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

Recommendations for Energy Efficiency Improvements

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pwc

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Introduction

Introduction

Key areas of inefficiencies

In the SAARC nations, broadly in the power systems, the key energy efficiency issues pertaining to countries are:

- Relatively lower efficiency and reliability of thermal power plants mainly in countries like ***India, Pakistan, Bangladesh and Sri Lanka***.
- Significantly high losses in electricity transmission and delivery systems in countries like ***Afghanistan, India and Pakistan***.
- Lack of regulatory policies for implementation of energy efficiency in power utilities in countries like ***Afghanistan, Bhutan, Nepal and Maldives***.

Major energy saving potential

In SAARC nations, some immediate steps should be adopted to have an immediate payback of investment:

- Scope for significant improvement in efficiency of coal fired thermal power plants by 3 – 6 % in countries like ***India, Pakistan and Bangladesh***.
- In countries like ***Sri Lanka and Bangladesh*** net generation and energy efficiency of gas/oil fired single cycle power generators can be improved by 15 – 20% by installation of heat recovery steam generator (HRSG).
- Massive drive and policies to curb commercial losses in distribution system in countries like ***Nepal, India and Pakistan***.

Process of identifying recommendations

Selecting the key issues

In line of the objective of the study, a secondary and primary research was done to list the possible technical and non-technical losses and key obstacles faced by the sector was identified.

The key policy, financial, governance, social and environmental issues were identified for better understanding into individual country area of improvement and measures, which can be adopted for the same.

Listing possible energy efficiency improvement measures

List of possible energy conservation measures was prepared by considering:

- **The best practices adopted by various countries around the world.**
- **Consultation with various venders and internal expertise available**
- **Quantifying the requirement and future applicability of the measure**
- **Already available infrastructure and future plan of the country.**

Prioritizing and tailoring the recommendation as per country requirement

- **The recommendation for individual country are based on the financial, social and geographical conditions.**
- **The technical recommendations are based on the future plan of the country and are made attractive by selecting measures with high return and low payback.**
- **The non-technical recommendations are suggested after reviewing the regulatory and legal framework of individual country.**

Energy Conservation Measures in Generation

Some of the measures to prevent controllable losses in generation sector is presented below

Proper monitoring of critical parameters	In absence of automation tools, the critical parameters of temperature, pressure and flow are not monitored. Some of the tools, which can be used for monitoring these parameters are: • ELTRIX Plant Performance Management (PPM) • Steag PADO (Performance, Diagnostic and Optimization) • Enerlytics for gas-based generation plant
Renovation and modernization of equipment	An effective and economical way to improve the efficiency and reduce auxiliary power consumption of existing power stations is to renovate and modernize the inefficient equipment with the new and efficient technology. Some of the measures to save energy are: • Installation of Heat recovery steam boiler in single cycle gas/oil turbine • Use of VFD motors where motors are oversized • Replacement of old motors with energy efficient motor • Upgrade of turbine blades and vanes for gas turbine • Installation of O_2 analyzers at various stages of boiler • Installation of Pumped storage facility for Hydro power plant
Proper maintenance and operation practices	Some of the measures for improvement in O&M practice are: • Formation of a central team to monitor performance and efficiency • KPIs like root cause analyses of failure of equipment, equipment spare budget, maintenance time spent on particular equipment should be discussed weekly by the plant officials. • Training of operational and maintenance staff in energy conservation and efficiency improvement in power plant.

Energy Conservation Measures in Generation

Some of the measures to prevent controllable losses in distribution sector is presented below

Preventing Transformer Losses	• The utility should consider procuring most efficient transformer present in the local market or if feasible available at comparable rates globally. • the transformer sizing should be decided keeping 20% margin of the peak demand in that area.
Installation of smart meters	• The utility should consider installing only smart meters where new meters need to be installed. • Action plan should be formed to replace old meters with smart meters in a phased manner.
Preventing Line losses	• Increasing the voltage level in distribution networks reduces the current required to distribute the same amount of power, increases current capacity of the grid and reduces substantial voltage drops and line losses.
Redesigning distribution network	Redesigning the distribution network in such a way to: • Reduce the number of energized transformers in the system. • Direct coupling of higher voltage levels to lower ones without the use of intermediate transformers

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Recommendations for Afghanistan

Energy Efficiency Recommendations

Generation

Turbines Rehabilitation

The original OEM of the power plant can suggest compatible turbine (increase in generation by 20-25%)

Reduction in friction

Regular cleaning and removal of sediments, algae and unwanted plantations should be done

Maintaining head of reservoir

Proper planning should be done to import more electricity during period of low reservoir head.

Proper maintenance practice

Monitoring of performance of each equipment should be done.

Distribution

Network expansion Planning

Forecast network requirement based on geography and plan capacity augmentation.

Submetering of feeders

This measure will help in identifying major commercial loss areas in the distribution network.

Strict Vigilance

Setting up vigilance squads to check and prevent pilferage of energy and severe penalties should be imposed.

Smart Meters

Installation of smart meters for all the new connections and phase wise replacement of old meters

Non Technical

Target setting for loss reduction

The government should form regulations for compulsory loss reduction for DISCOs and GENCOs.

Security

There should be strict laws, which provide security to DISCOs officials conducting field vigilance.

Standardization for procurement

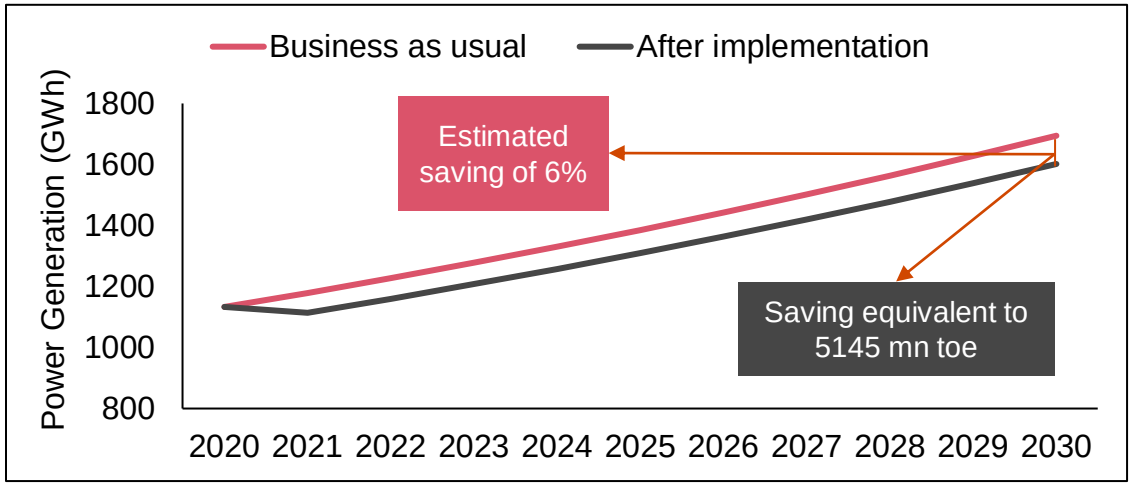
There should be performance and energy efficient clause in the equipment procurement tenders.

