Pakistan Low Carbon Scenario Analysis:

Project Summary Document

IISD ECN Report with Support of CCRD & PITCO

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1. Introduction

This document provides a condensed summary of the Low-Carbon Scenarios Analysis project, highlighting two critical parts of this project: the development of a reference case for emissions, as well as the identification of options for Pakistan to reduce its GHG emissions across key sectors. For more detailed information, full reports and briefing notes/factsheets are available for both the reference case and GHG mitigation options.

2. Project Background

Pakistan is a developing country that is impacted by climate change, while being a small contributor to global GHG emissions. However, national emissions will increase with population, economic, industrial and urban growth. Appropriate low-carbon interventions can help to ensure that Pakistan remains a low emitter as the country develops, without hampering growth. To determine what this future could look like, there is an urgent need to improve the evidence base surrounding GHG emissions and mitigation options in Pakistan.

The purpose of this Low Carbon Scenario Analysis project was to improve this evidence base through activities designed to:

- Improve understanding of low-carbon options – identification of priority opportunities for low-carbon development; and
- Improve mitigation planning – creation of the evidence base for INDCs, national communications, GHG inventory, Biennial Update Reports, Nationally Appropriate Mitigation Actions (NAMAs) and REDD+ actions.

When this project was initiated the last complete published emissions inventory for Pakistan was nearly 20 years old, and a subsequent study from 2007 was never published. The CDKN-supported project team therefore sought to fulfill the aforementioned goals by undertaking a suite of activities designed around two fundamental tasks:

- Development of a robust, detailed GHG emissions reference case for Pakistan. This reference case would present an accurate picture of current emissions levels in the country, complete with projections for future emissions trajectories until 2030.
- Development of a series of GHG emissions mitigation options. These options were to be developed through detailed technical analysis and engagement of key stakeholders in Pakistan. They were designed to present the Government of Pakistan with a set of actions across key emitting sectors that the Government could consider enacting to reduce future GHG emissions levels, and serve as an input to development of future NDCs and national climate change policies.

Together these two outputs would provide Pakistan with an evidentiary basis on which it could develop its own policies and national climate change documents. A related sub-objective of this project was to undertake detailed engagement with local stakeholders in Pakistan, raising awareness of opportunities to undertake low carbon development and reduce GHG emissions in the country. The intent was also that this work could be built upon by others in the future, for example in the development of NDCs and National Communications. The following sections highlight the results of the project

3. Reference Case Scenario Development

The reference case was developed in order to provide a measure of current (base year 2012) emissions for Pakistan (building on past emissions profiles and more recent data) as well as a projection that represents the most likely future of Pakistan to 2030. This projection is in the absence of additional government actions and policies to reduce greenhouse gas emissions, which are part of the GHG mitigation options analysis that follows. The starting point of the reference case was the development of a historical inventory of GHG emissions between 2000 and 2012/13. Projections to 2030 of emissions are then prepared by making assumptions of how activity related to specific sources of emissions changes over time. The main drivers of emissions are related to economic growth, changes in population, energy supply and prices as well as the adoption of new technologies and the impact of government policies and measures. The reference case is structured to align with typical GHG inventory sectors used by the IPCC and cover all relevant sectors.

The intent of the reference case is to capture existing policies and measures that are already in place (e.g., energy efficiency measures) and present the most realistic projection of the future given what is known about planned private and public investment. The reference case is developed using a simple accounting type model and does not model individual policies and measures, but rather attempts to extrapolate existing trends and consider changes to energy end-uses, industrial production and activities that result in the generation of greenhouse gas emissions.

4. GHG Emission Reference Case Projection

Figure 1 provides the reference case estimates for year 2012 emissions, and Figure 2 shows the historical and the projected emissions.

FIGURE 1: EMISSIONS IN 2012(Mt CO2e)

