PAKISTAN'S FIRST BIENNIAL UPDATE REPORT (BUR-1)

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

APRIL 2022

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Abbreviations & Acronyms

ADB	Asian Development Bank
AEDB	Alternative Energy Development Board
AFD	Agence Francaise de Developpement
AJ&K	Azad Jammu and Kashmir
APFC	Active Power Factor Correction Factor
APTMA	All Pakistan Textile Mills Association
ARE	Alternate Renewable Energy
ASAD-PAEC	Applied System Analysis Division – Pakistan Atomic Energy Commission
ASHRAE	The American Society of Heating, Refrigerating & Air Conditioning Engineers
AWD	Alternate Wetting and Drying
BAP	Biodiversity Action Plan
BRESL	Barriers Removal Efficiency Standards and Labeling
BRT	Bus Rapid Transit
BTTAP	Billion Trees Tsunami Afforestation Project
CAFÉ	Corporate Average Fuel Economy
CAGR	Compounded Annual Growth Rate
CAS	Center for Advance Studies
CBD	Convention on Biological Diversity
CBDR	Common But Differentiated Responsibility
CCNG	Combine Cycle Natural Gas
CCS	Climate Change Scenario
CDA	Capital Development Authority
CDD	Cooling Degree Days
CDM	Clean Development Mechanism
CERAD	Center for Energy Research & Development
CFL	Compact Fluorescent Lamp
COD	Commercial Operation Date
CPEC	China - Pakistan Economic Corridor
CPEIR	Climate Public Expenditure and Institutional Review
CPI	Cleaner Production Institute
CPPA	Central Power Purchasing Agency
CSA	Climate Smart Agriculture
CSO	Civil Society Organization
DCP	Data Collection Platform
DDMU	District Disaster Management Unit
DDWP	Departmental Development Working Party
DISCO	Distribution Company
DMP	Drainage Master Plan
DOC	Degradable Organic Carbon
DRM	Disaster Risk Management
DSSAT	Decision Support System for Agrotechnology Transfer
E&RE	Energy and Resource Efficiency
ECC	Energy Control Centre
ECPCT	Energy Conservation Project for Punjab Tanneries
EDB	Engineering & Development Board
EE&C	Energy Efficiency & Conservation
EECP	Energy Efficiency & Capacity Project
EES&L	Energy Efficiency Standard & Labeling
EIA	Environmental Impact Assessment
EMDS	Electric Motor Driven System
EPA	Environmental Protection Agency
ESCO	Energy Service Company
ESM	Environmentally Sound Management
ESRF	Ecosystem Restoration Fund
EST	Environmentally Sound Technologies
EU	European Union
EV	Electric Vehicle
FAO	Food and Agriculture Organization
FATA	Federally Administrated Tribal Area
FCPF	Forest Carbon Partnership Facility
FFC	Federal Flood Commission
FFD	Flood Forecasting Division
FICCP	Framework for Implementation of Climate Change Policy (2014-2030)
GB	Gilgit- Baltistan
GCF	Green Climate Fund
GCISC	Global Change Impact Studies Centre
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GIS/RS	Geographic Information System/ Remote Sensing
GIZ	Deutsche Gesellschaftfür Internationale Zusammenarbeit GmbH
GLOF	Glacial Lake Outburst Flood
GMRC	Glacier Monitoring Research Center
GoP	Government of Pakistan
GoKP	Government of Khyber Pakhtunkhwa
GoPb	Government of Punjab
GoGB	Government of Gilgit Baltistan
GoS	Government of Sindh
GPP	Green Pakistan Program
GTS	Global Telecommunication System
Gwh	Gigawatt Hour
Ha	Hectare
HDIP	Hydrocarbon Development Institute of Pakistan
HKH	Hindu Kush Himalayan
HPC	High Performance Computing
HRS	Heat Recovery Systems
HSD	High Speed Diesel
HVAC	Heating, Ventilating & Air Conditioning
IBIS	Indus Basin Irrigation System

ICARDA	International Center for Agricultural Research in the Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
IEE	Initial Environmental Examination
IEP	Integrated Energy Plan
IETC	International Environmental Technology Centre
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IREET	Implementation of Resource & Energy Efficient Technology
IRS	Indus River System
IRSA	Indus River System Authority
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JPE	Joint Program on Environment
KOEL	Karachi Organic Energy Limited
KP	Khyber Pakhtunkhwa
KV	Kilovolt
LCD	Liquid Crystal Display
LDO	Low Dropout Voltage
LEAD-Pakistan	Leadership for Environment and Development – Pakistan
LED	Light Emitting Diodes
LFCC	Low Forestry Cover Counties
LHW	Lady Health Worker
LOI	Letter of Intent
LOS	Letter of Support
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
LUCF	Land Use Change and Forestry
MAF	Million Acre Feet
MoCC	Ministry of Climate Change
MODIS	Market Oriented Deposit Insurance Scheme
MoE	Ministry of Environment
MoIP	Ministry of Industries and Production
MoPD&SI	Ministry of Planning, Development and Special Initiatives
MoWP	Ministry of Water and Power
MSW	Municipal Solid Waste
NAP	National Adaptation Plan
NARC	National Agriculture Research Center
NCCP	National Climate Change Policy
NCV	Net Calorific Value
NDCs	Nationally Determined Contributions
NDMA	National Disaster Management Authority
NDMO	National Disaster Management Ordinance
NDP	National Development Plan
NEECA	National Energy Efficiency & Conservation Authority
NEPRA	National Electric Power Regulatory Authority
NEQs	National Environmental Quality Standards
NEU	Non Energy Use
NGO	Non-Governmental Organization
NIO	National Institute of Oceanography
NMVOC	Non-Methane Volatile Organic Compound
NSUSC	North Sindh Urban Services Corporation Ltd
NTDC	National Transmission and Dispatch Company Ltd
NTWC	National Seismic Monitoring & Tsunami Early Warning Centre
NUST	National University of Science & Technology
NWFC	National Weather Forecasting Centre
OXFAM	Oxford Committee for Famine Relief
Pak-EPA	Pakistan Environmental Protection Agency
PARC	Pakistan Agriculture Research Council
PCRET	Pakistan Council of Renewable Energy Technologies
PCRWR	Pakistan Council of Research in Water Resources
PDMA	Provincial Disaster Management Authority
PEPA	Pakistan Environmental Protection Act
PEPCO	Pakistan Electric Power Company
PFI	Pakistan Forest Institute
PISD	Program for Industrial Sustainable Development
PMD	Pakistan Metrological Department
PNSSP	Pakistan National Student Satellite Programme
POPs	Persistent Organic Pollutants
PSMA	Pakistan Sugar Mills Association
PSWC	Pakistan Space Weather Centre
PTA	Pakistan Tanners Association
PTA-NZ	Pakistan Tanners Association North Zone
PTPS	Pakistan Transport Plan Study
PV	Photo Voltaic
R&D	Research and Development
REER	Real Effective Exchange Range
RE&EE	Renewable Energy and Energy Efficiency
REDD	Reducing Emissions from Deforestation and Forest Degradation
RNE	Royal Netherlands Embassy
SAARC	South Asian Association for Regional Cooperation
SBP	State Bank of Pakistan
SDGs	Sustainable Development Goals
SDPI	Sustainable Development Policy Institute
SFM	Sustainable Forests Management
SIHP	Snow and Ice Hydrology Project
SLR	Sea Level Rise
SME	Small and Medium - Sized Enterprises
SUPARCO	Space and Upper Atmosphere Research Commission

SWD	Solid Waste Disposal	UNIDO	United Nations Industrial Development Organization
T&D	Transmission and Distribution	USAID	United States Assistance for International Development
TCWC	Tropical Cyclone Early Warning Centre	VFD	Variable Frequency Drive
TNA	Technology Needs Assessment	WAPDA	Water and Power Development Authority
TWEIP	Tube - Wells Efficiency Improvement Program	WASA	Water and Sanitation Authority
UET	University of Engineering & Technology	WWF	World Wide Fund for Nature
UIB	Upper Indus Basin	ZSD	Zoological Survey Department
UNEP	United Nations Environment Programme		
UNFCCC	United Nations Framework Convention on Climate Change		