Privatization of Utilities

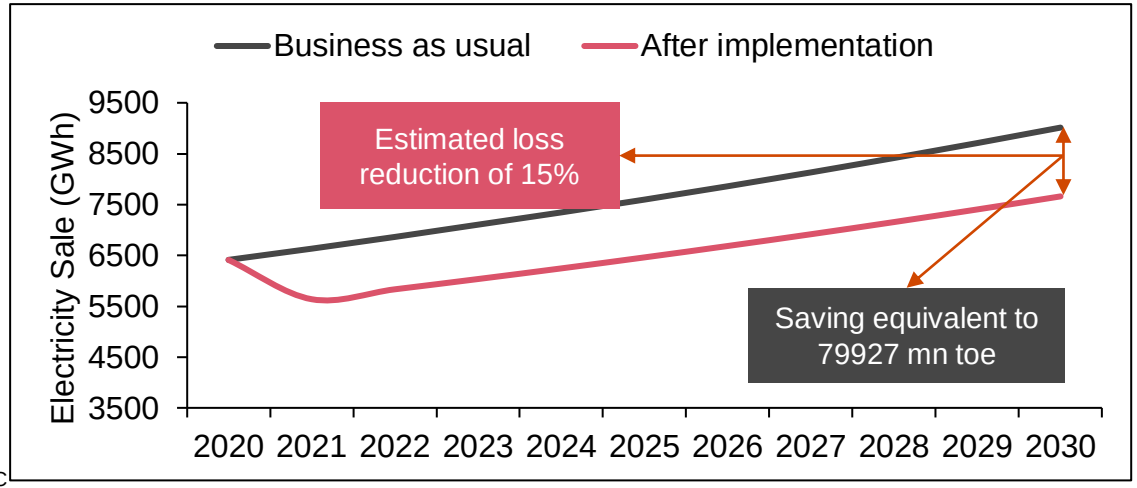
The involvement of private companies will enhance the domestic generation.

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- Capacity building of the utility officials/personnel though workshops to build understanding and enhance knowledge on energy efficiency opportunities.
- Financial institutions should be able to finance the energy efficiency projects at subsidized interest rates
- The security situation needs to be improved for encouraging private investment in the country

Expected Outcome

- **989.4** GWh per year energy saving
- **85073** toe per year, Energy saving
- **61.1 mn** US $, per year, Monetary saving potential
- **3.85 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment					
Proper maintenance and overhauling of hydropower plant	Technical	Hydro power plant	High	High	Moderately Easy
Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation & Distribution		Significant	
Deployment of manpower for strict vigilance	Regulatory	Distribution	Very High	High	
Recommended for consideration and adoption					
Replacement of old transformers with energy efficient transformers	Technical	Distribution	High	Significant	Moderately Easy
Rehabilitation of existing turbine of hydro power plant to increase the generation and efficiency		Hydro power plant	Significant	Medium	Slightly Complicated
Installation of smart meters for existing consumers and submetering at the feeder level.		Distribution	Very High	High	Moderately Easy
Recommended but require special attention and additional consideration before adoption					
Privatization of utilities for decreasing various losses	Regulatory	Distribution	Significant	High	Complicated
Recommended for strong consideration by the government					
Formation of guidelines for energy audits of utilities	Policy	Generation and Distribution	Significant	High	Moderately Easy
Policy for providing security and authority to vigilance teams		Distribution	Very High		
Policy development for procurement of only energy efficient equipment in power utilities		Generation and Distribution			Moderately Easy

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Recommendations for Bangladesh

Energy Efficiency Recommendations

Generation

Cogeneration power plants

Retrofitting the plant with heat recovery steam generator (HRSG).

Installation of Monitoring tools

Installation of monitoring and optimizing tool can minimize the operational inefficiencies.

Energy efficient equipment

Retrofitting old equipment can decrease auxiliary power consumption and increase efficiency.

Awareness and development of officials

Proper awareness sessions should be scheduled for officials on operation and efficiency.

Distribution

Implementation of SCADA system

Monitoring of system can be done more effectively by SCADA system.

Substation Automation System

The automation in feeders will detect the overloading/

HVDS network

Bangladesh can expand its HVDS network in rural and sub urban cities.

Underground distribution system

In areas having high T&D losses, underground cabling should be promoted.

Non Technical

Renovation of old plants

Government can form policies through which inefficient plants be penalized.

Energy Audit

Implementation of framework to bind the utilities for mandatory energy audit.

Target for load reduction

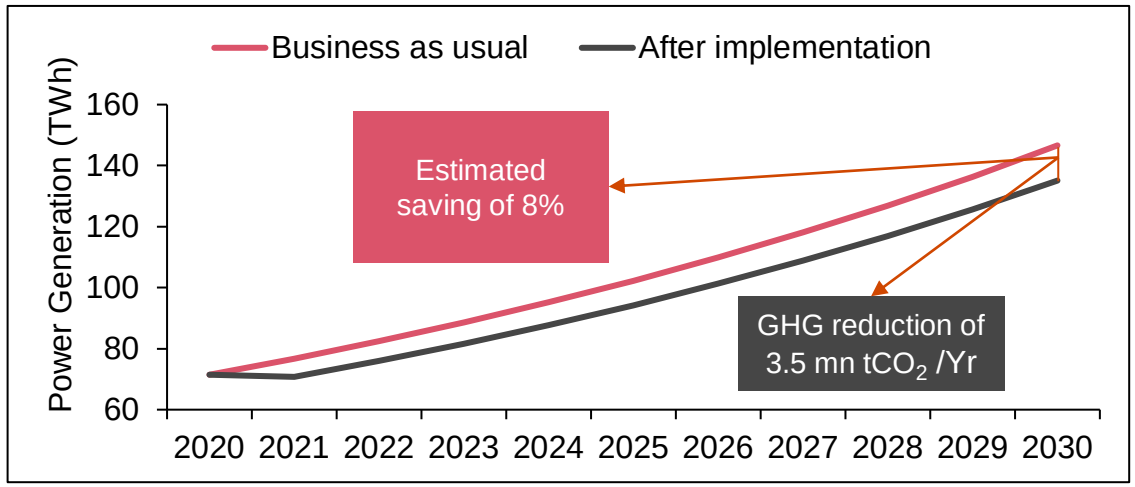
The utilities should be provided load reduction targets.