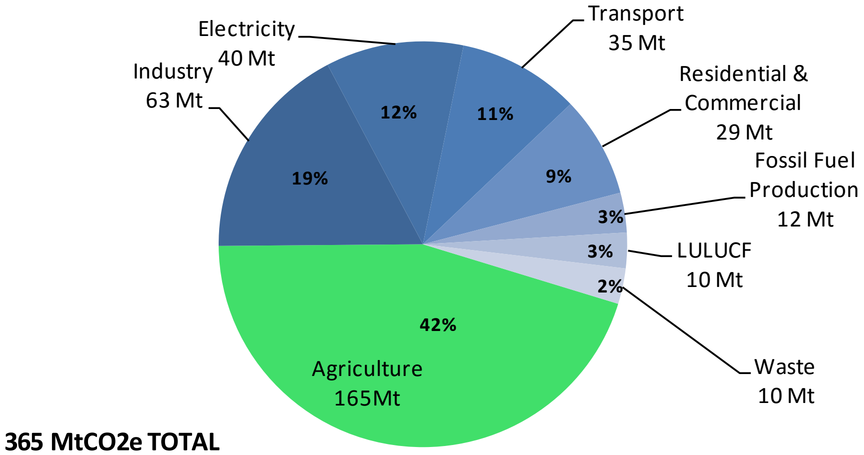
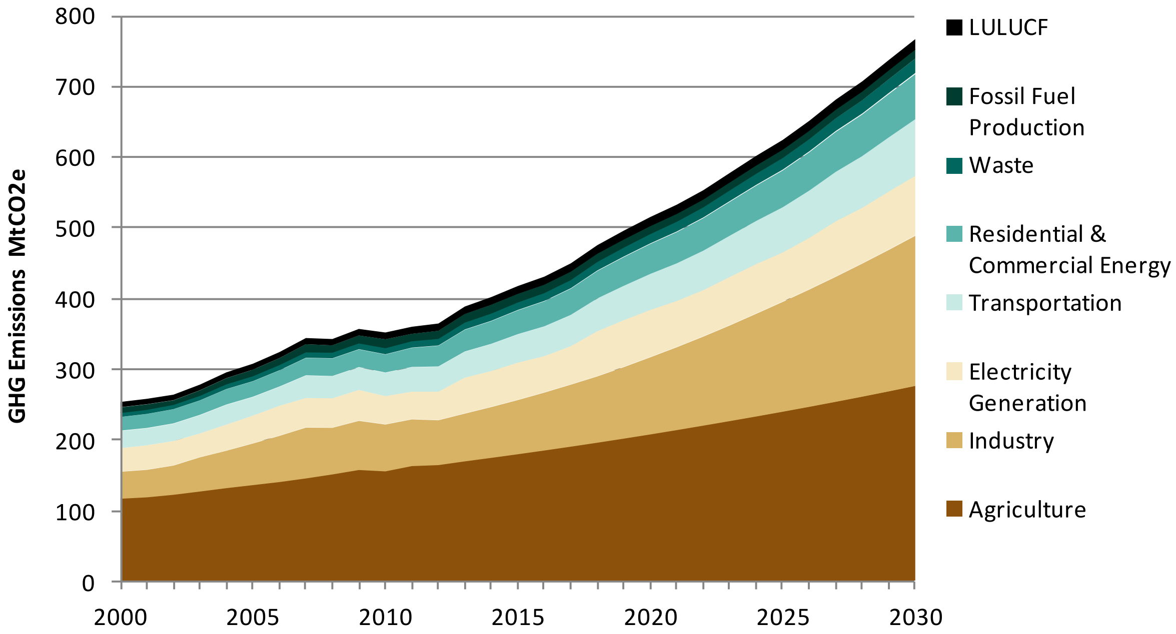


FIGURE 2: EMISSIONS REFERENCE CASE PROJECTIONS (MT CO2E)



5. GHG Mitigation Options Analysis

This analysis of GHG mitigation aims to inform Pakistan's policy makers and provide the evidence base for prioritizing low-carbon development.

This analysis demonstrates how the implementation of low-carbon development options can bend down emissions from the projected reference case in each sector. The overall work concludes with the identification of priority actions to enable low-carbon development and attract climate finance. In addition to the options quantified in this briefing note, a full list of options and detailed methodology are presented in separate sectoral reports and factsheets.

Options were identified from a review of existing policies and strategies, independent studies and key sectoral improvements that have demonstrated their success in similar contexts (i.e. best practices from other countries). Options were prioritized based on their commercial and technical viability in Pakistan. The methodology for calculating emissions reductions, as well as more detail on assumptions and figures, can be found in the corresponding technical reports.

Stakeholder consultation was undertaken with sectoral experts on these options for the purpose of seeking feedback on the results and identifying additional areas for GHG mitigation. This stakeholder consultation was led by the Centre for Climate Research and Development supported by IISD, ECN and PITCO.

Agriculture

Agriculture contributes more than a fifth of the country's GDP (21.4%) and employs almost half of the country's workforce (45%). There is a minimum expectation of 5% growth per annum for the sector. The sector is also a large driver of the country's emissions contributing nearly 42% of national GHG emissions in 2012.

