leakage Control Rules

These rules were formed in continuation of electricity theft control act, which defines the rules and regulations and duties of inspector inspecting theft and tempering.

2002

Electricity Theft Control Act

It aim was to prevent unauthorized use of electricity by hooking and tempering of meters.

2015

Paris Agreement

Landmark agreement between 195 countries to limit warming to **well below 2 degrees Celsius**

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

2021 and beyond...

As present Nepal import electricity from India, the main aim for Nepal will be to reduce the T&D losses and increase the efficiency of generating stations to become self reliable in power sector.

Technical Losses

Power Generation

Hydro Power Plant

Losses due to sediment in water:
Sediments in water causes excess degradation of components like turbine blade, control valve etc. causing loss in net generation capacity.

Losses due to resistance in path of water:
The losses in Nepal is about 3% and is equivalent to a loss of 89 GWh.

Mechanical losses between the turbine and generator systems

Power Distribution

Losses due to outdated infrastructure:
Financial loss to NEA has affected upgradation of distribution infrastructure.

Losses due to geographical factor:
Nepal being a hilly region with challenges terrain faces issues of high T&D losses.

Loss due to lengthy distribution lines:
Due to Rural Electrification Programme, which has resulted in lengthy lines of low voltage, leading to losses in the distribution lines.

***Primary consultation**: Officials of Nepal Electricity Authority and various energy expert based in Nepal*
***Secondary research:** Nepal Electricity Authority annual report and reports by various multilateral and bilateral agencies*

Non-Technical Losses

Policy Related Issues

- Provision of Energy Audit for generation and distribution sector.
- Policy can be included against inaction by supervisor/investigating officer if any irregularities are found in the process.

Governance and Administrative issue

- Due to administrative negligence some regions in Nepal like Attariya and Janakpur have high losses and problem of hooking and tempered meters is still present in these areas.
- Due to administrative issues planned expansion of distribution network was not carried in many urban regions of Nepal.

Financial Constraints

- The energy efficiency measures in Hydropower plants are capital intensive and more focus is given on expanding generation capacity rather than increasing the efficiency.
- The government of Nepal is still in process of achieving 100% electrification. Thus, the expansion of network is given more priority and fund allocation.

Social and Environmental issues

- Nepal has encountered with number of natural calamities like floods, earthquake etc. As a result, focus is on maintain then system rather than implementation of energy efficiency measures due to unavailability of funds.