The Sustainable and Renewable Energy Development Authority

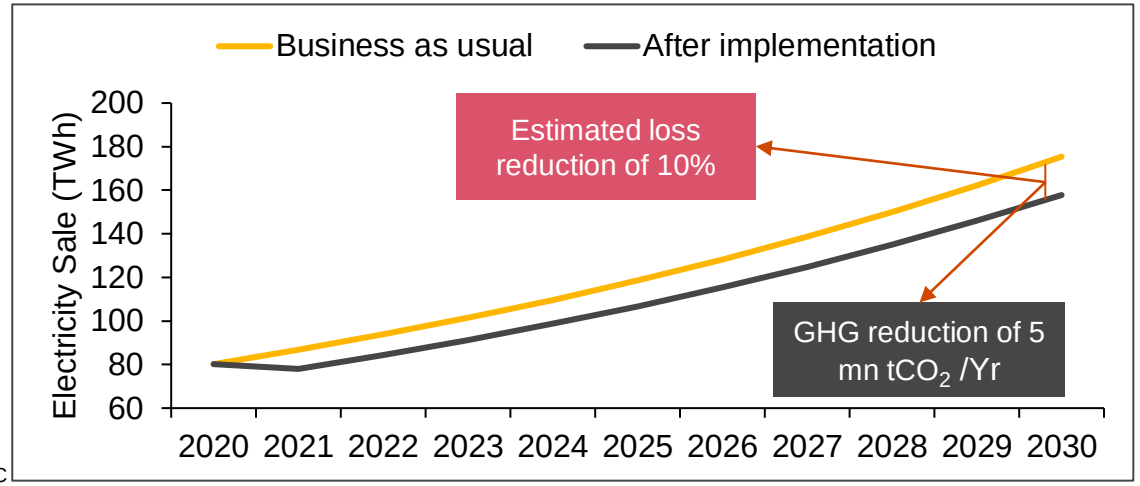
Power should be provided to agency for penalising utility in case of inefficiencies.

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- The government needs to define the energy efficiency target based on fuel type of power plants. As Bangladesh has number of gas-based power plants, which has exceeded their lifetime and implementing energy efficiency measures may not be feasible in these plants.
- Effective capacity building of officials of DISCOs. The utility manpower must be trained on global best practices in energy efficient DISCO operation

Expected Outcome

- **12,651** GWh per year energy saving
- **8.5** mn tCO_2 per year, GHG reduction potential
- **910.9 mn** US $, per year, Monetary saving potential
- **975.8 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment					
Installation of real time performance monitoring tool in thermal power plant	Technical	Thermal Power gas, coal & Oil	High	Very High	Moderately Easy
Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution		Significant	
Installation of smart prepaid meters for regions where T&D losses are maximum	Technical	Distribution		High	
Recommended for consideration and adoption					
Replacement of old inefficient equipment with energy efficient one	Technical	Thermal Power using gas, coal & Oil	High	Very High	Moderately Easy
Automation system for substation by implementing SCADA system		Distribution	Significant	Significant	Slightly Complicated
Installation of capacitor banks			Medium	Medium	Moderately Easy
Promotion of net metering system for consumers	Regulatory		Significant	High	
Recommended but require special attention and additional consideration before adoption					
Installation of HRSG system in simple cycle power plant	Technical	Thermal power using gas	Very High	Very High	Slightly Complicated
Modifications in distribution lines by introducing underground cabling and HVDS system		Distribution	Medium	Significant	Difficult
Recommended for strong consideration by the government					
Redevelopment of guidelines set by SREDA for energy audits	Policy	Generation and Distribution	High	Significant	Easy
Revision of tariff structure and provision of offering incentive to utilities in case they achieve T&D loss reduction target	Regulatory		Significant	High	Slightly Complicated
Renovation of old inefficient power plants	Policy	Generation	Very High	Very High	

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Recommendations for Bhutan

Energy Efficiency Recommendations

Generation

Turbines Maintenance and replacement

Generation company may consider retrofitting of old turbine, which can increase net generation by 20%.

Reduction of friction in the conveyance systems

There are should be regular cleaning and removal of sediments, algae and unwanted plantations should be done.

Pump Storage in power plant

It will help in restoring the optimum head in the reservoir and the plant will generate power at maximum efficiency.

Distribution

Upgrade of distribution network

The distribution network should be upgraded with more advance SCADA and substations.

Transformer replacement

The existing transformers can be replaced by more efficient transformers for reducing the T&D losses.

HVDS network

Due to hilly terrain, Bhutan can redesign its distribution network and place transformers and LV lines near load centre.

Non Technical

Feasibility for pump storage power plants

Emphasis on this system for future projects will provide more flexibility for power generation.

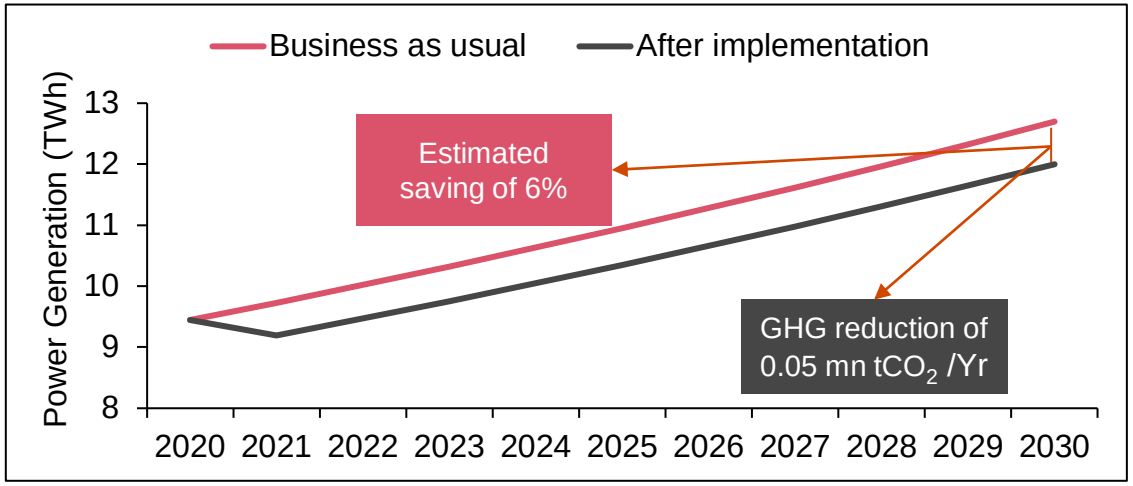
Energy Audit

The government should implement framework for mandatory energy audit of power generation and distribution utility at a defined period of time.

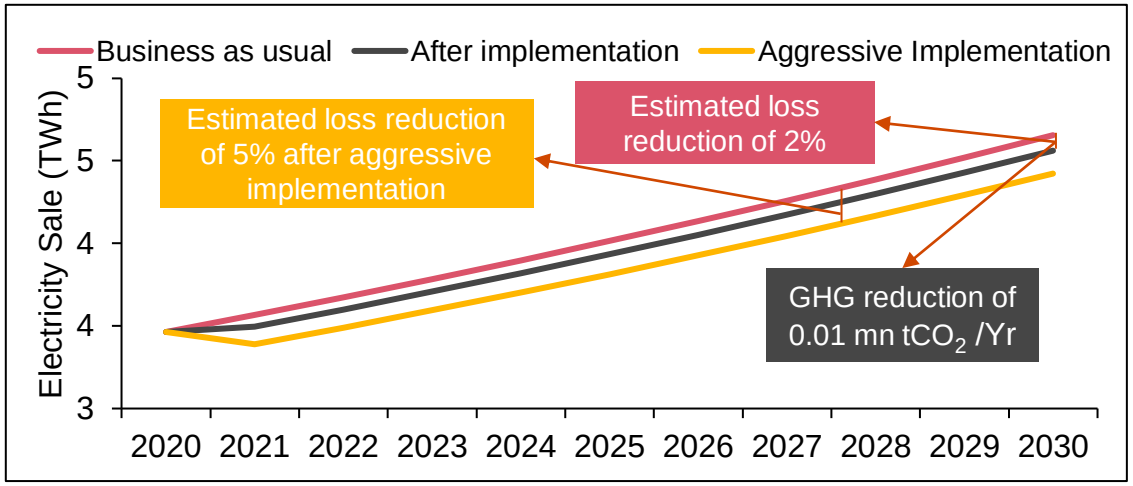
Bhutan can refer best practices of other similar countries for implementation of these measures.