The challenge for the sector is to be more productive to meet country needs, while coping with increased climate risks. The stability of the sector is threatened by extreme weather as well as temperature changes, both of which can deplete quality of agricultural soil.

12 options were identified based on GHG abatement potential, sustainable development benefits, cost effectiveness, evidence of existing action, and barriers to implementation:

- Improve irrigation/water management
- Reduce methane from rice cultivation
- Promote better manure storage & management
- Implement agroforestry practices
- Introduce genetically modified crops that are more carbon responsive
- Limit and reduce crop burning practices
- Use agricultural and animal wastes to produce biogas and organic fertilizer
- Reduce nitrous oxide release from soils by efficient & targeted use of chemical fertilizers
- Promote no-till farming to improve soil carbon
- Develop and adopt new breeds of cattle which are more productive in terms of milk and meat, and have lower methane production from enteric fermentation
- Use of organic pesticides and fertilizers
- Identify and implement ideal cropping patterns to manage soil nitrogen and reduce needs for chemical fertilizers

Five GHG mitigation options were identified that offer abatement potential, could be quantified, can be implemented immediately without significant barriers, and which are cost-effective. All are examined below, with a summary of GHG benefits and cost.

Merits of options such as reducing methane production from enteric fermentation were considered as well, given that more than 60% of agricultural emissions result from it. However, these could not be quantified during the initial screening of options due to uncertainties and data availabilities. This does not mean that adopting certain feedstock mixes, for instance, would not have the potential to contribute greatly to reduce emissions. Developing new breeds of cattle that have lower methane production from enteric fermentation could also have the co-benefits of being more productive in terms of milk and meat as well.

TABLE 1: 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)
Improve Irrigation/Water Management	1.58	0.6%	Low (<$25)
Reduce Methane from Rice Cultivation	1.16	0.4%	Low
Implement Agroforestry Practices	8.4	3.1%	Very low (<$10)
Promote better manure storage and management	0.15	0.06%	Low
Limit and Reduce Basmati Rice Crop Burning Practices	0.54	0.2%	Low
TOTAL AGRICULTURE SECTOR	**11.83**	**4.3%**	Low

Forestry

There is considerable uncertainty associated with estimates of national forest cover given differences in definition, survey methods and time of assessment. The official estimate is 5% of the total land area. Approximately 45% is conifer forest and the remainder is scrub (30-40%), plantations, riverine forest, trees on farmland or mangroves.

Mass afforestation and tree planting campaigns have been undertaken. Despite this, between 1990 and 2015, Pakistan saw a net loss of forest. Estimates of deforestation also vary but all sources agree that forests are declining. The key drivers for deforestation are demand for forest products outstripping supply (mostly fuel wood), population expansion, grazing, illegal harvesting and land use change.

Nine options were identified. The methodology for calculating emissions reductions, as well as more detail on assumptions and figures, can be found in the corresponding technical report for the forestry sector. Five quantifiable mitigation options (in bold) were identified that offer abatement potential, can be implemented immediately without significant barriers, and which are cost-effective.

- **Community-based forest management**
- **Preservation of conifer forest land**
- **Commercial plantations**
- **Reforestation of degraded land**
- **Agroforestry**
- Riverine forestry plantations
- Rangeland afforestation
- Irrigated plantations
- Reduce dependency on firewood

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 (US$/Tonne CO_2e Reduced)
Community-based forest management	3.2	21.3%	Very low (<$10)
Preservation of conifer forest land	4	26.6%	Low (<$25)
Implement Agroforestry Practices	8.4	56.0%	Very low (<$10)
Commercial plantations	3.2	21.3%	High (<$100)
Reforestation of degraded land	2.9	19.3%	Medium (<$50)
TOTAL FORESTRY SECTOR	**21.7**		Low-to-medium

Residential, Commercial and Agricultural Energy Demand

Together, residential, commercial and agricultural (RCA) energy consumption account for just under 30% of Pakistan's energy demand. Domestic energy consumption is rising consistently compared to industrial energy use, indicating a rise in economic welfare and increase of electrical appliances. Natural gas still dominates the fuel mix, complemented by biomass and electricity. The RCA sector contributed roughly 9% of national GHG emissions in 2012, with around 70% of the population having access to electricity.

The main challenge is to satisfy increasing energy demand in a sustainable manner in the face of unstable grid infrastructure and energy security risks. Considering suppressed demand will likely absorb any efficiency gains in the coming decade, energy demand reductions quoted here are rather seen as energy gap reductions.