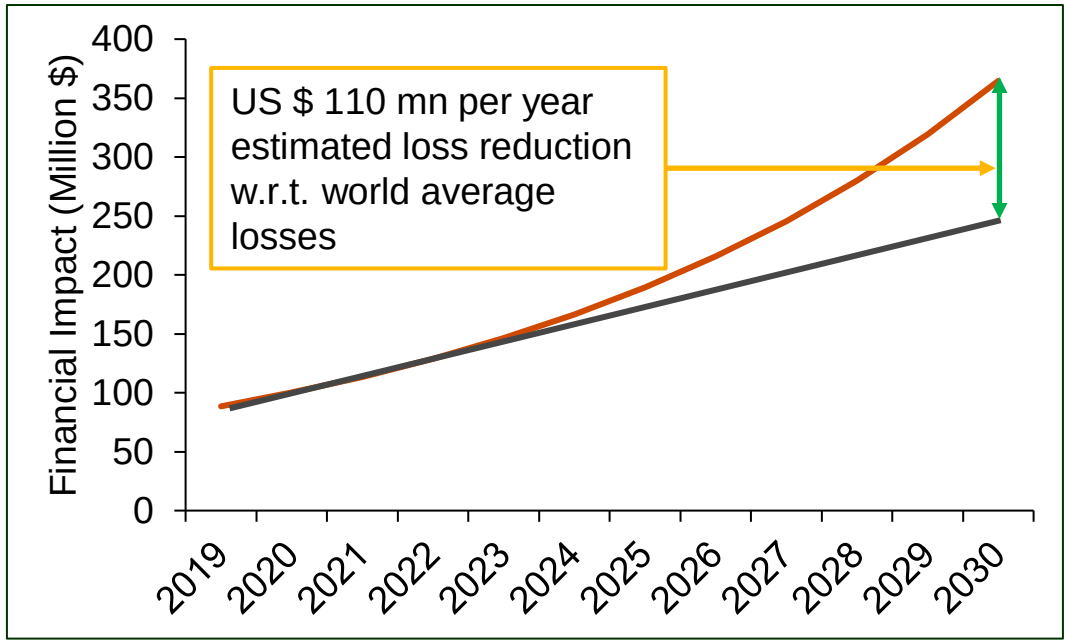
Challenges and Barriers

Payback	Power generation in Nepal is largely **dependent on hydro power**, which is not expensive as compared to conventional sources such as coal, oil. However, due to low cost of generation, ***the payback of energy efficiency measures is less attractive*** (payback period >3 years)
Financial	Nepal, being a developing nation, is largely ***dependent on financial aid*** from financial institutions such as ADB, The World bank for implementing projects in the country.
Technological	The ***penetration of new efficient technologies*** is very low in Nepal, mainly due to small size energy efficient market in the nation. Foreign agencies need to be involved in implementation of various energy efficiency programs.
Investment	***Nepal distribution sector is still in development stage*** and the **investment focus** on energy efficiency measures is **low on priority**.

Future Challenges and Financial Impact of Losses

- Nepal is ***dependent on neighbouring countries for technological and logistic support***. Effective implementation of energy efficiency measures is largely dependent on relations with that country.
- A ***change in policies of government*** (no long-term commitment), which can endanger investment done by various private players in implementation of energy efficiency measures

Distribution sector T&D losses can be improved by 2.64% compared with world average where T&D losses are nearly 8.64%.



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EE Analysis

Pakistan

Pakistan, story so far…

2005
National energy conservation policy

It provide guidelines and possible actions that can enhance end-use efficiency for various energy-consuming sectors of the economy

2005
National Environmental Policy

The policy aims to promote energy efficiency and renewable source of energy in order to achieve self reliance.

2010
National Sustainable Development Strategy

It aim is to develop country energy sector in vibrant and equitable manner. It also promote efficient use of energy and water

2012
National Climate Change Policy

It provide framework for addressing the issues that Pakistan faces or will face in future due to the changing climate.

2015
Paris Agreement

Landmark agreement between 195 countries to limit warming to well below 2 degrees Celsius

2016
National Energy Efficiency and Conservation Act

It provides the much-needed governance framework that can facilitate wide scale adoption of sound energy efficient practices throughout all sectors of economy.

2021 and beyond...

Pakistan aim to reduce its dependency on gas and liquid fuel-based power plant and is focusing on renewable and coal-based power generation options.

Technical Losses

Power Generation

Gas based Thermal Power Plant (GT units)

Losses due to low net capacity:

The Net Capacity of a number of units/machines of different power stations of GENCOs remained lower.

Losses due to outage of generating units:

Due to rising gas price and coal power plants, continues caused frequent starting and stopping of units depending on the peak load.

Loss due to aging of power plants:

The average age of most of the gas-based power station is 20 years and they are running at 80-90% of rated capacity.

***Primary consultation**: Various energy experts based in Pakistan.*
***Secondary research:** NEPRA, WAPDA, Pakistan statistical report and reports by various multilateral and bilateral agencies*

Thermal Power Plant (HFO, Gas and Coal as a fuel)

Losses due to use of obsolete technology:

All the coal and oil based thermal power stations in Pakistan are based on subcritical technology which have lower efficiency.

Losses due to improper monitoring of critical parameters:

The losses due to inefficient operation of thermal power plant in Pakistan is estimated to be around 3210 GWh

Losses due to excess auxiliary power consumption:

A typical unit has an auxiliary power consumption is in range of 10.38% for oil fired and 26.73% for coal fired power plant.

Loss due to aging of power plants:

Due to aging of plants, there is an energy loss of 229.1 GWh.