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- The Bhutan government should formulate policy for incentivizing adoption of energy efficiency measures by the utility.
- Government can subsidise procurement of energy efficient transformers, smart meters and other equipment.
- The country being carbon neutral, technology advancement in low carbon space might not be implemented in the country.

Expected Outcome

- **572** GWh per year, energy saving
- **0.06** mn tCO_2 per year, GHG reduction potential
- **19.4 mn** US $, per year, Monetary saving potential
- **61.8 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

#	Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment						
1	Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution	High	Significant	Moderately Easy
Recommended for consideration and adoption						
2	Replacement of inefficient with more efficient transformers	Technical	Distribution	High	Significant	Moderately Easy
3	Proper maintenance of turbine and related auxiliaries of hydro power plant		Hydro power plant	Significant	High	Moderately Easy
4	Upgradation of LV lines to HV lines		Distribution	High	Significant	Moderately Easy
Recommended but require special attention and additional consideration before adoption						
5	Installation of pump storage hydropower plants for flexibility in operation	Technical	Hydro power plant	Significant	Medium	Slightly Complicated
Recommended for strong consideration by the government						
6	Formation of guidelines for energy audits of utilities	Policy	Generation and Distribution	Significant	High	Moderately Easy

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Recommendations for India

Energy Efficiency Recommendations

Generation

Auxiliary power consumption

Replacement of existing equipment with energy efficient one.

Proper use of monitoring tool

The utilities should motivate its officials to use the monitoring tools present in the plant

Process improvement

Various process in the plant should be done by following proper steps as suggested by OEM.

Awareness and development of officials

Proper awareness sessions to be scheduled for officials on operation, maintenance and efficiency.

Distribution

Underground distribution system

Underground distribution lines helps in preventing AT&C losses.

Transformer replacement

Replacement of existing overloaded and inefficient transformers.

Substation Automation System

Automation of substation can be an effective measure to reduce overloading of feeders.

Promoting Net Metering System

It allows the consumer to sell excess generation from renewable source of energy and help to reduce distribution loss.

Non Technical

Monitoring of PAT data

The government should hire its own agencies and should conducting M&V and energy audit of utilities

More effective policy

Issues like security of vigilance team, political interference should be addressed by government

Fuel shortage

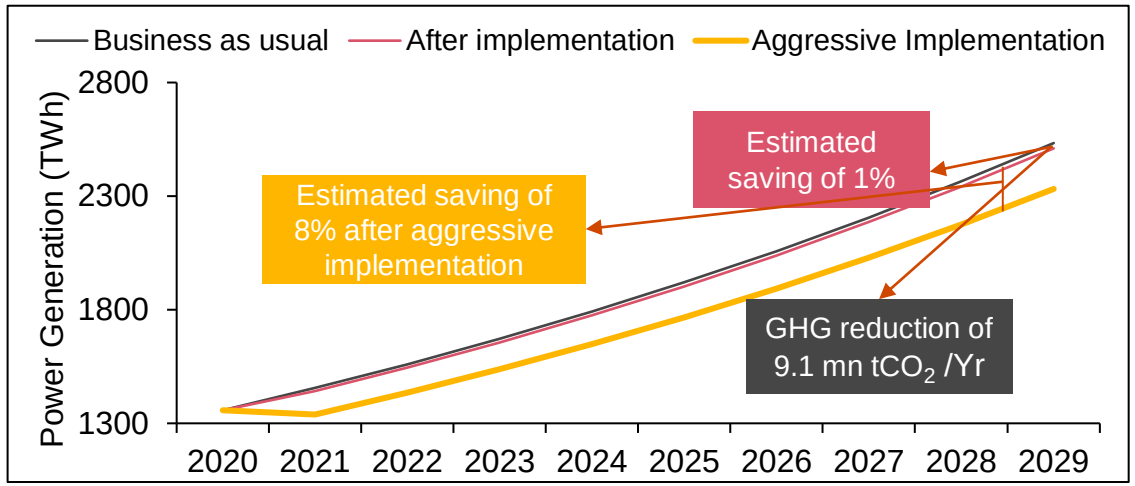
Gas and imported coal based thermal plants faces issues of shortage or expensive fuel prices.

Standardization for procurement

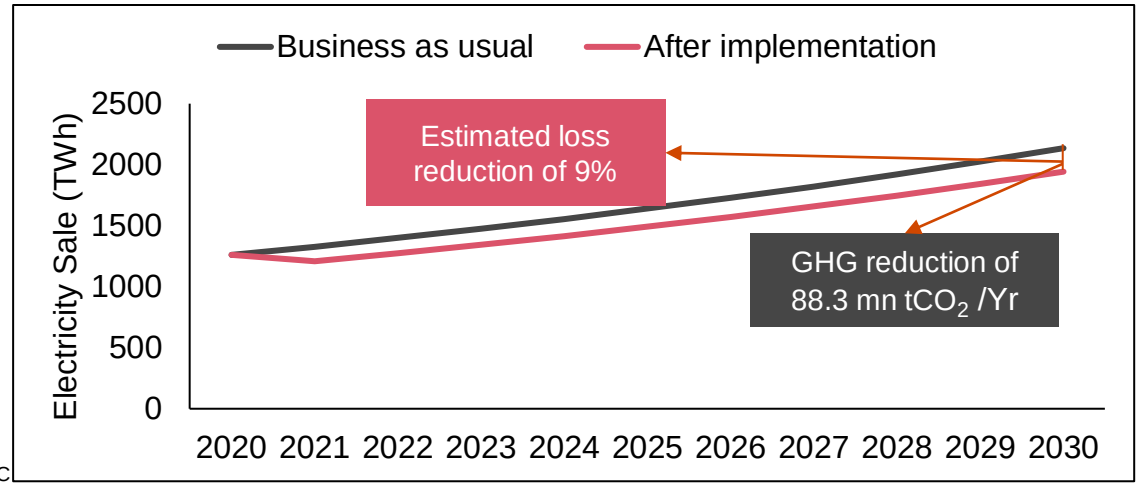
There should be performance and energy efficiency related clauses in the tenders

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- For effective loss reduction strategy, interference from local leaders should be minimised.
- Considering the size of country promotion of ESCO in implementation of EE measures for utilities needs attention
- Financial support by the government, implementation of EE measures

