Pakistan Low Carbon Scenario Analysis:

GHG Reference Case Projection - Briefing Note

IISD ECN Report with Support of CCRD & PITCO

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1. Introduction

This document provides a condensed summary of the GHG emission reference case projection for Pakistan that was prepared for the Low-Carbon Scenarios Analysis project conducted by the International Institute for Sustainable Development (IISD) and the Energy Research Centre of the Netherlands (ECN), with the support of the Climate and Development Knowledge Network (CDKN).

The reference case presents historical emissions from 2000 to 2012/13 and a projection of annual emissions out to 2030, and is the reference case against which the abatement potential of low-carbon development options that emerge from the Low- Carbon Scenarios Analysis project are assessed. The full report provides additional detail and analysis.

2. Reference Case Scenario Development

There currently exists no comprehensive official up to date emission inventory available for Pakistan, and therefore an independent GHG emissions inventory and projection (i.e., the reference case) was developed for the Pakistan Low Carbon Analysis project.

The reference case was developed for a single BAU scenario that aims to represent the most likely future of Pakistan to 2030 in the absence of additional government actions and policies to reduce greenhouse gas emissions. 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. While multiple reference case scenarios could have been considered in the analysis, a single reference case is selected in order to have a single starting point for the mitigation options analysis. A sensitivity analysis was conducted to look at additional scenarios where different rates of economic growth and energy efficiency improvements were considered.

The intent of the reference case is to capture existing policies and measures that are already in place (e.g., energy efficiency measures, regulations) and to 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.

The reference case is structured to align with typical GHG inventory sectors used by the IPCC and cover all relevant sectors including; Energy, Industrial Processes, Agriculture, Forestry and waste sectors.

3. Methodology

All major greenhouse gases that are reported under the United Nation Convention on Climate Change (UNFCCC) are included in the reference case. GHG emissions include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and Hydroflurocarbons (HFCs). GHG emission estimates follow the principles and guidance of the *2006 IPCC Guidelines* or the *Revised 1996 IPCC Guidelines*. In the simplest form, emissions are estimated by multiplying some type of activity data by an appropriate emission factor. Reference case calculations generally follow the Tier 1 approach in the 2006 IPCC Guidelines, but on occasion Tier 2 methods are applied. Emissions are presented in this factsheet in megatonnes of carbon dioxide equivalent (Mt CO_2e). A megatonne is equivalent to a 1,000,000 tonnes. Carbon dioxide equivalent expresses the overall radiative forcing of different greenhouse gas emissions by a common metric (i.e., the radiative forcing of carbon dioxide) so that the relative importance of emissions of greenhouse gases such as CO_2, CH_4 and N_2O can be easily compared.

Sources and sinks from all major IPCC sectors (Energy, Agriculture, Industrial Processes, Land Use and Land-Use Change and Forestry (LULUCF) and Waste Sectors) have been included in the reference case estimates. The Energy sector was further sub-divided into five energy sub-sectors of Residential, Commercial and Agriculture Energy Demand, Industrial Energy Demand, Fossil Fuel Production, Transportation, and Electricity Generation. The reference case also includes a few sources that were not included in the inventory prepared by the Pakistan Atomic Energy Commission (PAEC ASAD 2009).

Projections are based on the expected change over time in the activity or in the emission factor. The change in the activity data may be directly related to economic and population growth, the mix of energy supply resources and technology changes.

The assumption is that economic growth will have an average annual overall growth rate in Gross Domestic Product (GDP) of 6% between 2015 and 2030. While this is lower than the target in Pakistan's Vision 2025 of 8% it is a balance of a number of different projections, the sensitivity analysis does consider what would happen to emissions at both higher and lower growth rates. Reference case projections for population and household size are based on data from the Pakistan Economic Review 2013-2014. Projections for energy supply are based on various forecasts such as the National Electric Power Regulatory Authority (NEPRA) 2014 forecast for the electricity sector and the Pakistan Gas Supply-Demand Study (ILF, 2014) for gas projections.

The reference case model does not track the stock and relative energy efficiency or greenhouse gas intensity and replacement of associated end-uses (e.g., vehicles or appliances). Rather the model tracks on an annual basis the average efficiency value for different end-uses and adjusts this value to represent changes to the overall stock. This annual change in efficiency expressed as a percentage is referred to as the autonomous energy efficiency improvement (AEEI) value.

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 according to reference case estimates.