Units

°C	Celsius	LNG	Liquefied Natural Gas
CH	Benzene	MJ	Megajoule
CH_4	Methane	Mt	Million Tonne
CO	Carbon Monoxide	Mt CO2e	Million Ton of CO_2 Equivalent
CO_2	Carbon Dioxide	MTOE	Million or Mega Tonnes of Oil Equivalent
CO2e	Carbon Dioxide Equivalent	MTon	Million Ton
e	Equivalent	MVA	Million Volt-Amps
EV	Electric Vehicle	MW	Megawatts
Gg	Gigagram	MWh	Megawatt Hour
$GgCO_2$	Gigagram of CO_2	N	Nitrogen
GWh	Gigawatt Hours	N_2O	Nitrous Oxide
H_2O	Water	NH_3	Ammonia
HP	Horse Power	NH_4	Ammonium
KBD	Thousand Barrels Per Day	NMVOCs	Non-Methane Volatile Organic Compounds
Kgoe	Kilogram Oil Equivalent	NO_2	Nitrogen Dioxide
Km	Kilometers	NO_3	Nitrate
kV	Kilovolt	NO_x	Nitrogen Oxides
kWh	Kilowatt Hour	pkm	Passenger Kilometers
L	Liter	tkm	Tonne Kilometers

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Foreword

With extreme high vulnerability, the temperature increase of 0.63 °C has been observed over the century, which implies that the warming over Pakistan was twice as fast as the global mean temperature rise. Besides the disastrous impacts of climate change, Pakistan has been emerging as a global leader in climate action. The mega initiatives of Ten Billion Tree Tsunami Project (10BTTP), Eco-system Restoration Initiative (ESRI), Clean Green Pakistan Movement, Recharge Pakistan Initiative are gathering global recognition.

The focus of Government of Pakistan's climate actions during the decade ahead is decided by the current climate-induced vulnerabilities, aimed at achieving reduced poverty and ensuring a stable economy. To further strengthen the climate action, Pakistan submitted its updated Nationally Determined Contributions (NDC), which showcases Pakistan's progress in climate action that ranges from policy and programs on Nature-based Solutions (NbS) to technology-based interventions. Pakistan, recognizing the role of nature in climate adaptation and mitigation, has developed robust natural capital restoration efforts.

Pakistan's has designed a comprehensive recovery programme for the pandemic, which caters for greening all the steps, including response, recovery and re-design of our systems. The Green Economic Stimulus was launched, which aims at promoting environmental activities having an economic impact. The Stimulus focuses on creating livelihood opportunities for daily wagers in the forestry and waste management sectors by involving in mass plantations, setting up of nurseries, protecting natural forests and promotion of honey, fruits and olive plantation in Pakistan.

The First Biennial Updated Report (BUR1) to the United Nations Framework Convention on Climate Change (UNFCCC) has been prepared as a reporting requirement to the Convention. The process adopted for the preparation of BUR1 relies on the existing research and analytical competence of nodal national institutions dealing with various thematic areas of the national communication.

I congratulate the officials of the Ministry of Climate Change for successfully compiling the extensive information in its present form and as per obligatory reporting requirements of the Convention. Appreciation also goes to all the contributing authors and experts for devoting their time to complete the requisite analysis and the stakeholders for their support in reviewing the content. It is believed that the analysis presented in BUR1 would enable enhanced and coherent climate response in Pakistan.

Malik Amin Aslam
Special Assistant to Prime Minister on Climate Change
Government of Pakistan

Preface

There is abundant evidence of the climate crisis plaguing the world today, but especially impacting the developing world. Despite a meagre overall contribution to greenhouse gases, Pakistan is highly vulnerable to the climate threats including water stress, desertification glacier melting, extreme events and spread of diseases. These threats pose severe challenges in terms of ecology, agriculture, economic development and sustainability.

Keeping in view the climate challenges and threats to our environment, the Government of Pakistan has adopted a robust climate action agenda. Pakistan has undertaken a number of initiatives to address these variegated climate issues. The Prime Minister of Pakistan has approved the 'Living River Initiative' for Ecological Restoration of Indus River Basin for Climate Resilient Future. Under this flagship initiative, multiple ecological regions will be targeted for restoration and preservation. The Plan contributes to the Sustainable Development Goals on; zero hunger, climate action, life below water and life above land. The Billion Tree Afforestation Program, followed by the even more ambitious Ten Billion Tree Tsunami nationwide project has resulted in massive reforestation across Pakistan. The National Electric Vehicle Policy has been approved, targeting a 30% shift to electric by 2030. The “Protected Areas Initiative”, launched during the COVID-19 era, is enhancing our national coverage of protected areas from 12% to 15% of land area while preserving Pakistan's unique and valuable biodiversity.

Let me congratulate the Ministry of Climate Change for developing Pakistan's First Biennial Update Report, which has been prepared after extensive consultation with all stakeholders and in accordance with the guidelines specified by the United Nations Framework Convention on Climate Change (UNFCCC). The report presents Pakistan National Inventory of GHG Emissions. It also acknowledges gender aspects of Climate Change to address inequalities and human development bottlenecks in achieving the 2030 Sustainable Development Agenda. Mitigation Actions identified in the report are especially proposed in context of Pakistan's unique environmental and sociocultural landscape.

The BUR report reiterates Pakistan's commitment towards UNFCCC and the 2030 Sustainable Agenda, which is now part of the Government's development policy. This important exercise has helped to highlight financial and technical capacity building needs as well as gaps and constraints in achieving the sustainable development goals. Pakistan remains committed to global partnerships and actions to address climate challenges and achieving a sustainable future for all.

Ms. Zartaj Gul
Minister of State for Climate Change
Government of Pakistan

Executive Summary

This report is the First Biennial Update for submission to the United Nations Framework Convention on Climate Change (UNFCCC). The report is developed as per UNFCCC guidelines and consists of 6 Chapters namely: 1. National Circumstances; 2. National Greenhouse Gas Inventory Information (2017-18); 3. Gender and Climate Change; 4. Nationally Appropriate Mitigation Actions; 5. Monitoring, Reporting and Verification; and, 6. Constraints, Gaps & Solutions and Need for Financial/Technical/Capacity Building Support.

National Circumstances: Pakistan is endowed with a diverse range of climatic conditions. The climate varies from arid to semiarid where three-fourths of the country receive rainfall of less than 250 millimeters (mm) annually, except in the southern slopes of Himalaya and the sub mountain region in the northern segment of the country, where annual rainfall ranges from 760 to 2,000 mm. The summer monsoon accounts for around 60% of the total annual precipitation.

The country has witnessed an increase of 0.63 °C during the past century. However, during the period 1981-2005, the decadal mean temperature rise over Pakistan was 0.39 °C as compared to 0.177 °C for the globe as a whole, which implies that the warming over Pakistan was twice as fast as the global mean temperature rise. The Country is ranked one of the top 10 most vulnerable countries to climate change. The Global Climate Risk Index has placed Pakistan on the eighth spot in the list of countries most vulnerable to climate change in its annual report for 2020. With the trend of increasing temperatures, there is increased frequency as well as intensity of extreme climate events such as floods, droughts, cyclones, heavy rain spells, extremely high temperatures etc. due to which the agriculture sector suffered the heavy economic losses.

Keeping in view the climate variability and change threats, Pakistan has undertaken a number of initiatives and measures to address the issues arising out of climate change. These include the Ten Billion Tree Tsunami Project (10BTTP), Eco-system Restoration Initiative (ESRI), approval of an Electric Vehicle Policy, Clean Green Pakistan Movement, Recharge Pakistan Initiative, Transition towards Renewable Energy, Youth and Climate Change Program, Ban on Polythene Bags, Stakeholders Awareness Raising Program, and a number of Mega Projects like scaling of Glacial Lake Outburst Floods (GLOF) Risk Reduction, Zero Emission, Bus Rapid Transit system; and Transforming the Indus Basin with climate resilient agriculture and water management.

National inventory of GHG Emissions: The report presents National GHG Inventory of Pakistan based on the latest data sets available as part of the Pakistan BUR1 Project executed by the MoCC in the light of Katowice decision. The estimated total GHG emissions are estimated at 489.87 Mt CO2e contributed by: Energy sector 218.94; Industrial processes 25.76; AFLOU 223.45; and Waste 21.72 respectively.

Gender aspects of Climate Change: The report acknowledges that due to various social barriers, gender stereotypes are grown with their roots deepen in the soil of culture, religion, family, society and system that restrict the abilities of a person to fully bloom and they impede the strengths of a human being to be skillful enough to tackle the challenge of climate change. In a system with gender inequality, freedom compromises its strengths and the agenda behind sustainability remain unfulfilled. Inequalities in human development are a defining bottleneck in achieving the 2030 Agenda for Sustainable Development. Policies matter for inequalities. And inequalities matter for policies.