Based on extensive review, 12 options were identified to improve energy use in the RCA sector:

- Efficient lighting
- Efficient stoves
- Efficient water heaters
- Efficient space heaters
- Efficient refrigerators
- Efficient air conditioners
- Efficient fans
- Efficient water pumps
- Efficient irrigation
- Improved roof insulation
- Solar thermal water heating
- Increased use of biomass and biogas

The first nine mitigation options were able to be quantified, examined in detail below, with a summary of GHG benefits and cost.

TABLE 3: EMISSION MITIGATION MEASURES AND IMPACTS

Emission Mitigation Measure	Abatement Potential in 2030	GHG Emission savings in 2030 (in Mt CO2e)	Investment costs (USD million)	Payback time (years)
Efficient lighting	22% (CFLs) 4% (FTLs)	2.19	763	0.9 (res) 0.2 (com)
Efficient stoves	43%	12.86	275	0.5 (res) 0.2 (com)
Efficient water heaters	30%	2.47	124	1.3 (res) 0.5 (com)
Efficient space heaters	36%	1.10	205	4.8 (res) 1.9 (com)
Efficient refrigerators	23%	0.89	703	1.5 (res) 0.8 (com)
Efficient air conditioners	6%	0.86	361	0.9 (res) 0.5 (com)
Efficient fans	32%	4.59	991	1.2 (res) 0.8 (com)
Efficient water pumps	47%	0.63	1335	10.9 (res)
Efficient irrigation	24% (electric), 31% (diesel)	2.98	828	0.4 (electric) 0.8 (diesel

Energy Supply

Pakistan faces significant challenges in the energy sector with one-third of the population lacking access to grid electricity. A reliable energy sector is essential to Pakistan's economic growth and prosperity. Power outages cause the industrial sector to underperform hence affecting their competitiveness in the export market. As per NEPRA, the power sector is responsible for 2 to 3 percent reduction in the annual GDP of the country. The electricity distribution and transmission losses in 2014 stood at 18.5%.

A list of mitigation options and supporting targets and measures for the energy supply sector was prepared. Eight options were quantified based on an assessment of their feasibility of implementation from the perspective of cost and technology, potential mitigation impact, and their significance to Government 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 4.

TABLE 4: 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**		

Industry

Pakistan has transformed itself from a largely agrarian economy to a semi-industrialized one. Industry is now an important contributor, representing roughly 25% of GDP. At the same time, energy use and emissions released during certain industrial processes contributed approximately 18% of GHG emissions in 2012, or 60 MtCO2e. The sector predominantly comprises large to middle scale manufacturing, mining and quarrying and construction.

Many industrial energy efficiency options reduce costs and allow for higher levels of production. They can also contribute significantly to improving working conditions and environmental outcomes. The challenge will be to incentivize or push industry to take action on energy efficiency by appropriate policy-making and regulation.

Options were prioritized based on their commercial and technical viability in Pakistan. The final set of options for the analysis were:

TABLE 5: EMISSION MITIGATION MEASURES

Industry sector	Abatement option
Cement	- Shifting the production from single-stage dry kilns to high efficiency multi-stage dry kilns - Standardization of fuel for cement industry
Brick	- Converting the existing bull trench kilns (BTK) to modified bull trench kilns (MBTK) with improved combustion - Converting BTKs and clamp kilns to zig-zag kilns (ZZK) - Best available technology (BAT) standard for ZZK - Standardize fuel for brick kilns
Textile	- Combination of various energy efficiency measures - Energy and water audits
Iron and steel	- Introduce BAT for blast-furnace-process for iron production - Conversion of electric arc furnaces to induction furnaces - Efficiency improvements for steel re-rolling process
Fertilizer	- Improved steam reforming and Haber Bosch process
Paper and pulp	- Thermal efficiency improvements
Sugar	- Limited energy saving potential, however, bagasse could be used for increased power production with export - Replace boilers with more efficient and high performance boilers - Ultimately considered in the analysis on 'energy supply'
Other industries	- Thermal efficiency improvements

The GHG mitigation potentials of these options were as follows:

TABLE 6: EMISSION MITIGATION MEASURES AND IMPACTS

Emissions Mitigation Measure	GHG Emission Reductions in 2030 ($MtCO_2e$)	GHG Emission Reductions from Sector BAU in 2030 (%)
Cement	14.7	7.5%
Brick	3.0	1.5%
Textile	1.4	0.7%
Iron and steel	6.2	3.2%
Fertilizer	1.4	0.7%
Paper and pulp	1.0	0.5%
Other industries	0.7	0.4%
TOTAL INDUSTRY SECTOR	**28.4**	**14%**

Transport

The transport sector contributes 13.7% of Pakistan's gross domestic product (GDP) and 5% of employment. In total, the sector handles an estimated 140 billion ton-km of inland freight and 540 billion passenger-km and contributed to roughly 11% of Pakistan's emissions in 2012.