FIGURE 1: EMISSIONS IN 2012 (MT CO2E)

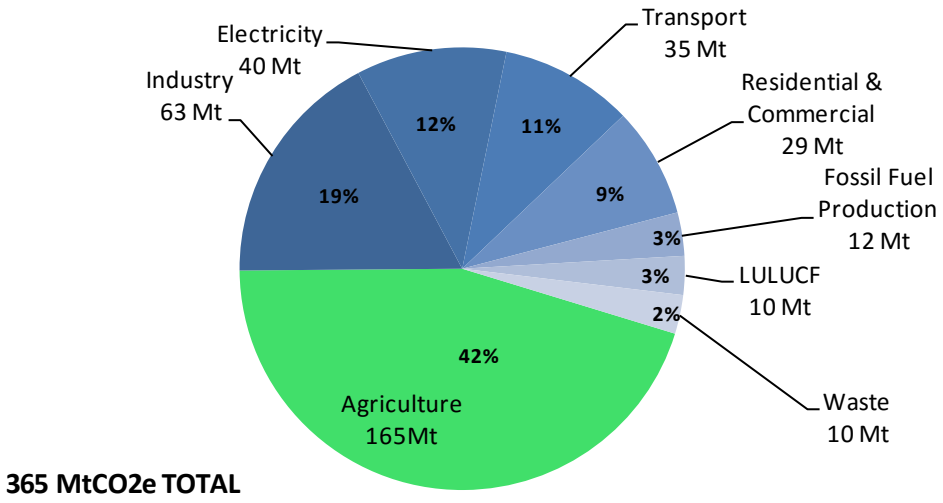
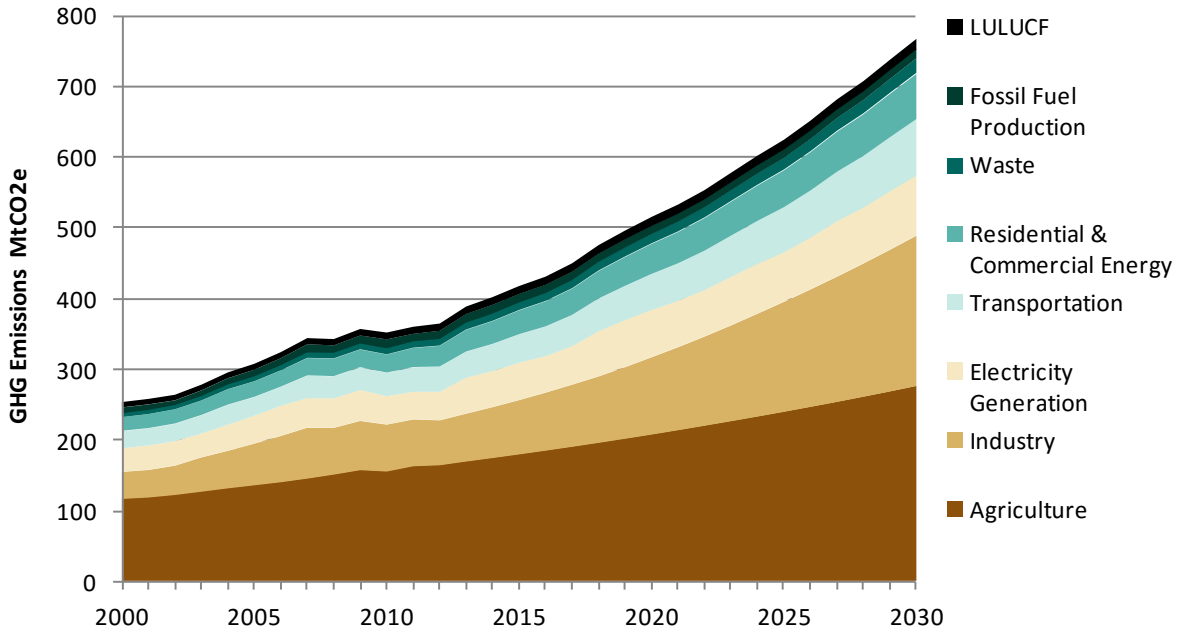


FIGURE 2: EMISSIONS REFERENCE CASE PROJECTIONS (MT CO2E)



5. Uncertainty Analysis

Two different drivers of emissions were varied in the model to determine the impact on future emission projections to 2030. The first driver is the growth rate in the total Gross Domestic Product (GDP). The reference case LCS model uses an average annual overall GDP growth rate of approximately 6.1%, although different sectors such as manufacturing, transport, agriculture and services have differentiated growth rates. The second driver is autonomous energy efficiency improvements (AEEI) that are associated with different end-uses in the model. These assumptions for AEEI improvements are summarized in the individual reference case sectors above (Section 2).

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.

GDP Growth

The rate of total growth in Gross Domestic Product (GDP) was varied by considering three alternative GDP growth scenarios compared to the GDP growth in the reference case (6.1% average annual overall GDP growth). A low GDP growth scenario of 2% lower, a high GDP growth scenario of 2% higher that aligns approximately with GDP growth forecasts outlined in Vision 2025 and a third very high growth scenario of 3% higher is also considered that effectively attempts to model a condition where all planned projects are built and growth is substantially spurred by the China-Pakistan Economic Corridor (CPEC).