Expected Outcome

- **118,805** GWh per year, energy saving
- **97.4** mn tCO_2 per year, GHG reduction potential
- **4990 mn** US $, per year, Monetary saving potential
- **19134 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment					
Use of already available standard operational and maintenance practices for thermal plants	Technical	Thermal Power using Coal & Gas	High	High	Moderately Easy
Use of monitoring tool already installed in some plants and installation of new system in plants where it is not installed yet				Very High	
Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution		Significant	
Recommended for consideration and adoption					
Replacement of inefficient with more efficient transformers	Technical	Distribution	High	High	Moderately Easy
Replacement of old inefficient equipment with energy efficient one		Thermal Power using Coal & Gas		Very High	
Proper maintenance of turbine and related auxiliaries of hydro power plant		Hydro power plant	Significant	Significant	Moderately Easy
Upgrade the distribution system with underground cabling and HVDS system		Distribution	High		Moderately Easy
Recommended but require special attention and additional consideration before adoption					
Redevelopment of distribution network for better reliability and to reduce losses	Technical	Distribution	Very High	Significant	Slightly Complicated
Promoting net metering for DISCO consumers	Regulatory	Distribution	Medium	Medium	Moderately Easy
Recommended for strong consideration by the government					
Policy improvement to effectively monitor PAT data submitted by utilities	Policy	Generation and Distribution	Significant	High	Moderately Easy
Assistance to DISCOs for improving their financial health	Regulatory	Distribution	High	Significant	Difficult
Policy development for more effective load allocation to coal and gas based thermal power plant	Policy	Generation	Very High	High	Difficult
Policies for better availability of imported coal to thermal power plant designed for high GCV operation			Significant		Slightly Complicated

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Recommendations for Maldives

Energy Efficiency Recommendations

Generation

Flue Gas Heat Recovery System

FGHR-AC can be used to recover waste heat from exiting flue gas to produce air conditioning effect.

Exhaust Gas Recirculation

EGR system recirculates the exhaust gas back in the engine and it has a potential of reducing SOC by 5-8 %

Variable Geometry Turbocharger (VGT)

The VGT can help in increasing torque availability at low speeds and hence improve fuel economy.

Distribution

Underground Cabling

It will be effective for increasing line capacity due to space constraint.

Replacement of transformers with compact transformers

The existing transformers are overloaded and can be replaced with compact transformers due to space constraint.

Changing 11 kV lines with 33 kV lines

The overloading of lines can be prevented by replacing existing 11 kV lines with 33 kV lines, which will reduce the line losses.

Non Technical

Standardization of Specific Oil Consumption for DG set

Government can standardize SOC for DG sets and purchase of DG below a permissible value of SOC should be illegal.

Energy Audit

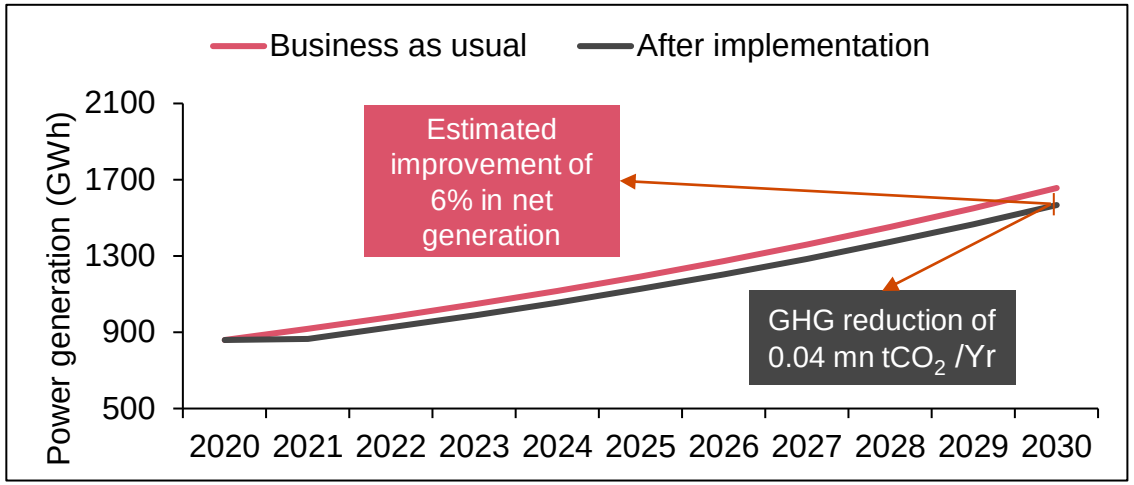
The government should implement framework for mandatory energy audit of power generation and distribution utility at a defined period of time.

Prioritize use of renewables

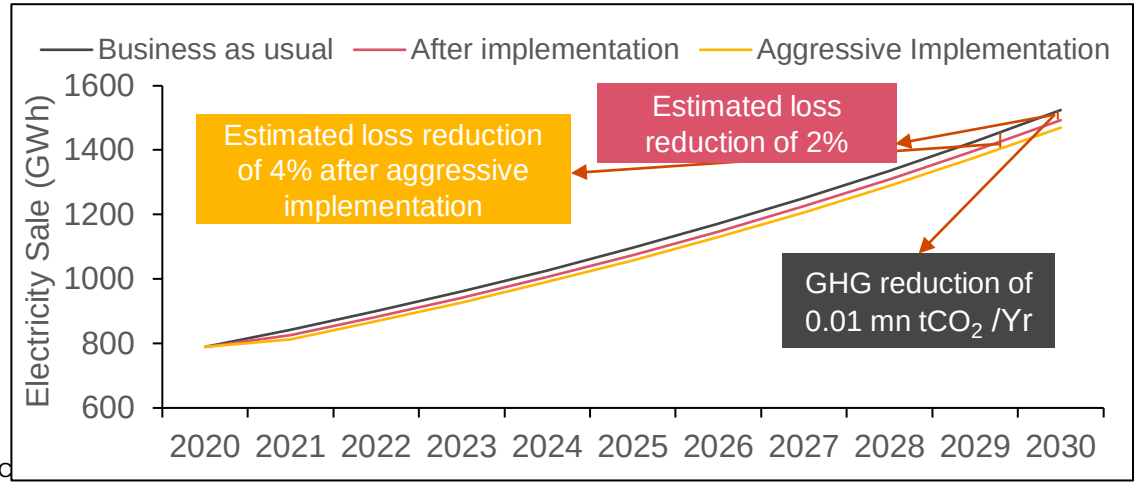
The government should form policies to motivate use of renewables

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- Due to geographical limitation of the country, a careful approach needs to be drawn before planning any measures.
- An effective implementation agency or private investor must be available for utilities through foreign collaborations.
- An awareness program should be planned for various stakeholders in the country.