The transport infrastructure in Pakistan is overwhelmed by long wait and travel times, high costs and poor reliability that hinder the country's economic growth and reduce the competitiveness of exports. The poor performance of the sector is estimated to cost the economy as much as 4% of GDP each year.

Options were identified based on their GHG abatement potential, sustainable development benefits, cost effectiveness, evidence of existing action, and barriers to implementation:

- Passenger cars, taxis, and vans efficiency norms
- Road to rail transfer
- Bus Rapid Transit (BRT) systems
- Car maintenance
- Electrification of railways

- Fuel switching to CNG/LNG
- Switch to biofuels
- Promotion of non-motorized transport
- Road freight switch to pipeline
- Tendering of public transport routes
- Fuel efficient aircraft
- Switch from 2- to 4-stroke engines in motorcycles
- Proper maintenance of existing roads

The first four measures were selected for quantification, as outlined in Table 7.

TABLE 7: EMISSION MITIGATION MEASURES AND IMPACTS

Emission Mitigation Measure	GHG Emission Reductions in 2030 (MtCO2e)	GHG Emission Reductions from Sector BAU in 2030
Passenger cars, taxis, and vans efficiency norms	7.45	9.2%
Road to rail switch	2.25	2.8%
Road to BRT Switch	0.19	0.2%
Car maintenance	0.17	0.2%

Waste

The waste sector is very small in terms of emissions: It represents less than 2% of Pakistan's GHG emissions. The sector can be divided into four parts that are sources of emissions: Human sewage, industrial wastewater, domestic wastewater, and solid waste. These four sources produce a variety of greenhouse gasses: Carbon Dioxide (CO_2) from burned waste and waste that is exposed to air, Methane (CH_4) from waste that is digested by bacteria in the absence of air, and Nitrous Oxide (N_2O), which comes from the degradation of human waste.

The key characteristic of the waste sector is that it is still at an early stage of development, with a relatively small proportion of the waste collected, especially outside or urban centers. The collected waste is also not really managed, as it is mostly dumped in landfills that lack sanitary or processing facilities. Some steps have however recently taken place, with the starting of a sanitary landfill and of a compost facility in separate locations in Lahore. These facilities involve joint ventures between the government and private companies and aim at marketing products such as compost for fertilisation and landfill gas for heat and electricity. Such products could potentially deliver enough revenue to support those facilities. The main challenge is to find the right conditions to gather value from these projects and have them standing on their own.

Several options were identified to improve energy use in the waste sector:

- Compost
- Landfill gas utilization
- Changing diets of Pakistani citizens to reduce protein intake
- Wastewater treatment options

The first two GHG mitigation options were quantified and are examined in detail below.

TABLE 8: EMISSION MITIGATION MEASURES AND IMPACTS

Emission Mitigation Measure	GHG Emission Reductions in 2030 ($MtCO_2e$)	GHG Emission Reductions from Sector BAU in 2030	Investment costs (USD million)
Compost	0.90	4.4%	19
Landfill gas utilization	0.88	4.3%	245

6. Sensitivity Analysis

While the project developed only one baseline for future GHG emissions in Pakistan; the project team did conduct a sensitivity analysis on this baseline to determine how the future emissions of the country may be affected by changes in characteristics such as GDP growth. What this means is that the project team assumed cases when GDP growth is higher an lower than the 6.1 % GDP growth estimated in the original reference case baseline. In running this sensitivity analysis, the project team was able to provide for the Government of Pakistan an idea of what emissions growth might look like under GDP growth scenarios of 2 percent less than the baseline (roughly 4 percent GDP growth) as well as two scenarios where GDP growth might be 2 or 3 percent higher than currently anticipated (8 and 9 percent GDP growth scenarios). The outcomes of this sensitivity analysis are represented in Figure 3 and Table 9.

