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 effects their competitiveness in the export market. The electricity distribution and transmission losses in 2014 stood at 18.5. As per NEPRA, the power sector is responsible for 2 to 3 percent reduction in the annual GDP of the country.

The major factors leading to energy crisis 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 year 2012 were 51.58 MtCO2. Which are expected to increase to 82.38 MtCO2 by year 2020 and 101.67 M tCO2 by year 2030. Projected annual GHG emissions from grid electricity generated is indicated in Figure 1.

Emissions are projected to rise by 97% between 2012 and 2030. Emissions are forecast to grow from approximately 51.58 MtCO2 in year 2012 to approximately 101.67 MtCO2 in year 2030.

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

Emissions from Grid Electricity as BAU Scenario	tCO2/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 GoP plans and strategies in future

The selected mitigation options are;

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

Summary results regarding each mitigation options are provided in the table 1.

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
Centralized Solar	2.38	2.81%	290.56
De-centralized 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
86 Sugar Mills operating in the country. Most of the sugar mills are operating on low/medium pressure (around 24 bar) technology. At low pressure steam to electricity generation ratio at 10.30 kg steam/kWh.

Mitigation Potential
By implementing high pressure technology (100 bar steam pressure) each sugar mill can have the better efficiency of 5.49 kg steam/kWh (50% efficiency improvement). By the year 2030 it is expected that 20 sugar mills will be converted to the high pressure technology which will provide additional 592 MW of electricity to the national grid which will result in GHG emission reduction of 14.92 MtCO2 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 which has the sustainable collection and supply mechanism is municipal solid waste (MSW).

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

Mitigation Potential
Gross quantity of MSW generated in the 8 major cities of the country estimated to be 25,352 tons/day with the collection efficiency of only 64%. Even with the current state a proper landfill constructed at these 8 cities, there is at least potential of 50MW of electricity export to the grid by year 2030. Which will reduce 0.43 MtCO2 from 2012 to 2030.

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

Centralised Solar

Large scale grid connected centralized solar power plants.

Scenario Definition
Pakistan has the huge potential of PV solar based power plants. But due to high upfront cost this potential is not properly utilized. But 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 year 2030 additional 3,259 MW electricity will be supplied to the national grid from PV solar power plants. These power plants will reduce 23.73 MtCO2 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 finalized by 2017. And it is estimated that by 2018 the national grid will be able to handle net metering projects. Distributed PV Solar power plants are the most suitable for net metering.

Mitigation Potential
By the end of year 2030 it is expected that potential of distributed PV solar power plants (through net metering) will reach 4,000 MW. Which will contribute to reduce 13.33 MtCO2 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 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 year 2030 additional 4,195 MW wind power based electricity will be added to the national grid. Which will reduce 49.03 MtCO2 from year 2012 to 2030.

Benefits and Impacts
Utilization 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 total capacity of 128 MW are operational at different sizes in the country. Government is trying to incentivize 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 year 2030. Which 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 (PPIB) there will be addition of 3,000 MW electricity to the national grid through private investment in large scale hydro power projects. Furthermore, WAPDA has also many large scale hydro projects under pipeline. From those it is expected that two HPP Dasu Dam (4,320 MW) & Terbela 4th Extension (1,410 MW) will be added to the national grid by the end of year 2030. This will result in GHG emission reduction of 121.38 MtCO2 from 2012 to 2030.

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

Grid Transmission Losses

Reduce power transmission & distribution losses in national grid of Pakistan

Scenario Definition

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

Mitigation Potential

NTDC is planning to reduce the level of T&D losses to 16% by 2017 and to 10% 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% line loses by 2025 could possibly be delayed. Hence, it is conservative to estimate that target of reducing line losses to 10% 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.