Expected Outcome

- **63** GWh per year, energy saving
- **0.04** mn tCO_2 per year, GHG reduction potential
- **22.1 mn** US $, per year, Monetary saving potential
- **29.3 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment					
Flue Gas Heat Recovery System for Air-conditioning use	Technical	IC Engine	High	High	Slightly Complicated
Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution		Significant	Moderately Easy
Recommended for consideration and adoption					
Installation of Variable Geometry Turbocharger (VGT) with intercooler system for performance improvement of Diesel Generator	Technical	IC Engine	High	Very High	Slightly Complicated
Ensure steady load conditions on the DG set	Regulatory	Distribution	Very High	Significant	Moderately Easy
Replacement of existing transformers with high rated compact transformers	Technical		High		
Upgradation of existing 11 kV with 33 kV lines in Male			Very High	High	
Recommended but require special attention and additional consideration before adoption					
Use of renewables source of energy for generation in islands with less population	Regulatory	Generation	Very High	Very High	Difficult
Recommended for strong consideration by the government					
Formation of guidelines for energy audits of utilities	Policy	Generation and Distribution	Significant	High	Moderately Easy
Policy development for standardizing specific oil consumptions of Diesel generators		Distribution	Very High		

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Recommendations for Nepal

Energy Efficiency Recommendations

Generation

Turbines Maintenance and replacement

Generation company may consider retrofitting of old turbine, which can increase net generation by 20%.

Reduction of friction in the conveyance systems

There are should be regular cleaning and removal of sediments, algae and unwanted plantations should be done.

Pump Storage in power plant

It will help in restoring the optimum head in the reservoir and the plant will generate power at maximum efficiency.

Distribution

Smart Meters

Replacement of all manual meters with smart meters, which are tampering proof and will reduce losses.

Strict Vigilance

Setting up vigilance squads to check and prevent pilferage of energy and severe penalties should be imposed.

HVDS network

Due to hilly terrain, Nepal can redesign its distribution network and place transformers and LV lines near load centre.

Non Technical

Energy Audit

The government should implement framework for mandatory energy audit of power generation and distribution utility at a defined period of time.

Standardization for procurement

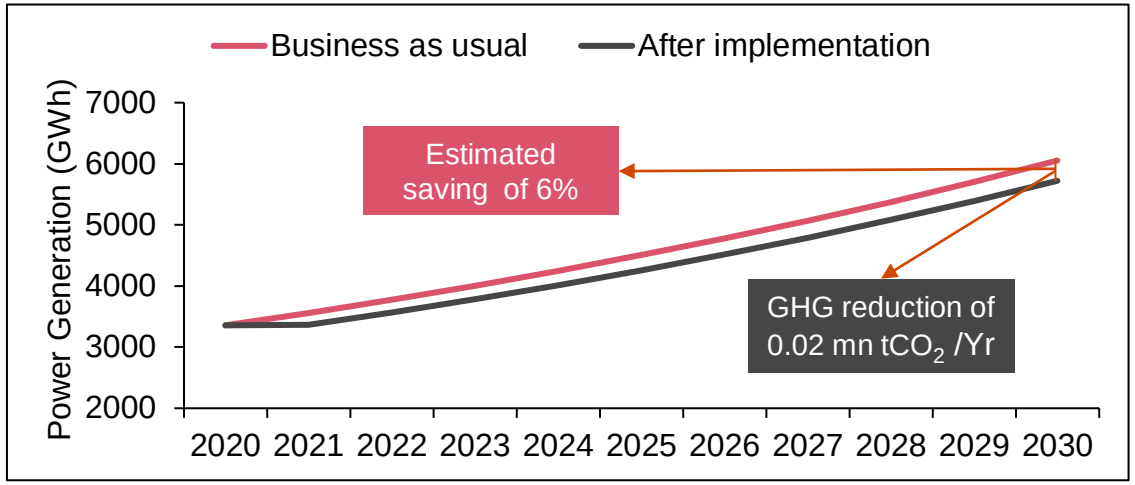
The government should only allow highly efficient equipment used in power sector

Privatization of Utilities

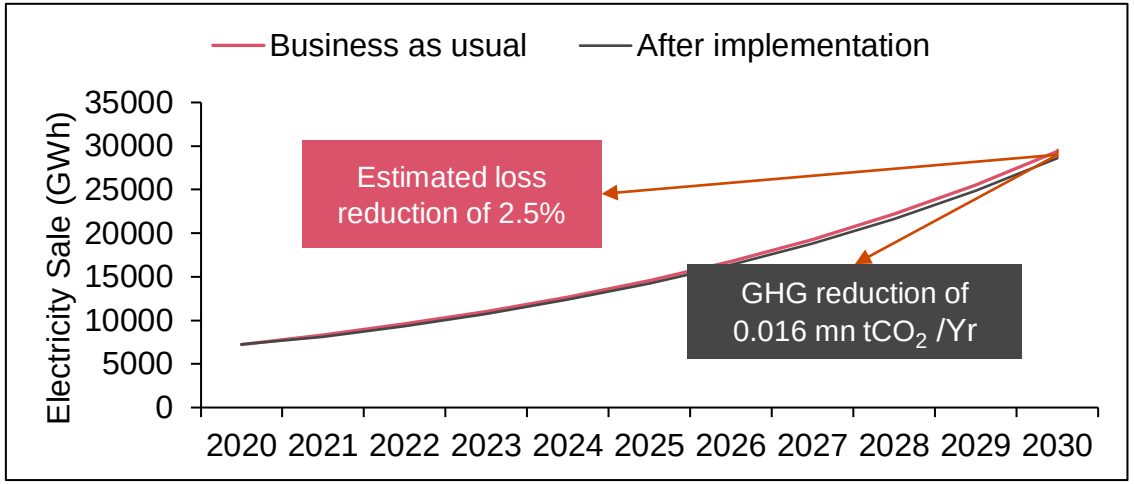
Nepal should encourage more private entities in power sector to invest in power generation and distribution sector.

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- The government should consider sustainable development of generation sector and funds should be provided to utilities for implementing energy efficiency measures
- The Nepal government should provide institutional and technical support to utility for implementing energy efficiency measures.

Expected Outcome

- **321.4** GWh per year, energy saving
- **0.032** mn tCO_2 per year, GHG reduction potential
- **32.1 mn** US $, per year, Monetary saving potential
- **106 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

#	Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment						
1	Deployment of manpower for strict vigilance	Regulatory	Distribution	Very High	High	Moderately Easy
2	Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution	High	Significant	Moderately Easy
Recommended for consideration and adoption						
3	Promotion of net metering system	Regulatory	Distribution	High	Significant	Moderately Easy
4	Proper maintenance of turbine and related auxiliaries of hydro power plant	Technical	Hydro power plant	Significant	High	Moderately Easy
5	Installation of smart meters in high T&D loss areas		Distribution	Very High		Moderately Easy
6	Upgradation of LV lines to HV lines		Distribution	High	Significant	
Recommended but require special attention and additional consideration before adoption						
7	Installation of pump storage hydropower plants for flexibility in operation	Technical	Hydro power plant	Significant	Medium	Slightly Complicated
Recommended for strong consideration by the government						
8	Formation of guidelines for energy audits of utilities	Policy	Generation and Distribution	Significant	High	Moderately Easy
9	Policy development for procurement of only energy efficient equipment in power utilities			Very High		Slightly Complicated

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Recommendations for Pakistan

Energy Efficiency Recommendations

Generation

Installation of Monitoring tools

Different monitoring tools can be used for operational efficiency.

Turbines maintenance

Recommendation can be requested from original OEM for more efficient turbine.