Technical Losses

Power Distribution

Over loaded distribution circuits:

Overloaded transformers and feeders have been identified as the primary contributors of interruptions of power supply and losses in Pakistan's DISCO's.

Electricity Theft:

DISCOs has faced issues like illegal hooking and tempering of meters.

Lengthy distribution line loss:

Pakistan has a large and scattered share of rural population, which leads to lengthy and scattered distribution lines.

Losses due to improper maintenance of transformers and lines

Non-Technical Losses

Policy Related Issues

- As per National Energy Efficiency and Conservation Act, energy audits will be for different designated consumers, but no proper measures were taken by the authority to force these designated consumers to implement energy efficiency measures.
- The lack in policy formation for modernization of existing plants has led to inefficient operation and consumption of more fuel.
- Slow structural reforms for privatization.

Governance and Administrative issue

- The centralized control of Ministry of Water and Power over the utilities.
- Due to confutations between different government agencies in Pakistan, there is delay in policy implementations, which has a cascading effect on performance of utilities.
- Delay in approval process has caused old and inefficient power plants to run beyond their normal operating life.

Financial Constraints

- This tariff by NEPRA does not fully account for the cost incurred by DISCOs.
- High T&D loss causes huge financial burden on DISCOs.

Social and Environmental issues

- Capacity addition measures like installation of substations needs land space, and, in some cases, vegetation is needed to be removed. The delay in NOC causes delay in expansion, thus increasing T&D losses in the network
- High T&D loss is due to the inefficiency, collusion of power sector officials with consumers and unwillingness of consumers to pay bills. Also, government is not penalising such elements due to political reasons.