The report outlines the social norms in Pakistan's patriarchal society and a look at the gender inequality statistics. It also provides an analysis of national policies and finds that, while identifying women as vulnerable groups, the policies are silent on participation in climate actions. It also discusses the institutional mechanism for dealing with gender and climate change aspects and climate change variability and impacts on gender. Conclusions and recommendations are included to help outline a Gender Action Plan to promote gender equality while keeping all the social and political constraints in mind.

Nationally Appropriate Mitigation Actions: The report provides an update on mitigation potential and actions in line with Pakistan's Second National Communication (SNC) for sustainable development. The report outlines Pakistan's commitment to address the challenges of climate change through its Framework for Implementation of Climate Change Policy 2014-2030 and highlights major national and sub-national level climate-friendly measures initiated until December 2018 in Pakistan.

The BUR1 report reiterates Pakistan's commitment and obligations towards the UNFCCC and Paris Agreement, and the objective to limit the average global temperature increase to 1.5 to 2.0 °C. In this reporting period, Pakistan has taken genuine steps in major sectors of the economy to curb the GHG emission. In this reporting period, the establishment of National Energy Efficiency & Conservation Authority (NEECA) and its various programs, Industrial energy audits programs, National Transport Policy, National Electric Vehicle Policy, revision of energy building codes, 10 BTTP at national level are the major initiatives. These measures and actions can be intensified in coming years with expected availability of international climate finance, technology development and transfer, and capacity building.

Measurement, Reporting and Verification (MRV): A review of the current MRV situation and MRV processes in Pakistan for different sectors including: energy; agriculture and livestock; industrial; land use change and forestry; and waste management is included in the report. Proposed essential features of a national MRV system including: MRV components; Reporting requirements; and MRV pathways for GHG inventory, mitigation and adaptation, and support are described in detail. The report also identifies data providers for GHG inventory and Mitigation/ adaptation actions/ policies and support required and received. Key components of institutional arrangements, stakeholders' engagements, organizations' mandates, expertise, data flows, and coordination system and tools are also described in detail.

Constraints, Gaps, Financial and Technical Capacity Building Needs: The report gives details of updated information required from non-Annex I countries in accordance with decision 2/CP.17, Annex III and includes a description of constraints and gaps with related solutions, and the financial, technical and capacity needs of Pakistan, including the level of support received to enable the preparation and submission of biennial update report. Constraints and gaps in greenhouse gas (GHG) inventory preparation, assesses the vulnerabilities, mitigation and adaptation actions taken are identified based on literature review and a detailed survey to collect primary information. Information on mitigation gaps and adaptation actions are presented sectors wise; however, some general constraints that are common among all sectors are described separately. These constraints and gaps are identified in terms of economic, social, technical and political aspects.

The report acknowledges that, in order to combat the negative impacts of climate change, an effective strategy focusing on all four of GHG features including inventory preparation, vulnerability assessment, adaptation, and mitigation actions is required. Financial, technical, and capacity building support at the international and national level is needed to strengthen the efforts being undertaken to address the issue of climate change.

Chapter No. 1

National Circumstances

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National Circumstances

1. Location, Geography & Climate

Pakistan, with a geographical area of 79.6 million hectares (Mha), lies between 23° 35' to 37° 05' North latitude and 60° 50' to 77° 50' East longitude. It touches the Hindukush Mountains in the North and extends to the Arabian Sea in the South (Fig 1.1). The country has a varied topography that consists of the flat Indus plain in the east, Cholistan and Thar deserts with sand dunes and clay pans in the south east and the Balochistan plateau in the south west. In addition, the Karakoram Range, one of the world's highest mountain ranges, is in the north and northwest part of the country.

The Country is endowed with a diverse range of climatic conditions. The eastern areas of the southern half and north eastern areas mainly receive precipitation through the southwest summer monsoon (from June to September), while the north western and western part of the southern half of the country gets rain mainly through western weather disturbances in winter (from December to March). The summer monsoon accounts for around 60% of the total annual precipitation. The climate varies from arid to semiarid where three-fourths of the country receive rainfall of less than 250 millimeters (mm) annually, except in the southern slopes of Himalaya and the sub mountain region in the northern segment of the country, where annual rainfall ranges from 760 to 2,000 mm.

The northern region includes some of the world's highest mountain peaks, such as the 8,611 meters [m] high K-2 and the largest (outside the arctic regions) glaciers including the 70 kilometer (Km) long Siachen and the 63 km long Biafo that feed the Indus River and some of its tributaries. During winter, the temperatures in this region drop to as low as –50°C and stays around 15°C in the warmest months of May to September.

The western and southern segments of the country represent the Indus Basin and the Balochistan Plateau. The transboundary Indus Basin covers 520,000 km2 or 65% of the country's total area, including the provinces of Punjab and Khyber Pakhtunkhwa (KP), most of the Sindh province and the eastern part of Balochistan province.

The average annual rainfall in the Indus plain is around 230 mm. The temperature differences between the upper and lower basin plains are quite noticeable: the mean winter temperature (December - February) in the lower plain is 14 to 20°C and 2 to 23°C in the upper plain areas, while during summer (March–June), the mean monthly temperature varies from 42 to 44°C in the lower plan, and 23 to 49°C in the upper plain. The Balochistan Plateau is a vast wilderness of mountain ranges in the southwest of the country with an average altitude of about 600 m. Some seasonal rivers cross this region but most of its northwestern part is a wide expanse of desert similar to the deserts found in the central part of the country, such as Thar and Cholistan. The rainfall in this region is less than 210 mm annually or 20 to 30 mm per month.

Fig. 1.1: Pakistan – Political Map

2. Climate Change – An Overview

There was an increase of 0.63°C during the past century in conformity with the average global temperature increase. However, during the period 1981-2005, the decadal mean temperature rise over Pakistan was 0.39°C as compared to 0.177°C for the globe as a whole (Sheikh et al. 2009), which implies that the warming over Pakistan was twice as fast as the global mean temperature rise. The climate change projections based on Global Circulation Models (GCMs) also indicate that the average temperature over Pakistan will increase during the current century at a pace slightly faster than that of the average global temperature (Islam et al., 2009). Besides, the projections indicate that the northern half of the country above 31°N will experience more warming than the southern part.

Pakistan's vulnerability to climate change impacts is well documented and acknowledged. With the trend of increasing temperatures, there is increased frequency as well as intensity of extreme climate events such as floods, droughts, cyclones, heavy rain spells, extremely high temperatures etc. in the country. Table 1.1 lists such events during two periods viz. 1985-2000 and 2001-2020 to enable comparison of occurrences of various extreme events between these two periods. It may be noted that the monsoon variability has also been observed to increase substantially since 2000 (Ali et al., 2019). As a result, Pakistan has experienced flood events of varying magnitude every year since 2010 which have caused huge devastation to property and loss of life.

Persistent drought prevailed in the southern part of the country during 1998-2002 and again in 2014 and 2015; Tharparkar and adjoining districts in Sindh are facing drought situation even now. An extreme event of heat wave was witnessed by Pakistan in Sindh province including the metropolitan city of Karachi from 17 to 25 June 2015 (MoCC, 2015).

Due to such extreme events, agriculture sector has suffered the most with heavy economic losses. The latest event of persistently high temperature in the 3rd and last weeks of August of 2019 has been responsible for huge losses to the rice and maize crops. The super-cyclones that hit Makran Coast in the South, and increased incidences of landslides, Glacial Lake Outburst Floods (GLOFs) in the Northern Areas bear testimony to the extreme vulnerability of the Country to climate change.

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) for the Asia region notes that sensitivity to climate change threats, in agriculture dependent economies (such as Pakistan), arises from their distinct geography, demographic trends, socio-economic factors, and lack of adaptive capacity that, when taken together, determine the vulnerability profile by perpetuating a vicious cycle of poverty. The climate change projections of the AR5 for South Asia as a whole show that warming is likely to be above the global mean and climate change will impact the glaciers' melting rate and precipitation patterns, particularly the timing and strength of monsoon rainfalls. Consequently, this will significantly impact the productivity and efficiency of water-dependent sectors such as agriculture and energy.

Sr. No.	Extreme Events	Period 1985 - 2000	Period 2001 - 2020
1	Large Scale Floods	1988, 1992, 1997	2003, 2006, 2010, 2011, 2012, 2013, 2014, 2015
2	Localized Cloud Bursts	1996 (Lahore)	2001 (Islamabad), 2009 (Karachi)
3	Droughts	1998, 1999, 2000	2001, 2014, 2018
4	Intense Heat Waves	---	2003, 2005, 2007, 2010, 2015, 2019
5	Severe Cyclonic Storms	1999	2007, 2010, 2016

Table 1.1: Extreme Climate Events during the periods 1985–2000 and 2001–2020

Source: GCISC, 2020 (Compilation of historical climate events)

Pakistan has been ranked one of the top 10 most vulnerable countries to climate change. The Global Climate Risk Index has placed Pakistan on the eighth spot in the list of countries most vulnerable to climate change in its annual report for 2020. Further, based on analysis of the 2000-2020 data of damages caused by hydro-meteorological extreme events (German Watch, 2021), the Country has been included amongst three countries which have consistently been hit hard by climate vagaries.

