Greenhouse Gas Mitigation Options for Pakistan: Energy Sector

Key Facts

Pakistan faces significant challenges in the energy sector with one-third of the population lacking access to grid electricity. Power outages cause the industrial sector to underperform and affect their competitiveness in the export market. The electricity distribution and transmission losses in 2014 stood at 18.5per cent. As per the National Electric Power Regulatory Authority (NEPRA), the power sector is responsible for two to three per cent reduction in the annual GDP of the country.

The major factors leading to energy crises are (i) the gap between end-user and cost-recovery tariffs (ii) limited private sector participation as a result of concerns about electricity payments, and (iii) lack of transparency.

GHG Baseline

The baseline emissions from the grid electricity generation in the year 2012 were 51.58 $MtCO_{2e}$. These emissions are expected to increase to 82.38 $MtCO_2$ by the year 2020 and 101.67 $MtCO_2$ by the year 2030. The projected annual greenhouse gas (GHG) emissions from grid electricity generated is indicated in Table 1.

Emissions are projected to rise by 97 per cent between 2012 and 2030. Emissions are forecast to grow from approximately 51.58 $MtCO_2$ in the year 2012 to approximately 101.67 $MtCO_2$ in the year 2030.

TABLE 1: PROJECTED GREENHOUSE GAS EMISSIONS IN ENERGY SECTOR (MT CO_2E)

Emissions from Grid Electricity as BAU Scenario	tCO_2/Year
2012	40,050,275
2015	52,592,673
2020	66,784,630
2025	69,813,890
2030	84,696,653

Mitigation Options

A list of mitigation options and supporting targets and measures for the energy supply sector was prepared. Later on, eight priority options have been selected based on an assessment of their feasibility of implementation from the perspective of:

a) Cost and technology perspective
b) The potential mitigation impact
c) Their significance to Government of Pakistan plans and strategies in the future

The selected mitigation options are:

- Biomass residues (cogeneration)
- Biomass residues (large-scale biogas)
- Centralised solar
- Distributed solar (grid connected)
- Wind (onshore large-scale)
- Mini/micro hydro
- Large Scale Hydel
- Grid and transmission losses

Summary results regarding each mitigation option are provided in Table 2.

TABLE 2: EMISSION MITIGATION MEASURES AND IMPACTS

Emissions Mitigation Measure	GHG Emission Reductions in 2030 ($MtCO_2e$)	GHG Emission Reductions from Sector BAU in 2030 (%)	Marginal Abatement Cost ($/Tonne CO_2e Reduced)
Biomass Residues Cogeneration	1.44	1.7%	57.37
Biomass Residues (large-scale biogas)	0.10	0.12%	343.55
Centralised Solar	2.38	2.81%	290.56
De-centralised Solar	2.92	3.45%	710.91
Wind Power Plants	6.54	7.72%	217.96
Mini/Micro Hydro Power Plants	2.44	2.89%	192.61
Large Scale Hydel	10.62	12.54%	246.28
Power T&D losses	8.28	9.78%	-
TOTAL ENERGY SECTOR	**34.72**	**41.01%**	

Biomass Residue (Co-generation)

Bagasse based high-pressure co-generation technology in the sugar industry.

Scenario Definition
There are 86 sugar mills operating in the country. Most of the sugar mills are operating on low/medium pressure (around 24 bar) technology, at a low-pressure steam to electricity generation ratio of 10.30 kg steam/kWh.

Mitigation Potential
By implementing high-pressure technology (100 bar steam pressure) each sugar mill can have improved efficiency of 5.49 kg steam/kWh (50 per cent efficiency improvement). By the year 2030 it is expected that 20 sugar mills will be converted to the high-pressure technology which will provide an additional 592 MW of electricity to the national grid resulting in GHG emission reduction of 14.92 $MtCO_2$ from 2012 to 2030.

Benefits and Impacts
- Energy efficiency improvement at the sugar sector of the country.
- Addition of renewable electricity to the national grid.

Biomass Residue (Large Scale Biogas)

Biogas generation from organic wastes at landfill sites near big cities of Pakistan

Scenario Definition
The most abundant biomass that has the sustainable collection and supply mechanism is municipal solid waste (MSW).

By dumping the MSW in a proper landfill and utilising landfill gas for electricity generation, this huge untapped potential can be utilised.

Mitigation Potential
The gross quantity of MSW generated in the eight major cities of the country is estimated to be 25,352 tonnes/day with the collection efficiency of only 64 per cent. Even with the current state, a proper landfill constructed at these eight cities, there is potential of at least 50MW of electricity to export to the grid by the year 2030. This will reduce 0.43 $MtCO_2$ from 2012 to 2030.

Benefits and Impacts
With the implementation of landfill and biogas power plants, there will be more health and environmental benefits than simple electricity generation. The cities will be cleaner and overall health of people will increase.