Energy efficient equipment

Retrofitting old equipment can decrease auxiliary power consumption and increase efficiency.

Awareness and development of officials

Proper awareness sessions should be scheduled for officials on operation and efficiency.

Distribution

Smart Meters

The smart meters will only work when the meters have sufficient balance thus improving collection efficiency.

Identification of the major loss

Due to wide terrain, DISCOs should identify their major losses and should prevent them.

Reducing the length of LT lines

Relocation of distribution sub stations/installations of additional distribution transformers.

Underground distribution system

In areas having high T&D losses, underground cabling should be promoted.

Non Technical

Shift in power generation type

Government should shift to more efficient and cost-effective power generation technologies.

Energy Audit

Allowing only highly efficient equipment to be used in power sector.

Standardization for procurement

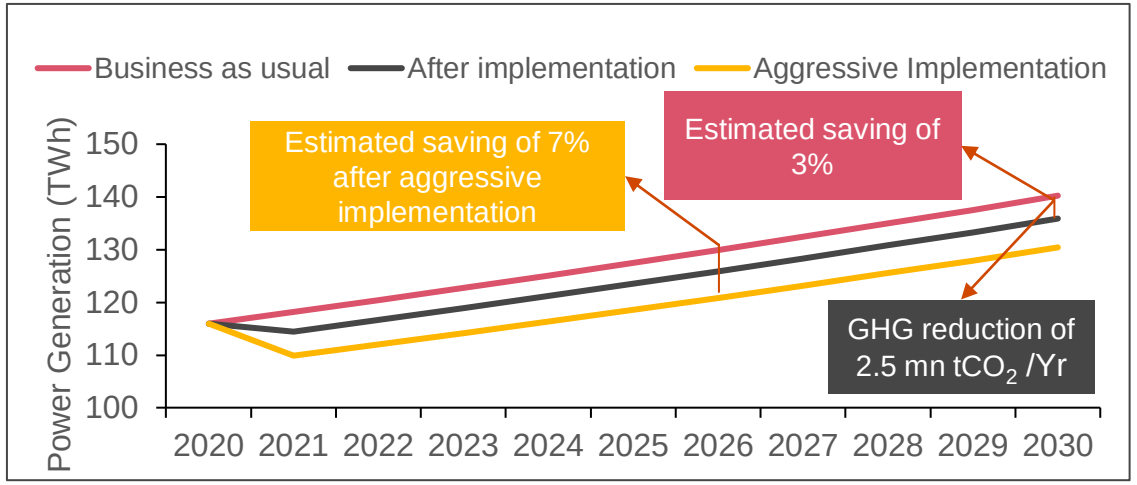
The utilities should be provided load reduction targets.

Privatization of Utilities

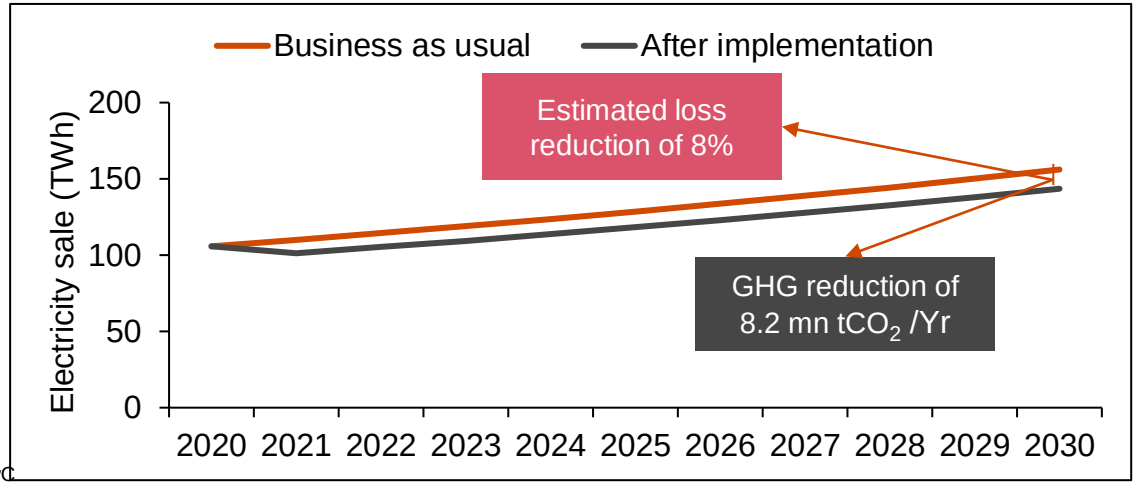
Pakistan should encourage more private entities in power sector.

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- The government should project more attractive and feasible energy efficiency programs to financial institutions for mobilizing funds for implementation of programs
- Pakistan government should invest more on local research and development of energy saving equipment

Expected Outcome

- **11674** GWh per year, energy saving
- **8.2** mn tCO_2 per year, GHG reduction potential
- **700.4 mn** US $, per year, Monetary saving potential
- **2,482 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment					
Effective monitoring of critical parameters in power plant by use of various PADO tools	Technical	Thermal Power Gas, Oil and coal	High	Very High	Moderately Easy
Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution		Significant	
Development and adoption of standard O&M practices for thermal power plants	Regulatory	Thermal Power Gas, Oil and coal	Significant	High	Slightly Complicated
Recommended for consideration and adoption					
Installation of smart prepaid meters for regions where T&D losses are maximum	Technical	Distribution	High	Significant	Moderately Easy
Replacement of inefficient with more efficient transformers				High	
Replacement of old inefficient equipment with energy efficient one		Thermal Power Gas, Oil and coal		Very High	Slightly Complicated
Proper maintenance of turbine and related auxiliaries of hydro power plant		Hydro power plant	Significant	Significant	Difficult
Upgradation of LV lines to HV lines		Distribution	High		Moderately Easy
Recommended but require special attention and additional consideration before adoption					
Redevelopment of distribution network for better reliability and to reduce losses	Regulatory	Distribution	Medium	Medium	Complicated
Recommended for strong consideration by the government					
Redevelopment of guidelines set by National Energy Efficiency and Conservation Authority for energy audits	Policy	Generation and Distribution	Significant	High	Moderately Easy
Policy development for procurement of only energy efficient equipment in power utilities			Very High		Slightly Complicated
Policy for development of efficient and latest type generation plants to be installed in future		Generation	High	Very High	Difficult

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Recommendations for Sri Lanka

Energy Efficiency Recommendations

Generation

Cogeneration power plants

Sri Lanka's simple cycle powerplants, can be retrofitted with a heat recovery steam generator.

Monitoring tools

Different monitoring tools can be used for operational efficiency.

Energy efficient equipment

Retrofitting old equipment can decrease auxiliary power consumption and increase efficiency.

Awareness and development of officials

Proper awareness sessions should be scheduled for officials on operation and efficiency.

Distribution

Smart Meters

The smart meters will only work when the meters have sufficient balance thus improving collection efficiency.

Transformer replacement

Replacement of overloaded and inefficient transformers.

Reducing the length of LT lines

Relocation of distribution sub stations/installations of additional distribution transformers.