2.1. Climate Change and Glacial Melt

Glaciers here are important for their role in providing water resources and their hazard potential (Shroder, J.F. and M.P. Bishop, 2010). Glaciers of northern Pakistan, with an estimated area of 15,000 Km^2, are some of the largest and longest mid-latitude glaciers on Earth. These glaciers are the most sensitive precursors of climate change due to natural and anthropogenic reasons. Studies have revealed that 30°C isotherm has creeped upward by 725 m higher elevation than 28 years before. Frequency and duration of heat waves have both increased by two-fold. The rate of increase since 1990 has also doubled resulting in frequent occurrence of severe thunderstorms and lightening events. As an example of anthropogenic change in climate, ever fastest rate of glacial depletion is presented on Siachen glacier which has lost about 2 km of its length and 17% of ice mass since 1989. Surface velocity of the glacier has also increased considerably due to the interacting warmer atmosphere with frozen water reserves in the presence of large human concentration (Rasul G., et.al, 2008).

3. Demography

According to the last Population Census of 2017, Pakistan is fifth most populous country in the world with a population of 207.7 million[1]; between 1998–2017 the average population growth rate stood at 2.40% and population density of 256 people/Km^2. About 36 per cent of the population lives in urban areas whereas rural areas constitute the rest of 64 per cent. About 60.4% (Box 1.1) of the total population lies in the age group of 15-64 years with sizeable number of youths. The current total fertility rate of 3.8 is one of the highest in the Asia Pacific region and the country holds the second highest out-of-school population in the world of which two-thirds are girls. The poverty rate estimated at 2 USD per day purchasing power parity exceeds 50% of the total population with stark provincial disparities. The southern sub-regions of all provinces are noted for a very high ratio of severe poverty incidences compared to their northern counterparts, except for KP province, where severe poverty is equally high in both sub-regions. This high prevalence of poverty, coupled with the lack of and access to resources places the country in the low human development category, ranked 146 out of 187 countries, well below the average human development index value compared to other South Asian countries. As a multicultural and multi-ethnic society, the country hosts a large number of refugees from Afghanistan as well as internally displaced persons due to war on terror.

Box 1.1: Demography Brief (2017)

Population:	207.7 million (Male/Female Ratio 105.1)
Between 1-14:	35.4% (Male/Female Ratio 1.06)
Between 15-64:	60.4% (Male/Female Ratio 1.07)
Above 65:	4.2% (Male/Female Ratio 0.90)
Urban:	75.5 million
Rural:	132.2 million
Households:	32.2 million
Density:	256 persons/Km^2
Fertility Rate:	3.8

Frequent floods in the monsoon and drought in the dry seasons are normal phenomena with huge recurring social and economic costs to the country. Pakistan's demographic history spreads out from the Indus Valley Civilization to the division of Indian subcontinent to the modern era of parliamentary democracy. During these long years of history, the country experienced invasions and wars due to which there was mass influx of many ethnic groups from Central Asia, Middle East and Europe.

4. Economy

Pakistan's total labor force of 75.8 million in 2019-20 consists of 55.3 million males and 20.5 million females.

1 The current population on the basis of 2.4% growth rate is estimated at 223.9 million.

The share of agriculture-related employment has declined from more than 48.42% in 1999-2000 to 38.5% in 2019-20 (GoP, 2020). The services and manufacturing sectors are major contributors, showing increasing trends in employment. During the period 1999-2020, the employment share of services and industry (manufacturing and construction) sectors increased respectively from 34.25 to 38.01% (services sector) and from 17.33 to 25.3% (industry sector).

The per capita income in 2018-19 was 1,516 USD compared to 492 USD in 2002-03. The main factors responsible for this increase were relatively high growth rate of Gross Domestic Product (GDP) in real terms until 2007, lower growth in population, and stable exchange rate. However, Pakistan's economic performance was affected from 2007 onwards due to devastating floods, internal security hazards, and the energy crisis. As a result, during the last five years, the average GDP declined to 6% per annum. During 2016-17, the GDP grew at 7.05% but, during 2018-19, the GDP declined by 13.33% from 2017-18. Deterioration in the power sector has been the main constraint to economic growth in recent years (GoP, 2019). The sectoral shares of GDP production in 208-19 were: Agriculture: 18.5%, Manufacturing: 13.5% to 13.8% Other Industries: 5.8% and Services: 53.86% as compared to their respective shares of 26.2 %, 14.8 %, 7.8% and 51.2% in 1999-2000 (GoP, 2019).

The annual growth rate of primary energy supplies during FY 2017-18 and FY 2018-19 remained 8.44% and -2.88% respectively (HDIP 2019). Similarly, the annual growth rate of final energy consumption during this period remained 9.72% and 0.005% respectively (NEPRA, 2020).

Exports during the period July, 2019 to April, 2020 stood at USD 19.7 billion compared to USD 20.1 billion during July, 2018 to March, 2019, posting a decline of 2.4 %. A sharp decline in the Real Effective Exchange Rate (REER) due to market-based exchange rate and the government's initiative to provide cheaper electricity to the textile sector have enhanced the competitiveness of the Pakistani products in the global market. The total imports during July 2019 to April 2020 declined to USD 36.1 billion as compared to USD 40.3 billion in the same period in the previous year, a decline of 16.9% (GoP, 2020).

5. Overview of Development Sectors

5.1. Mining Sector

Pakistan has been endowed with huge mineral potential including precious metals, dimension stones, industrial minerals, rock salt, and coal. However, there has been very limited exploration by using modern managements, adequate capital and appropriate technical know-how. As such, the mineral sector contributes only a meager 3% to the national GDP. A major constraint is that most of the mineral deposits are concentrated in Balochistan, where the law-and-order situation has limited production. Absence of necessary infrastructure and lack of technical capacity of related departments have also contributed to production below the potential. There is need for developing technologies to process indigenous ores to extract products of high commercial value that can play a dominant role in economic uplift, employment generation, and boost exports. A number of initiatives to this effect are now being taken by the Government (GoP, 2020).

5.2. Energy Sector

Energy is an integral part of the economic order of Pakistan because energy demand and economic growth share a tight bond. Pakistan is overcoming a severe energy crisis that has directly and indirectly affected all sectors of the economy especially in terms of the evolving energy-mix. In term of energy-mix, Pakistan reliance on oil reached 43.5% in FY1998 and FY2001. For FY2018, oil reliance has reduced to 31.2 %. Similarly, hydro-power had a 13.1% share in FY1998, which is standing at 7.7% in 2017-18. Though the declining share of oil is a welcoming sign due to less burden on the national exchequer, the diminishing share of hydro-power represents the

shortsightedness of policy as well as the inability of successive governments to undertake such capital-intensive projects in a timely manner.

Pakistan's dependence on natural gas reached an all-time high of 50.4% in FY2006 in the overall energy mix. For the FY2018, reliance on gas has reduced to 34.6%. This reduction of share in the energy mix is somewhat attributed to declining natural gas reserves as well as restricted consumption of gas in the transport industry and the induction of LNG since 2015. The share of imported LNG has increased from 0.7% in FY2015 to 8.7% in FY2018, which represent a magnanimous increase of LNG in an energy mix. The share of coal has remained in single digit percentages over the last two decades. However, it increased to 12.7% in the FY2018. Likewise, the share of renewables was recorded to be 0.3% in the year FY2015, which steadily increased to 1.1% in FY2018. The share of nuclear on the other side has steadily increased to 2.7% in FY2018 compared to 0.2% in FY1997. (Pakistan Economic Survey, 2018-19).

The present levels of per capita energy consumption and electricity generation in Pakistan are about 529 kilowatt-hour (KWh) on PEPCO and 892 on KE system per annum (NEPRA, 2019) Oil and gas contribute almost 50 and 15% respectively to primary commercial energy supplies. The share of coal is only 7% of which more than two-thirds is due to imported coal despite Pakistan having over 186 billion tonne of coal reserves.

In the wake of growing shortage of natural gas (consequently that of electricity), heavy burden of oil imports and huge underutilized domestic coal reserves, the Government of Pakistan intends to increase the share of coal in the overall energy mix. This may however have negative implications for the country's Greenhouse Gases (GHG) mitigation efforts.