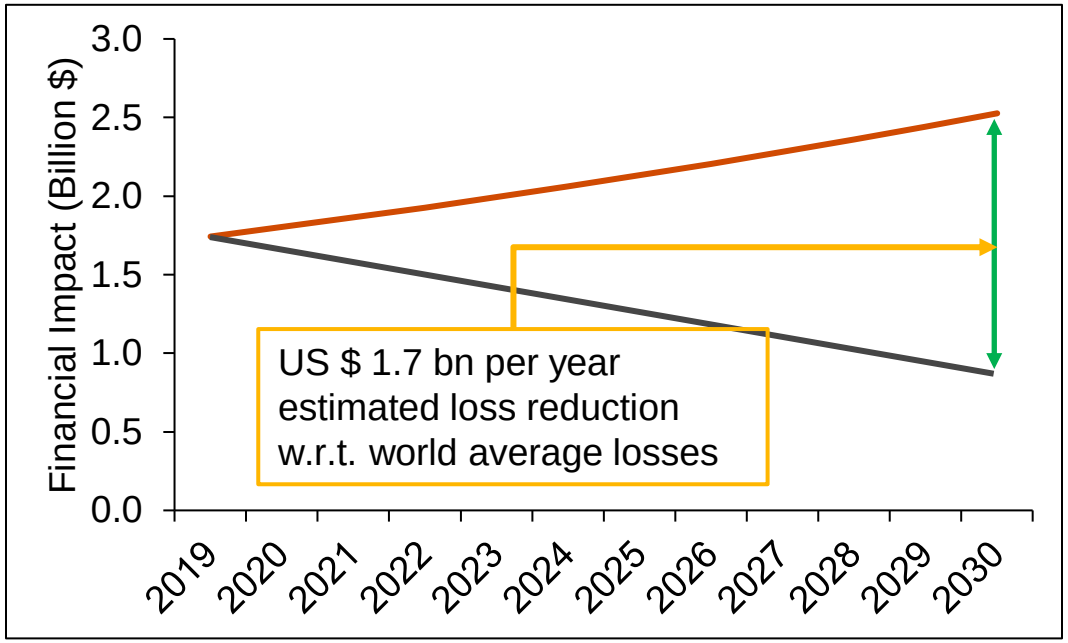
Challenges and Barriers

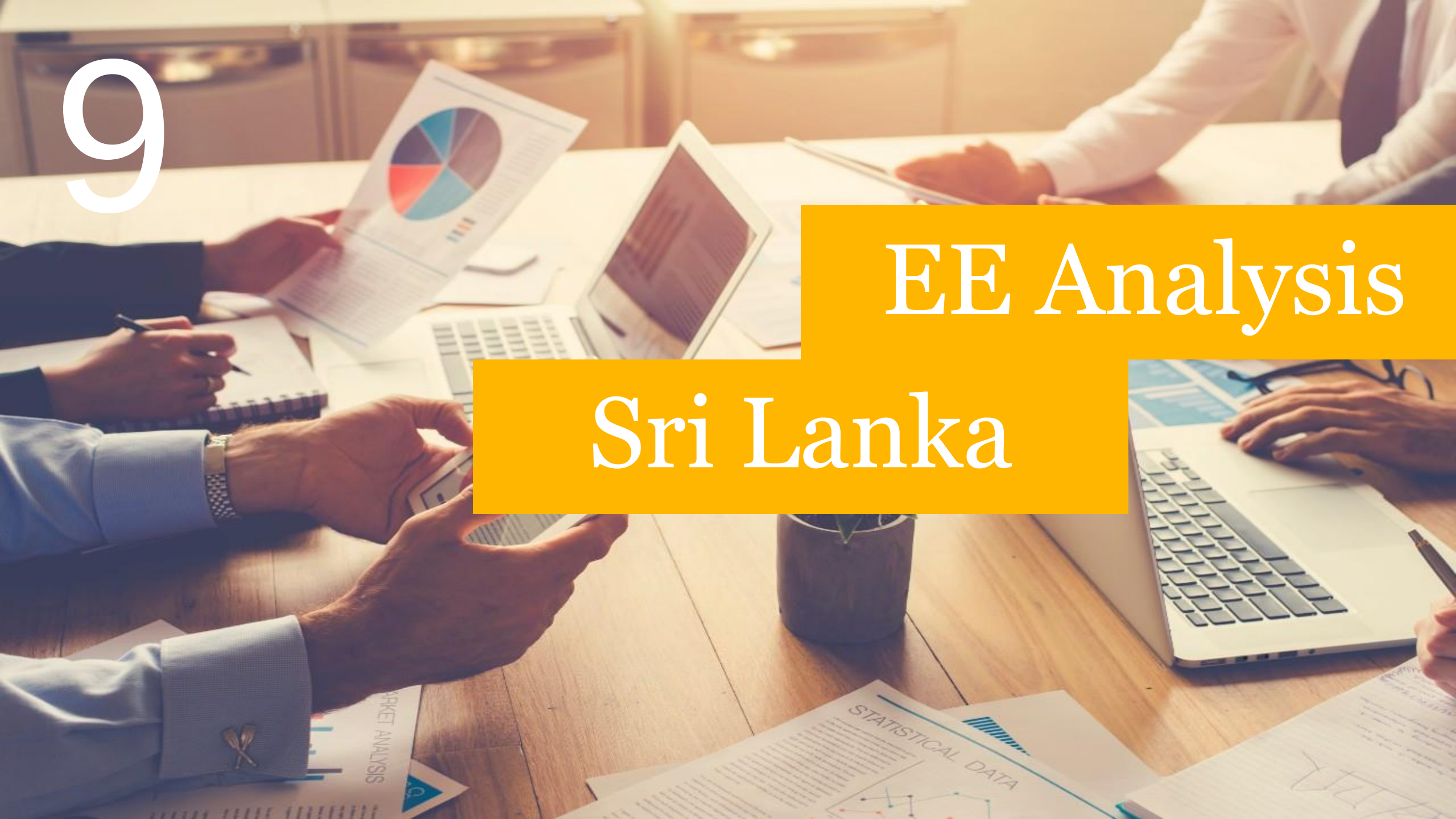
Cost	Pakistan's generation sector is predominated by government owned **power utilities, which majorly has gas and oil based thermal power plants in its mix**. Due to increasing prices of these fuels, these utilities have ***high generation cost***.
PLF	4 GENCOs in Pakistan are currently running at ***a very low PLF,*** so, the payback of the energy efficiency measures is longer than usual, and project is unviable in some cases.
Awareness	Utilities lack ***awareness in latest developments*** in energy efficient technologies available in the market.
Market	***The lack of domestic market for energy efficiency*** implementing agencies makes investment cost high, the same is imported from other Asian and European countries.
Financial	Due **to increased T&D losses** of government DISCOs, the EE measures may get delayed due to ***financial issues***. Also, Pakistan DISCOs are more concerned about expanding the distribution network.