Centralised Solar

Large-scale grid connected centralised solar power plants.

Scenario Definition
Pakistan has the huge potential of photovoltaic (PV) solar-based power plants. However, due to high upfront costs this potential is not properly utilised. With the new upfront tariff provided by NEPRA, and government incentives, this sector is expected to grow.

Mitigation Potential
It is expected that by the end of the year 2030, an additional 3,259 MW of electricity will be supplied to the national grid from PV solar power plants. These power plants will reduce 23.73 $MtCO_2$ from 2012 to 2030.

Benefits and Impacts

- Reduce burden on the fossil fuel imports
- Self-sustainable power source
- Import of more energy efficient PV solar panels in the country

Distributed Solar Grid Connected

Small-scale distributed solar PV with grid connection (net metered)

Scenario Definition
NEPRA has provided an initial guideline for net metering in Pakistan. The guidelines and policies regarding net metering are expected to be finalised by 2017. Further, it is estimated that by 2018 the national grid will be equipped to handle net metering projects. Distributed PV Solar power plants are the most suitable for net metering.

Mitigation Potential
By the end of the year 2030 it is expected that the potential of distributed PV solar power plants (through net metering) will reach 4,000 MW. This will contribute to reduce 13.33 $MtCO_2$ from 2012 to 2030.

Benefits and Impacts

- Reduction in load shedding.
- Self-sustainability in power generation at each household.
- Transfer of technology and knowledge to the local public.

Wind (Onshore Large Scale)

Large scale centralized onshore wind power

Scenario Definition
The Gharo-Keti Bandar Wind Corridor, spreading 60 km along the coastline of Sindh province and more than 170 km deep towards the land, alone has a potential to generate more than 60,000 MW of electricity. There are several wind power plants already commissioned and some are in the pipeline. With the attractive tariff for wind power generation by NEPRA, and incentives by government, this sector is expected to grow even further.

Mitigation Potential
It is anticipated that by the end of the year 2030 an additional 4,195 MW of wind power based electricity will be added to the national grid. This will reduce 49.03 $MtCO_2$ from year 2012 to 2030.

Benefits and Impacts

- Utilisation of untapped sustainable power resource.
- Latest technology transfer to the country.
- Reduction of grid emission factor.

Mini/Micro Hydro

Grid connected or mini-grid hydro power of less than 50 MW in scale

Scenario Definition
At present, projects having the total capacity of 128 MW are operational at different sizes in the country. The government is trying to incentivise mini micro hydro power plants to grow this sector.

Mitigation Potential
It is expected that the total capacity of grid connected mini/micro hydro power plants will reach 2,000 MW by the end of the year 2030. This will reduce 19.13 Million tCO2 from year 2012 to 2030.

Benefits and Impacts

- Cheap sustainable power generation.
- Transfer of technology and reduction of environmental impacts of the fossil fuel based power plants.

Large Scale Hydel

Installation of new large-scale hydro power plants (reservoir based and run of the river).

Scenario Definition
Pakistan has over 60,000 MW of electricity generation potential from hydro power plants (Large scale and run of river included). By the year 2012, the gross capacity of hydro power plants was around 7,000 MW. There are many upcoming hydro power projects in Pakistan. But due to lack of finances, this potential is largely untapped.

Mitigation Potential
As reported by Private Power Infrastructure Board, there will be an addition of 3,000 MW of electricity to the national grid through private investment in large scale hydro power projects. Furthermore, WAPDA also has many large-scale hydro projects in the pipeline. From those, it is expected that two HPP Dasu Dam (4,320 MW) and Terbela 4th Extension (1,410 MW) will be added to the national grid by the end of the year 2030. This will result in GHG emissions reductions of 121.38 $MtCO_2$ from 2012 to 2030.

Benefits and Impacts

- Economical and sustainable source of electricity
- Job creation during construction and operation phase of the project.
- Storage and management of water for agriculture use.

Grid Transmission Losses

Reduce power transmission and distribution (T&D) losses in the national grid of Pakistan

Scenario Definition

The national power transmission and distribution network had the line losses up to 19 per cent in the year 2012.

Mitigation Potential

NTDC is planning to reduce the level of T&D losses to 16 per cent by 2017 and to 10 per cent in 2025. This estimate is made according to the national power plan. However, due to the delay in the implementation of some of the projects the target to reach 10 per cent line loses by 2025 could possibly be delayed. Hence, it is conservative to estimate that the target of reducing line losses to 10 per cent will be achieved by 2030. This will reduce 72.01 $MtCO_2$ from 2012 to 2030.

Benefits and Impacts

- Improvement of T&D power network will help meet the ever-increasing demand of electricity in the country.
- T&D losses improvement will lessen the burden on the subsidy which government provides to the small and medium domestic consumers.
- Reduction in circular debt in power sector.

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