FIGURE 1: PROJECTED GREENHOUSE GAS EMISSIONS UNDER THREE GDP SCENARIOS (MT CO_2E)

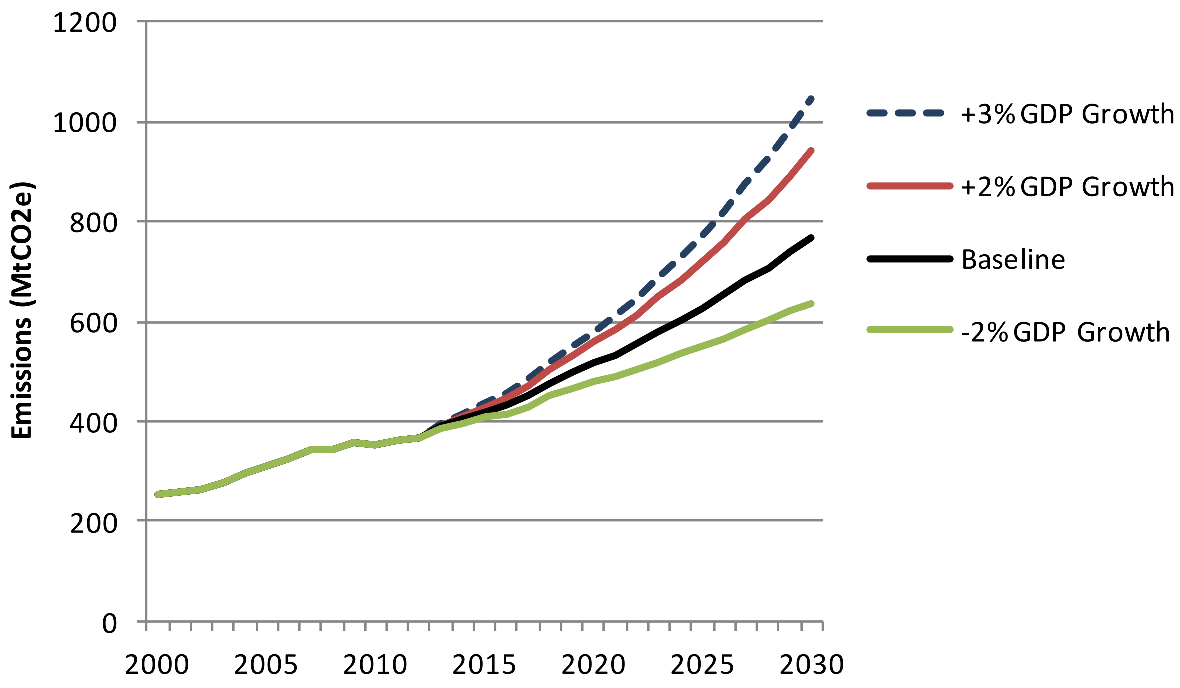


TABLE 9: RELATIVE IMPACT OF GDP GROWTH SCENARIOS TO LCS EMISSION REFERENCE CASE (%)

Scenario	Change in Emissions in 2030	
	(%)	$MtCO_2e$
+3% GDP Growth	36%	+ 278 $MtCO_2e$
+2% GDP Growth	22%	+ 172 $MtCO_2e$
-2% GDP Growth	-17%	-131 $MtCO_2e$

Clearly, energy prices will also have a strong impact on greenhouse gas emissions and all else being equal overall emissions would be expected to increase if energy prices fall, and decrease if energy prices rise in the reference case. Unfortunately, developing elasticities of demand for different fuels and developing energy price scenarios could not be conducted to consider energy prices as a driver of emissions for this project.

The sensitivity analysis indicates that GDP growth is an important driver of the difference between reference case emission projections to 2030. The 6% overall GDP growth rate forecast in the reference case is also lower than the more aggressive annual average growth rate of 8% of Pakistan's Vision 2025 target, which is represented in the +2 percent line in Figure 3 above.

7. Conclusion

This project has provided the Government of Pakistan with inputs to consider in its national and international climate change policies going forward. The reference case indicates that emissions are projected to grow considerably between now and 2030. This is a trend the government will have to consider carefully, and which will be heavily influenced by choices made in the energy, industry and agriculture sectors in particular. This trend will also be heavily influenced in GDP growth, where the more the Pakistan economy growth, the higher emissions levels in the country will be in the coming decades.

At the same time, the project has identified a number of options that Paksitan can consider to reduce future emissions and stall, or ideally even reverse this projected growth. The project team has identified options in all of the key emitting sectors. Some of these are easier to implement than others, if for no other reason than the cost of the actions, but all present ways in which Pakistan can address future emissions growth. In total these options represent well over 100 megatonnes of potential emissions reductions for the country, which would be a fundamental change towards low-carbon development in Pakistan if enacted.