Future Challenges and Financial Impact of Losses

- A ***shift in focus of government for coal and renewable source*** of energy may endanger investment made in increasing efficiency of these power plants.
- Due to ***dependency of importing energy efficiency equipment***, there is a possibility of scarcity of spare parts and service support in future.

- The generation sector can improve controllable losses by 9%.
- Distribution sector T&D losses can be improved by 16 % compared with world average.





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EE Analysis

Sri Lanka

Sri Lanka, story so far…

1983
Lanka Electricity Company
The Lanka Electricity Company was formed taking over the dilapidated electricity networks once owned to the local authorities.

1987
Ceylon Electricity Board Act
It provide way for formation of Ceylon Electricity board, which is the prime body for managing power infrastructure in the country.

2007
Sri Lanka Sustainable Energy Board Act
The purpose of this Act is to develop and promote indigenous renewable energy sources as an alternative to fossil fuel generated power, to enhance energy security and to promote energy efficiency.

2009
Sri Lanka Electricity Act
The act provided the regulations of the generation, transmission, distribution, supply and use of electricity in Sri Lanka

2011
Lakvijaya Power Station
The only thermal power plant in Sri Lanka 3*300 MW was commissioned.

2015
Paris Agreement
Landmark agreement between 195 countries to limit warming to well below 2 degrees Celsius

2021 and beyond...
Sri Lanka has faced various blackout and load shedding in the past. The main aim will be to strengthen its distribution network and increase the generation capacity.

Technical Losses

Power Generation

Thermal Power Plant

Losses due to improper monitoring of critical parameters:

The losses due to inefficient operation of thermal power plant in Sri Lanka.

Losses due to excess auxiliary power consumption:

The auxiliary power consumption is 10.1% of total generation, which is higher than rated value.

Losses due to improper selection of technology:

The sub critical thermal power plant was commissioned in year 2011 and at the same time super critical technology was already been used around the world.

Oil based Thermal Power Plant (GT units)

Losses due to unavailability of HRSG:

The total generated electricity can be increased approximately by 784 GWh per year after installation of HRSG.

- **Losses due to aging of gas power station**
- **Losses due to improper operation and maintenance**

Hydro Power Plant

- **Losses due to resistance in path ways**
- **Losses in turbine and other mechanical losses**

Primary consultation: *Ceylon Electricity Board and other energy expert based in Sri Lanka*
Secondary research: *Statistical Digest, CEB and analysis reports by various multilateral and bilateral agencies*

Technical Losses

Power Distribution

Losses due to lengthy distribution lines:

Almost 80% population lives in rural area, causes lengthy LV distribution lines.

Losses due to low power factor:

Due to huge inductive load in the system. The losses occur due to low power factor..

Losses due to improper planning of distribution network:

Although Sri Lanka has 98% electrification rate but the network is highly unplanned causing losses in the network.

Losses due to improper maintenance of transformers and lines

Non-Technical Losses

Policy Related Issues

- As per the Clause in the New Electricity Act no.20 of 2009, “the licensee has to give three-days’ notice of the intended entry by stating fully and accurately as possible, the nature of the work that intended to be done”. ***In case of illegal connections and meter tampering, consumers could remove or reverse the acts before the officer of the CEB visits the premises***.
- The lack in policy formation for modernization of existing plants has led to inefficient operation and consumption of more fuel.

Governance and Administrative issue

- The Sri Lanka power generation plants face issues of shortage of fuel especially coal. Due to this, there are problem of low power factor and frequent shutdowns.
- Lack of government focus on local research and development of energy efficiency measures and equipment.
- The forecasted of future demand in the country is not robust, due to which there are frequent power outages and over loading of distribution network.