Figure 3 and Table 1 illustrate the impact of these scenarios relative to the reference case.

FIGURE 3: PROJECTED GREENHOUSE GAS EMISSIONS UNDER FOUR GDP SCENARIOS (MT CO_2E)

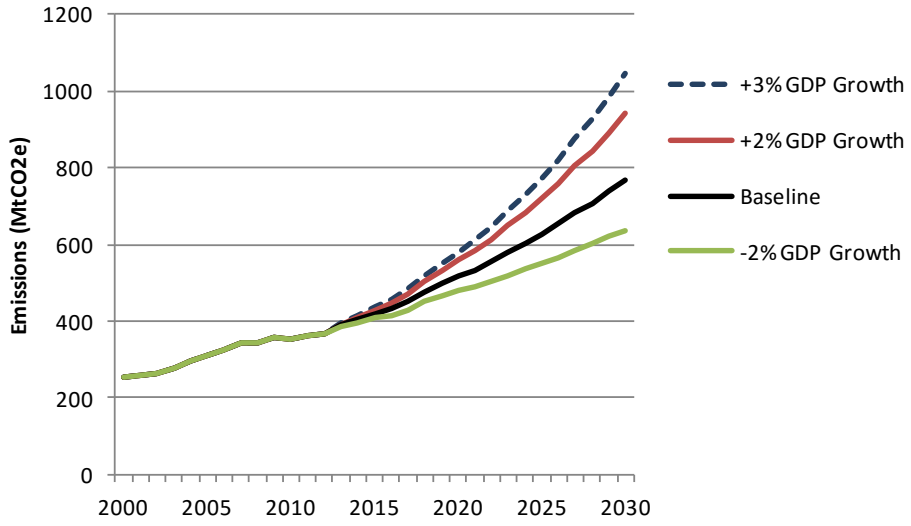


TABLE 1: RELATIVE IMPACT OF GDP GROWTH SCENARIOS TO LCS EMISSION REFERENCE CASE (%)

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 $MtCO_2e$

Autonomous Energy Efficiency Improvements

Autonomous energy efficiency improvements built into the reference case LCS model were varied +/- 50% to consider a low improvement in efficiency. For example, freight vehicles are assumed in the model to improve in energy efficiency (i.e., fuel economy) by 1% per year in the reference case model. A high AEEI scenario would consider an improvement in energy efficiency of 1.5% per year and a low AEEI scenario would consider an improvement in energy efficiency of 0.5% per year. The variance of AEEI impacts transportation, industry, residential, commercial and agriculture energy end-uses. Figure 4 and Table 2 illustrate the impact of these scenarios relative to the reference case.

FIGURE 4: PROJECTED GREENHOUSE GAS EMISSIONS UNDER THREE AEEI SCENARIOS (MT CO_2E)

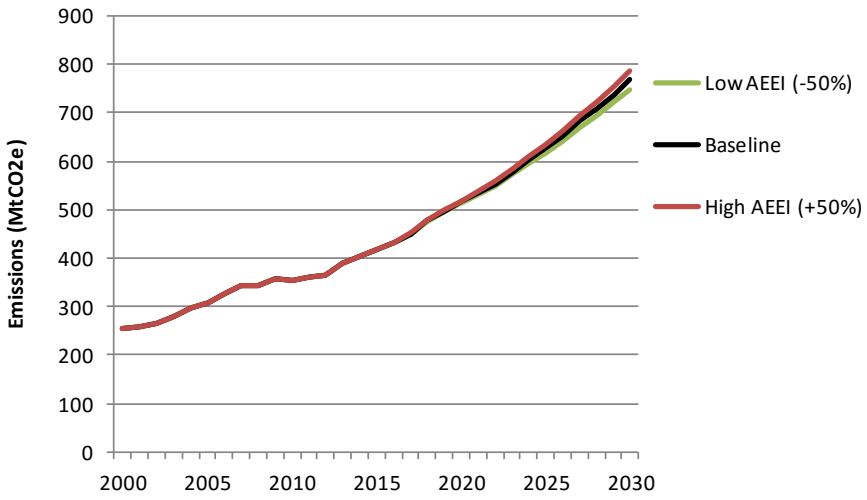


TABLE 2: RELATIVE IMPACT OF AEEI SCENARIOS TO LCS EMISSION REFERENCE CASE (%)

Scenario	Change in Emissions in 2030	
	(%)	$MtCO_2e$
Low AEEI (-50%)	3%	+ 20 $MtCO_2e$
High AEEI (+50%)	-3%	- 19 $MtCO_2e$

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