Capacitor banks

Fixing of capacitors to feeder pillars in order to reduce the reactive current.

Non Technical

Modernization of existing Power plants

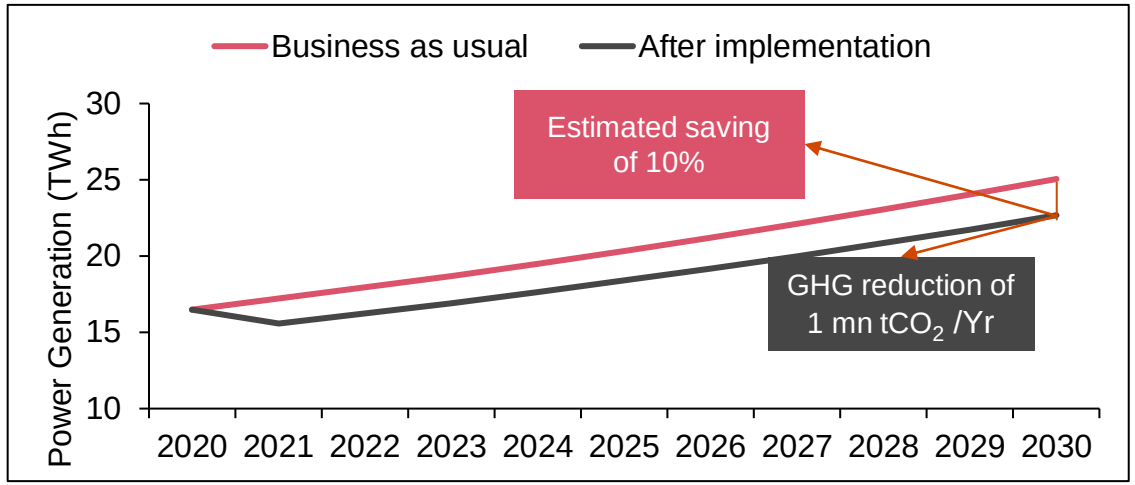
There should be clear policy in place either to completely close these inefficient plants or to perform renovation and modernization activity to increase their efficiency.

Energy Audit

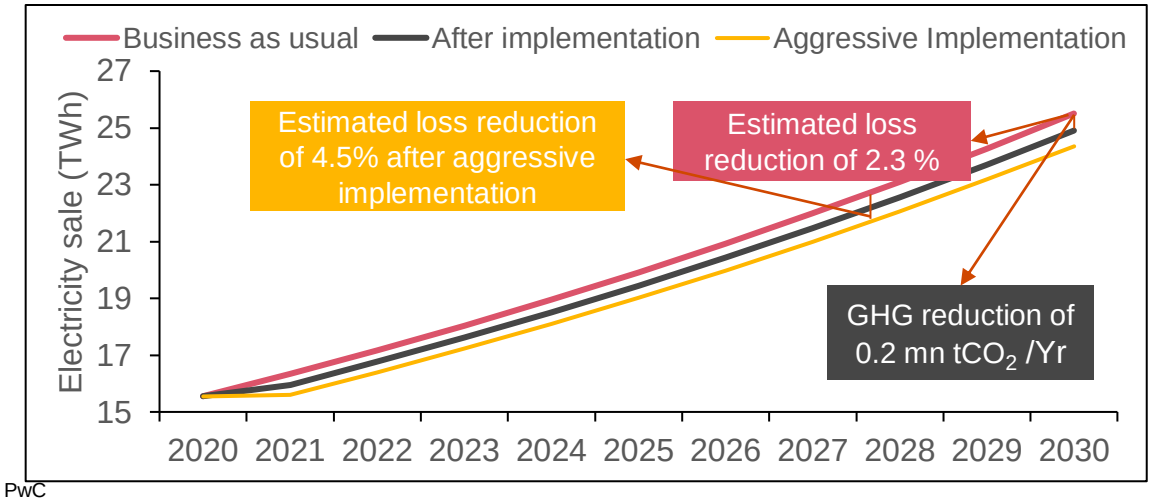
The Sri Lanka Sustainable Energy Authority should conduct energy audits and overlook the recommendations of these audits. Also, cross verification of the savings incurred by utilities by implementing measures suggested to them

Cost Benefit Analysis of Energy Efficiency Measures

Energy saving potential from recommendations in generation



Energy saving potential from recommendations in distribution



Pre Requisite for Implementation

- Proper feasibility study of EE measures before implementation
- Sri Lanka must develop local manufactures and use of domestically available technologies
- There is a need for capacity building of operators and officials on energy efficiency in thermal power plant.

Expected Outcome

- **1790** GWh per year, energy saving
- **1.3** mn tCO_2 per year, GHG reduction potential
- **179 mn** US $, per year, Monetary saving potential
- **784 mn** US $, Cost of implementation of recommendations

Summary of Energy Efficiency Measures

Recommendation	Type	Sector	Relevance	Saving	Ease of Implementation
Strongly recommended as they provide early payback of investment					
Monitoring of critical parameters in power plant	Technical	Thermal Power using coal & Oil	High	Very High	Moderately Easy
Awareness of utility officials in energy efficiency and loss reductions	Capacity Building	Generation and Distribution		Significant	
Development and adoption of standard operational and maintenance practices for thermal power plants	Regulatory	Thermal Power using coal & Oil	Significant	High	Slightly Complicated
Installation of smart prepaid meters for regions where T&D losses are maximum	Technical	Distribution		Significant	Moderately Easy
Recommended for consideration and adoption					
Replacement of old inefficient equipment with energy efficient one	Technical	Thermal Power using coal & Oil	High	Very High	Slightly Complicated
Proper maintenance of turbine and related auxiliaries of hydro power plant		Hydro power plant	Significant	Significant	Difficult
Upgradation of LV lines to HV lines		Distribution	High		Moderately Easy
Recommended but require special attention and additional consideration before adoption					
Installation of HRSG system in simple cycle power plant	Technical	Thermal power using Oil	Very High	Very High	Slightly Complicated
Redevelopment of distribution network for better reliability and to reduce losses	Regulatory	Distribution	Medium	Medium	Moderately Easy
Recommended for strong consideration by the government					
Formation of guidelines for energy audits of utilities	Policy	Generation and Distribution	Significant	High	Moderately Easy
Policy development for procurement of only energy efficient equipment in power utilities			Very High	High	Slightly Complicated

Summary of EE investment, saving and GHG reduction

Country	EE Investment (US$ million)	Monetary Saving (US$/year)	Payback (Years)	GHG reduction potential (million tCO_2)
Afghanistan	129.1	61.3	2.1	NA
Bangladesh	975.8	910.9	1.1	8.476
Bhutan	61.8	19.4	3.2	0.057
India	19133.6	4989.8	3.8	97.420
Maldives	29.3	22.1	1.3	0.047
Nepal	106.0	32.1	3.3	0.032
Pakistan	2481.0	700.4	4.0	8.172
Sri Lanka	784.0	181.0	4.4	1.252

Total **US $ 23.7 bn** **US 6.9 bn** **3.4 years** **115.5 mn t CO_2**

Thank you

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