Pakistan is a low-level emitter of GHG. During the fiscal year 2015-16, its total GHG emissions amounted to about 408 million tonne of CO_2 equivalent (CO2e), which is less than 1% of total global emissions. The per capita level of GHG emissions in the country is also very low; it corresponds to only one-third of the world average.

Government is focusing on exploiting the abundant potential of wind, solar and other Alternate Renewable Energy (ARE) resources for power generation whilst benefiting with the declining prices of renewable energy technologies through optimum mode of development. The GOP's strategic objectives of energy security, affordability of electricity, availability for all, environmental protection, sustainable development, social equity and mitigation of climate change are harnessed under the ARE Policy 2019, developed by the Ministry of Energy (Power Division) in consultation with key stakeholders. The Policy aims to create a conducive environment for sustainable growth of ARE sector in Pakistan and intends to have at least 20% of its generation capacity through ARE technologies by 2025 and 30% by 2030.

AREs have seen significant growth in different parts of the world in the last decade in terms of deployment, technological advancements and cost competitiveness. Experience under RE Policy 2006 coupled with international best practices provides the basis for a more comprehensive framework for ARE Policy 2019. It has an expanded scope encompassing all major alternative and renewable energy sources, competitive procurement and also addresses areas like distributed generation systems, off-grid solutions, B2B methodologies, and rural energy services. It carries forward most of the liberal and attractive incentives of RE Policy 2006 to maintain the investors' confidence, and places greater emphasis on aggressive growth of grid-connected ARET applications as well as a programmatic development of distributed ARE power generation market on more competitive terms. This target, together with over 30% hydel, will result in one of the most environmental friendly and affordable electricity mix, compared to the heavily dominated mix of imported fossil fuels in the past. Salient features of the ARE Policy 2019 include variety of investment options for tapping different ARE resources for on-grid and off-grid applications as well as encouraging consumer driven applications and initiatives. Attractive policy instruments supplement GOP's open-door initiatives for private investment in ARE sector in Pakistan as it is envisaged to contribute its share in strengthening and improving the power supply position of the country and help fueling rapid and environmentally sustainable economic growth. The measures introduced in the ARE Policy 2019 are expected to set the requisite processes in place so that ARE is fully mainstreamed and integrated within the

country's energy planning as well as the country's economic and social development for the eventual benefit of the people of Pakistan.

5.3. Water Sector

Water, which is one of the most important natural resources, is increasingly becoming scarce despite Pakistan's Indus Basin Irrigation System (IBIS), the world's largest contiguous irrigation system that comprises three large dams, 85 small dams, 19 barrages, 12 inter-river link canals and 45 canal commands. Sustained economic growth and human survival is impossible without it. Presently, about 93% water resources are used in agriculture, 5% in domestic sector and only 2% in industrial sector. The domestic and industrial sector uses are projected to increase to 15% by 2025, which will cause a reduction of agriculture sector's share in the resource.

Water resources are inextricably linked with climate; hence, the projected climate change has serious implications for Pakistan's water resources. The freshwater resources in Pakistan are mainly based on snow and glacier melt and monsoon rains, both highly sensitive to climate change. The average annual flow of Indus River System (IRS) is around 142 Million Acre-Feet (MAF) of which 104 MAF is diverted to the canal network, while major portion of the remaining balance of around 35 MAF outflows to the sea. Fortunately, Pakistan has a large useable groundwater aquifer, which is largely recharged from the surface flows and rains; the resource is being exploited heavily, particularly in some hyper-arid areas.

Proper management and use of water resources, keeping in view its economic value, is essential for sustainable development. Its scarcity affects health, sanitation, disaster risk reduction, poverty alleviation, environmental conservation and cuts across all SDGs. Furthermore, resource vulnerability from extreme weather events is growing due to the ever-increasing population, climate change, socio-economic issues and environmental degradation.

Glaciers are the most sensitive precursors of climate change due to natural and anthropogenic reasons. Studies have revealed that 30°C isotherm has creeped upward by 725m higher elevation than 28 years before. Frequency and duration of heat waves both have increased by two-fold. The rate of increase since 1990 has also been doubled resulting into frequent occurrence of severe thunderstorms and lightening events. As an example of anthropogenic change in climate, ever fastest rate of glacial depletion is presented on Siachen glacier which has lost about 2 Km of its length and 17% of ice mass since 1989. Surface velocity of the glacier has also increased considerably due to the interacting warmer atmosphere with frozen water reserves in the presence of large human concentration. Projected future temperatures would further exaggerate the ice depletion and drift related dynamic processes making the situation more and more complex for policy maker and planners.

The country-specific climate projections strongly suggest the following future trends in Pakistan.

- Decrease in the glacier volume and snow cover leading to alterations in the seasonal flow pattern of IRS;
- Increase in the formation and outburst of glacial lakes;
- Higher frequency and intensity of extreme climate events coupled with irregular monsoon rains causing frequent floods and droughts;
- Greater demand of water due to increased evapotranspiration rates at elevated temperatures.

The dwindling resource situation requires Integrated Water Resources Management (IWRM) participatory approach to be implemented at river basin level by involving downstream and upstream stakeholders in

planning and decision-making processes and by integrating water quality and quantity issues. This will help achieve long-term social, economic and environmental benefits.

To address the impact of climate change on water resources and to help enhance water security, a detailed plan of action has been suggested in the Framework for Implementation of Climate Change Policy promulgated in 2018.

5.4. Transport Sector

Transport sector has shown the highest growth rate among all sectors in the present and last decades and accounts for about 11% of GHG emissions (GCISC, 2021). Pakistan's Highway network comprises of 39 national highways, motorways, expressways and strategic roads. The existing portfolio of National Highway Authority (NHA) consists of 40 on-going projects with an allocation of PKR 117.52 billion in the PSDP 2019-20. With a network of 263,775 Km of roads, Pakistan is ranked at 22nd position in the World (GoP, 2020). The country is likely to improve its ranking significantly with the completion of new mega projects under the China Pakistan Economic Corridor (CPEC). Managing or slowing the growth of emissions in transport sector is one of the most significant challenges to overall mitigation efforts and is crucial for tackling climate change. The Government has also introduced couple of mass transit programs in the major cities like Islamabad, Lahore, Peshawar, Karachi, etc. which, besides providing the public transport facilities also aim at reducing the GHG emissions. Further the Government has introduced the Electric Vehicle Policy, which targets a robust electric vehicle market having a 30% and 90% share in passenger vehicles and heavy-duty trucks by 2030 and 2040 respectively. The implementation of the policy will go a long way to reduce GHGs emissions.

5.5. Industries Sector

Manufacturing plays a vital role in economic development of any country. The industrial sector is a major source of tax revenues for the government while contributing significantly to creating job opportunities. The contribution of this sector in GDP remained around 13.5-13.8% for almost a decade; however, it declined to 13% in the current year due mainly to Covid 19 epidemic. Major industries in Pakistan include textile, fertilizer, sugar, cement, steel and large petrochemical plants that contribute about 6% to the total GHG emissions due to industrial processes in addition to being responsible for over a quarter of the emissions attributed to the energy sector.

5.6. Agriculture, Livestock and Fisheries Sector

Since agriculture & livestock sectors are heavily dependent on the vagaries of nature, they are highly vulnerable to climate change phenomen. Climate change will impact food security in the country mainly through reduced crop productivity, adverse impact on livestock health and increased agricultural production losses because of extreme weather events. This will necessitate the agriculture and livestock sectors, particularly in rain-fed areas, to adapt to these climatic changes. Since the agriculture sector is heavily dependent on the water sector, a number of adaptation actions identified in the preceding section are equally applicable to the agriculture sector and will generally not be repeated.

5.6.1. Agriculture

Agriculture the key sector which is adversely affected by the vagaries of climate variability and change. Climate change can disrupt food availability, reduce access to food, and affect food quality. It is the lifeline and the single largest sector of Pakistan's economy contributing 19.3% to the GDP, employing 45% of the labor force and contributing more than 70% to the export earnings (GoP, 2020). The sector is greatly affected by short-term climate variability and could further be harmed significantly by long-term climate change.

It has been increasingly realized that climate change is the most important factor that is likely to affect productive resources and ultimately the agriculture production in a number of ways including: shortened growing period; irrigation water availability due to changes in river flows; increased crop evapotranspiration rates; droughts and, land degradation due to land erosion from flooding events.

Projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events and reduction in water availability may all result in reduced agricultural productivity. The crop modelling studies carried out at GCISC suggest that the aggregate impact of changes in climatic parameters like changes in temperature and rainfall exerted an overall negative impact on cereal crop yields, given that the management practices and use of technology remain unchanged. An analysis of future warming extremes (Consecutive Summer Day Index) impacting critical crop growth stages of wheat crop, the staple crop in Pakistan, indicate that the temperatures in the south eastern parts of Pakistan are exceeding the thresholds at the times of flowering and ripening. An overall increase of 1000 Growing Degree Days (GDDs) between historical and late century extreme scenarios (RCP8.5) has been observed in case of wheat, implying that south eastern parts of Pakistan are likely to become unsuitable for wheat production due to temperature extremes after mid-century (Shaheen et al., 2020).

Studies suggest an imminent need of adaptation interventions to cope with the negative impacts of climate change. An urgent response is required to help combat heat stress in cereal crops in order to ensure sustainability in food security. It requires high-quality research and policy planning for adopting to local scale, nationally oriented and forward-looking climate-smart practices and well-suited adaptation strategies, for resilient agriculture. Based on our study results, it is suggested that strategies like: bringing more area under cultivation in north-western and mid-western parts of Pakistan; multi-cropping and terracing options; early planting to avoid heat stress; and, developing drought tolerant and heat resistant varieties, can be wise options to minimize climate change impacts on wheat crop in Pakistan.

5.6.2. Livestock

Livestock is an important sub-sector of agriculture and its share in the total agriculture GDP has shown a slow and gradual increase during the last two decades. Currently, it contributes 11.22 per cent to the total national GDP and 60.54 per cent of agriculture value added. Over the years, livestock as subsector has surpassed crops as the biggest contributor to value addition in agriculture. The role of livestock in the rural economy may be gauged from the fact that more than 8 million families are engaged in livestock raising and derive 35-40 per cent of their income. The gross value addition of livestock increased from Rs1,430 billion in 2018-19 to Rs1,466 billion in 2019-20, showing an increase of 2.5% over the same period of last year (GoP, 2020). A study (Rehman A. et al., 2017) found that the output of milk, fat, eggs, bones and mutton has a positive significant relationship to the agricultural GDP of Pakistan, while the output of beef, poultry meat, wool, hair, skins and hides has a negative insignificant relationship to the agricultural GDP of Pakistan.

5.6.3. Fisheries

Fishery is a sub-sector of Agriculture that plays a significant role in achieving food security. The fisheries sector in Pakistan makes a significant contribution to the national economy, contributing about one percent to GDP and providing jobs to about one percent of the country's labor force. It is the most important economic activity in the coastal area of Pakistan. A study (Shah et al., 2018) infers that despite year after year increase in the fish production and export, tremendously low progress of production growth rate was noticed compare to other developing countries. The study also shows that the inland aquaculture production increasing rapidly beyond marine aquaculture. On the contrary, there is no existence of mariculture practices yet to support marine production and export along the coast of Pakistan, indicating enormous importance for future opportunities and national economic growth.

5.7. Forestry Sector

Pakistan is a country with one of the low forest-covers in the world, which is mainly due to the arid and semi-arid climate in most parts. Forest cover per capita is declining due to increase in human population as well as deforestation; currently the cover is only 0.023 ha of forest per capita against the world average of 1.0 ha. The forestry sector has a current share of 0.39 % in the overall national GDP and posted a growth of 7.17 % in 2018 (-2.37 % in 2017) due to higher timber production reported by KP province (GoP, 2018, MoCC, 2020).

The forests of Pakistan reflect great physiographic, climatic and edaphic diversities in the country. Table 1.2. represents Main Forest Types of Pakistan.

Climate Zone	Main Forest Stratum	Sun-Stratum
Tropical	Littoral and Swamp Forest	Mangroves
	Dry Deciduous	
	Thorn Forest	
	Riverain Forest	
Sub-Tropical	Broad-Leaved Evergreen Scrub-Forests	Montane Sub-Tropical Scrub
		Sub-Tropical Broad-Leaved Evergreen
	Chir[2] Pine Forests	
Temperate	Moist Temperate Forests	
	Dry Temperate Forests	Montane Dry Temperate Coniferous
		Dry Temperate Juniper and Chilgohza[3] Pine
		Dry Temperate Broad Leaved
Alpine	Sub-Alpine Forests	
Plantation	Linear	Roadside plantations
		Railway track side plantations
		Canal side plantations
	Irrigated Plantations	

Table 1.2: Forest Types of Pakistan

Source: MoCC, 2020

2 Pinus roxburghii
3 Pinus gerardiana

According to the findings in Forest Reference Emission Level of Pakistan (2020), the total forest land has been assessed as about 4.79 Mha, which was 5.45% of the country's territory in 2012. The officially reported area subject to afforestation was about 0.124 Mha between 2009 and 2013. Besides, there were also about 58,000 Km of linear plantation forests reported under control of the Provincial and State Forest departments.

By forest type, dry temperate forests have the largest proportional coverage (36%) followed by sub-tropical broadleaved scrub (19%), moist temperate (15%), chir pine (13%), riverine (4%), irrigated plantation (4%), thorn (3%), mangrove (3%) and sub-alpine forests (2%). The mean forest carbon stock was about 192 Mt in 2004-2012.

6. Environmental Management and Policies

In the absence of proper environmental policies and adequate environmental management mechanism, poor practices like non-judicious exploitation of natural resources and poor practices like improper disposal of industrial wastes and deforestation over the past several decades have resulted in considerable degradation of Pakistan's environment causing increased urban air pollution, contamination of water resources, land degradation, destruction of mountain ecosystems, extinction of species, loss of biodiversity, etc.

Pakistan is signatory to 15 international conventions and protocols related to environmental protection and preservation. The Country has actively participated in them as a member of the G77 + China group. In recent years, the government has taken a number of far-reaching steps in cooperation with other stakeholders to address these problems.

The above-mentioned programmes and activities clearly demonstrate the strong commitment of Pakistan to environmental protection and preservation, in general, and to all its obligations under the UNFCCC, in particular, and to the effort being made by it to do the needful at both national and international levels.

National Disaster Management Authority (NDMA) has undertaken several studies and assessments which show that the last five major flood events (2010-2014) resulted in huge monetary losses of over 18 billion USD, affected 38.12 million people, and damaged around 3.45 million houses and 4.3 Mha of cropped area. Further over 1,200 people lost their lives due to the unprecedented heat wave in Karachi during 2015 (GoP, 2016). On the other hand, the Global Climate Change Index 2020 reflects that under its Long-Term Climate Risk Index from 1999-2018 Pakistan has lost 9,989 lives, suffered economic losses worth $3.8 billion and witnessed 152 extreme weather events leading to the conclusion that Pakistan's vulnerability to climate change is increasing (Eckstein et al., 2020).

7. Urbanization

Cities around the world occupy only 2% land area but consume 60-80% energy, 75% natural resources, and are responsible for 75% carbon emissions (Kreft et al., 2017). Urban scenario in Pakistan is more or less the same. Cities in Pakistan have been expanding at a fast rate. For the past few decades, it has been the fastest urbanizing country in the region & is currently around 40% urbanized poised to cross 50% mark by 2030 (Kreft et al., 2017). The 88 million urban population is spread across hundreds of urban settlements, while more than 50% of the urban population lives in the top one million plus cities. However, there are only 2 cities with a population exceeding 10 million (Karachi 16 million and Lahore 11.3 million).

Sprawling land patterns need more land to be developed for accommodating urbanizing population. On an average the land consumption by cities has been way above the rate in population growth, leading to lower densities and higher vulnerabilities. The rapidly growing urban populations are intensifying pressures on the environment through increased demands for fresh water, energy, land, and other resources and generating more waste and pollution. Effective strategies can reduce the carbon pollution generated by the cities and produce environmental benefits, so as to make cities more resilient to future shocks, including the impacts of climate change. Creating cities that can cope with climate change requires building resilience in urban planning, taking advantage of mitigation opportunities and adapting to reduce vulnerabilities. The Government is following the process of developing an integrated system for urban resilience with measurable targets from the federal to the provincial and to the local levels, aiming to achieve success in the medium term.

8. Disaster Preparedness

Pakistan is highly vulnerable at varying degrees to a large number of climate-related natural disasters. Disaster prone areas include: areas along rivers prone to floods and erosion, coastal areas prone to tropical cyclones and tsunamis, arid and semi-arid areas prone to droughts, and hilly areas are at risk from hill-torrents flash floods, landslides, etc. Heightened vulnerabilities to disaster risks are caused due to expanding population, urbanization, changing land use practices, developmental activities in high-risk zones, and environmental degradation. Climate change is intensifying the above-mentioned hazards.