Social and Environmental issues

- Sri Lanka power sector has been in immense pressure due to increasing demand of electricity, but capacity addition plan by government faces huge public agitation like for Lakvijaya Power Station (3*900 MW).
- The problem of theft and tempering of meters is prominent; agitation among the DISCO officials and consumers are not scarce.
- Due to space constraints in the main load centre city of Colombo, identifying land space for distribution network expansion is a huge problem.

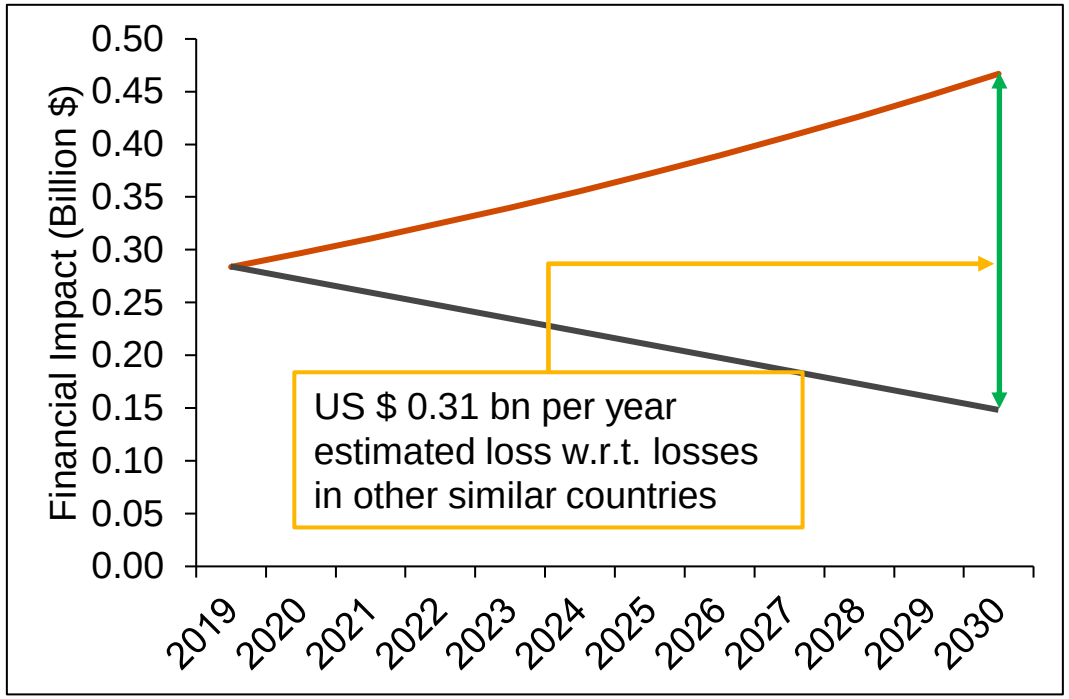
Challenges and Barriers

Financial	Years of civil war have adversely ***affected the financial health*** of State DISCOs and GENCOs, which are currently plagued with massive outstanding debts; this makes **investment for energy efficiency measures very difficult** to implement.
Implementation	In Sri Lanka, the hydro power plants normally run in wet and winter season and during dry seasons oil-based power generation plants are used. Due to ***underutilization of plants, in some cases the implementation of energy efficiency may become unviable***.
Awareness	Utilities are not much **aware about the latest energy efficient technologies** available in the market.

Future Challenges and Financial Impact of Losses

- The ***demand of electricity*** in Sri Lanka is largely concentrated ***in and around Colombo and nearby areas***. Hence, implementation of EE measures for other part of country may be difficult due to high payback period.
- Due to dependency of coal and gas based thermal power station, which are imported from other counties, there is continuous ***financial burden on the utility due to fluctuating price of fuel***. In absence of funds, EE measures may be difficult for them to implement.

- The generation sector can improve controllable losses by 11 %
- T&D losses can be improved by 2.34% compared with average T&D losses of 6% of similar countries.



Thank you

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