Most natural hazards like floods, droughts, cyclones, etc. cannot be avoided or prevented. However, with appropriate adaptive and preparedness measures along with proper climate-resilient development work in risk prone areas, these hazards can be prevented or their impacts minimized. At present, the institutional setup for disaster risk reduction in the country is a prime representative of the cross-sector mainstreaming of climate change in government. This is evident from its effective and prioritized mainstreaming through appropriate policy, legal and institutional arrangements, and implementing strategies and programs to minimize risks and vulnerabilities.

The National Disaster Management Authority (NDMA) established in 2006 has gained strong political support and ownership from the legislature and executive branches of the government. The National Disaster Management Council, headed by the Prime Minister of Pakistan, is an apex national policy-making body for disaster management. Other members of the National Disaster Management Council include: leaders of opposition parties in the parliament; chief ministers of all the provinces; Chairperson, Joint Chiefs of Staff Committee; ministers for defense, health, foreign affairs, social welfare, special education, finance, communication, and interior; and representatives of civil society. The Disaster Management Authorities (DMAs) are present at the National, Provincial, and District levels to manage and coordinate disaster related activities.

9. Vulnerable Ecosystems

Pakistan has a number of the world's ecological regions that support a rich variety of species contributing to the country's overall biodiversity. These valuable resources, however, are continuously deteriorating due to many factors including unsustainable exploitation and use; some species of important ecological functions are already on the verge of extinction. The loss, fragmentation and degradation of natural habitats are further compounding the issue and affecting biodiversity in the rangelands, forests, deserts, freshwater and marine ecosystems. Though deterioration of natural habitats has been taking place since long; however, the present decline of the habitats has increased alarmingly raising concerns that the anticipated effects of climate change on biodiversity will further worsen the situation.

The continuous loss of biodiversity calls for immediate response and solid action towards the conservation of these resources. The importance of conserving biological diversity, in the wake of climate change, has been repeatedly outlined in various policies, strategies, plans and programs of the Country. Pakistan developed its first Biodiversity Action Plan (BAP) in 1999 to implement the 2010 Biodiversity Targets. In line with Aichi Biodiversity Targets (2011-2020) and Sustainable Development Goals (SDGs), Pakistan has prepared the second National Biodiversity Strategy and Action Plan (NBSAP) 2017-2030. The actions demonstrate Pakistan's commitment to implement the objectives of the Convention on Biodiversity (CBD): conservation of biodiversity, the sustainable use of its components, and fair and equitable sharing of the benefits arising out of the utilization of genetic resources (MoCC, 2017). The NBSAP identifies legal, institutional, capacity, knowledge and technical gaps in implementing the ABTs and provides recommendations for overcoming these gaps. These include raising awareness and capacity, improving scientific and knowledge capabilities, mainstreaming biodiversity and thereby improving national coordination mechanisms, encouraging cross-sectoral collaboration and adopting a fresh financing strategy.

The NBSAP comprises of 74 proposed actions across five strategic goals and 20 ABTs requiring 74.8 million USD. The proposed actions are further classified into 31 thematic areas. The document has been prepared after extensive stakeholder consultations in all provinces of the Country and the draft was endorsed by all the provinces and territories.

10. Climate Change and Priorities

Keeping in view the climate variability and change threats, Pakistan has undertaken a number of initiatives and measures to address the issues arising out of climate change. Pakistan has surpassed mitigation contributions, and has taken climate change beyond Nationally Determined Contributions (NDCs) and took initiatives which contributed to reduction of 8.7% emissions between 2016-2018 (Fig 1.2)

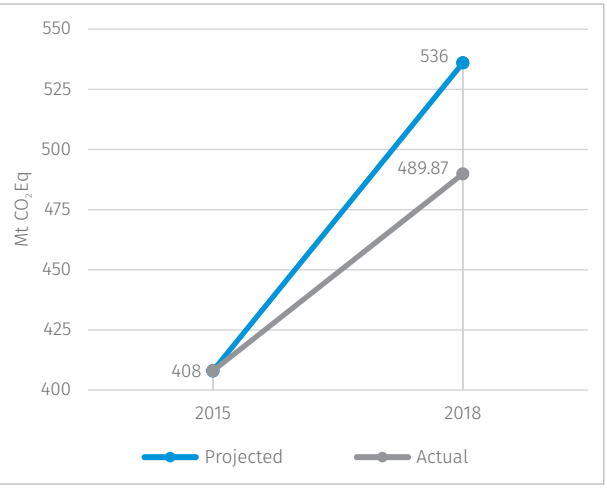

Fig 1.2: GHG Emission Reduction during 2016-2018 through Govt.'s efforts

Key actions taken by the Govt. of Pakistan in the recent years are as follows:

10.1. Ten Billion Tree Tsunami Project

Pakistan has successfully planted one billion trees in KP province in the last 6 years and increased the provincial forest cover by 6.3%. Pakistan has now raised the bar by initiating the 10 billion tree tsunami - across the whole country. This project is helping us to generate thousands of green jobs, revive the forest biodiversity, engage the indigenous communities and energize our youth to become custodians of a green future for our nation. It has been estimated that TBTTP will sequester 148.76 Mt CO_2 Eq. emissions over the next 10 years. In order to ensure complete transparency in TBTTP, Govt. of Pakistan, for the first time, has made arrangements for the 3rd party audit of the plantations done under the said program which is jointly being conducted by IUCN, WWF and FAO Pakistan.

10.2. The Miyawaki Forests

Small urban forests, as pilot projects, in several cities for mitigating urban heat island effect through native tree species that grow faster, sequester more carbon and are self-sustaining. Presently, 126 urban forest projects using the Miyawaki technique are being implemented across the country, with 51 in Lahore, 50 in Khyber Pakhtunkhwa, 20 in Islamabad and five in Karachi

10.3. REDD+ Indus delta (2019-2030 Delta Blue Carbon Phase I)

Restoring 350,000 ha in the Districts of Thatta and Sujawal in Sindh province through plantation in 60 years via a multi-phase public private partnership. Phase 1 aims at restoration of 224,997 ha of degraded land through large scale reforestation of which 75,000 ha was restored by 2020 with mangrove plantations.

10.4. Restoring Mangrove Forests

Under voluntary plantation drives, Pakistan has annually increased at an annual growth rate of 3.74%, making Pakistan the only country in the region with an expanding mangrove cover. Over four million mangroves were planted under various partnerships, involving public and private sectors as well as Civil Society Organizations (CSOs). Under TBTTP, Sindh

province has planned a plantation of 1.5 billion trees, mainly in mangrove areas. Preservation of mangrove forests will be used for carbon capture and to develop resilience against seawater intrusion and tropical storms. In Balochistan, 1,200 ha have been added over the years.

10.5. Eco-System Restoration Initiative (ESRI)

Government of Pakistan has launched this Initiative to:

a. facilitate transition towards environmentally resilient Pakistan by mainstreaming adaptation and mitigation through ecologically targeted initiatives covering afforestation, biodiversity conservation, enabling and enhancing policy environment consistent with the objectives outlined in Pakistan's Nationally Determined Contribution (NDC); and,
b. attain Land Degradation Neutrality by restoring at least 30% of degraded forest, 5% of degraded cropland, 6% of degraded grassland (rangeland) and 10% of degraded wetlands by 2030 to generate eco-system services and provide additional support to mitigating GHG emissions in Pakistan.

The initiative also seeks to establish an independent, transparent and comprehensive financial mechanism in Pakistan called "Eco-system Restoration Fund (ESRF)" to finance the projects and programmes under the initiative.

10.6. Electric Vehicle Policy

In order to mitigate the negative impacts of automobile sector on environment and give a boost to economy, Government has approved the National Electric Vehicle Policy targeting a 30% shift to electric vehicles by 2030 (MoCC, 2019). In addition, world's first "zero emissions" metro line project (GCF, 2018) has been launched in the city of Karachi under GCF Project FP-085.

10.7. Clean Green Pakistan Movement

"Clean Green Pakistan Movement" has been launched with a vision to drive a nationwide movement for clean and green environment for all citizens. A "Clean-Green Cities Index" has been initiated in 20 cities to trigger a shift towards improved waste management and sanitation.

10.8. Recharge Pakistan Initiative

"Recharge Pakistan" initiative is focused on shifting Country's direction by effectively managing and prudently utilizing water resources by turning catastrophic floods into an opportunity for recharging aquifers and natural restoration of ecosystems.

10.9. Transition towards Renewable Energy

Pakistan is making a transition towards renewable energy by harnessing the untapped potential of wind, solar and hydro power. Moreover, the country is striving to achieve a huge 60% shift towards clean "carbon free" energy by 2030.

10.10. Youth and Climate Change

Youth and Children in Pakistan are one of the largest groups at risk and measures that specifically target children and youth that have great potential to reduce the impacts of climate change. High vulnerabilities of children addressed through child-focused policies are also associated with the potential to off-set the climate induced losses due to degradation of health, education and protection that apprehend fiscal gains. Pakistan's current political climate is cognizant of the role youth can play in combating environmental challenges and have shown a political resolve to create an enabling environment for their active participation through the following initiatives:

- Clean Green Pakistan Champions
- Imran Khan's Tiger Force
- Green Stimulus Package
- The Kamyab Jawan scheme
- Ehsaas Nasho-numa Program

10.11. Ban on Polythene Bags

Dated 22 July 2019, MoCC, after approval of the Federal Cabinet, issued a Statutory Regulatory Order (SRO) namely "Ban on (Manufacturing, Import, Sale, Purchase, Storage and Usage) of Polythene Bags Regulations, 2019" and has taken the following steps to discourage excessive use of plastic and alternatives of polythene bags.

a. No person shall import, manufacture, stockpile, trade, supply, distribute, sell or use polythene plastic bags in Islamabad.
b. A comprehensive Implementation strategy is being followed in collaboration with Municipal Corporation Islamabad (MCI), Islamabad Capital Territory (ICT) Administration, Capital Development Authority (CDA) and Pakistan Environmental Protection Agency (Pak-EPA).
c. Bags made of cotton, jute and other permissible materials were prepared and distributed amongst parliamentarians, news media personnel, officials of Federal Ministries / Division and public at large as an alternative to plastic bags.

So far, more than 1,000 retail shops, restaurants, factories, etc. have been inspected for practicing use of polythene plastic bags. Around 3,000 kg plastic bags have been confiscated and Rs. 1,600,000 imposed as fines (from August 2019-February 2020).

10.12. Stakeholders Awareness Raising

Pakistan, in partnership with United Nations Environment Program (UNEP) has announced to host World Environment Day in Pakistan on 25 June 2021 on the theme of "Ecosystem Restoration" focusing on resetting our relation with nature. It will also mark the formal launch of the UN Decade on Ecosystem Restoration 2021-2020. As host of the event, Pakistan will highlight environmental issues and showcase the country's own initiatives and its role in global efforts. The day will be celebrated across the world through various events and activities, in line with latest COVID-19 regulations.

The Government has created an environment of working closely with key stakeholders (Research, Academia, Development partners, CSOs, private sector) for comprehensively addressing the climate change concerns through research, policy and implementation interfacing.

10.13. Mega Projects

Besides many other activities, Pakistan is implementing the following three mega projects with the support of Green Climate Fund (GCF) to benefit approximately 49 million people:

1. Scaling-up of GLOF risk reduction in Northern Pakistan costing 37.5 million USD (GCF Grant 37 million USD);
2. Building safe and accessible to all zero-emissions Bus Rapid Transit (BRT) system in Karachi costing 535 million USD (GCF Grant plus Loan 49 million USD); and,

3. Transforming the Indus Basin with climate resilient agriculture and water management at a cost of 47.7 million USD (Grant 35 million USD)

All the above initiatives are indicators of a shifting landscape in Pakistan under the new government towards a cleaner, greener and sustainable future aiming at lowering the emissions and ensuring climate resilient growth.

10.14. Climate Finance and Market & Non-Market-Based Approaches

Pakistan has enjoyed very limited access to international climate finance. The Govt has taken steps and considers employing the instruments on enhanced ambition provided in Article 6 of the Paris Agreement. Some of the initiatives that Pakistan has embarked upon include:

- Green bonds
- Nature performance bonds
- Carbon pricing instruments
- Blue carbon

10.15. Public-Private Partnerships

Pakistan encourages the involvement of the private sector in implementing its climate ambition across sectors and the development of nature-based solutions (NbS) that address Pakistan's mitigation and adaptation potential.

From 2020, new coal power plants are subject to a moratorium, and no generation of power through imported coal shall be allowed, shelving plans for two new coal fired power plants in favor of hydroelectric power and focusing on coal gasification and liquefaction for indigenous coal.

Chapter No. 2

National Greenhouse Gas Inventory Information (2017-18)

Chapter No. 2

National Greenhouse Gas Inventory Information (2017-18)

1. Overview

Article 4, paragraph 1 (a), and Article 12, paragraph 1 (a) of the United Nations Framework Convention on Climate Change (UNFCCC) requires from all non-Annex I Parties to communicate to the Conference of the Parties (COP) a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not covered under Montreal Protocol, to the extent its capacities permit, following guidelines contained in annex to decision 17/CP.8 (UNFCCC, 2003a; UN, 1992).

The present GHG Inventory 2017-18 of Pakistan has been prepared using the IPCC 2006 Guidelines for National GHG Inventories and provides information regarding GHGs, namely, CO_2, CH_4, and N_2O, emitted from anthropogenic sources. The inventory has been compiled using IPCC software Tier-1 methodologies for estimating GHG emissions and removals for all source/sink categories as per IPCC Guidelines in the light of Katowice decision (2018) for all parties to follow IPCC 2006 Guidelines.

The first GHG inventory for the country formally submitted to UNFCCC being part of initial national communication of Pakistan was prepared by M/s Hagler Bailly during the period 1999–2003, with the support of Global Environment Facility (GEF) through United Nations Environment Programme (UNEP) under the project GF/2200-97-57, for preparing Initial National Communication to UNFCCC. The inventory was developed for the fiscal year 1993-94 (herein called as 1994) based on IPCC 1996 Guidelines for inventory development. Total GHG emissions estimated in 1994 inventory are 181.7 million tonne (Mt) Carbon Dioxide Equivalent (CO2e) (UNFCCC, 2003b). Sector wise emissions estimates are: Energy 47.2%, Agriculture 39.4%, Industrial Processes 7.3%, Land Use and Forestry (LUCF) 3.6%, and Wastes 2.5%.

Applied System Analysis Division (ASAD) of Pakistan Atomic Energy Commission (PAEC), on the request of PAEC's Task Force on Climate Change, prepared the next GHG inventory for the year 2007-08 (herein called as 2008) in 2009 using 2006 IPCC Guidelines. The results are available in the form of a draft report. However, the inventory was not submitted to UNFCCC. In the 2008 inventory, estimated GHG emissions are 309.4 Mt CO2e comprising sector-wise share of Energy 50.7%; Agriculture 38.8%; Industrial processes 5.8%; LUCF 2.9%; and Waste 1.8% (Ahmad et al., 2009). Later on, in 2016, ASAD revised this inventory by using revised 1996 IPCC Guidelines instead of 2006 IPCC Guidelines. In the revised 2008 inventory, the estimated GHG emissions are 329.5 Mt CO2e comprising sector-wise share of: Energy 51.1%; Agriculture 38.2%; Industrial Processes 5.6%; LUCF 2.8%; and, Waste 2.2% (Ahmad et al., 2016).

In the absence of any formal institutional arrangements in the country for the preparation of GHG inventory, Global Change Impact Studies Centre (GCISC) took the initiative in 2014 to prepare GHG inventory of Pakistan by utilizing its indigenous capacities. The first inventory by GCISC was developed for the fiscal year 2011-12 (herein called as 2012) based on revised 1996 IPCC Guidelines during 2014-2015. Total GHG emissions estimated in 2012 inventory are 374.1 Mt of CO2e. Sector wise emissions estimated this Inventory were: Energy 45.8%; Agriculture 43.5%; Industrial Processes 5.2%, LUCF 2.6%; and Waste 2.8%, This inventory was published by GCISC as research report (GCISC-RR-19) in 2016 (Mir and Ijaz 2016).

Later the GHG-I for the year 2014-15 was prepared by the GCISC in 2016 using the UNFCCC Non-Annex I National GHG Inventory Software, Version 1.3.2. in accordance with Revised 1996 IPCC Guidelines, which employs Tier-1 approach using default emission factors depending on national circumstances and the availability of data in the country for emission estimation. As per inventory report, the total estimated GHG emissions for the year 2015 were 408.1 Mt CO2e with Sector wise shares of: Energy 45.5%, Agriculture 42.7%; Industrial Processes 5.4%; LUCF 2.5%; Waste 3.8%. This inventory was the basis for Pakistan's First Nationally Determined Contributors (NDCs) submitted to UNFCCC in November 2016.

Table 2.1 summarizes the GHG Inventory development processes and results.

In the light of Katowice decision, National GHG Inventory of Pakistan based on the latest data sets available as part of the Pakistan BUR1 Project executed by the Ministry of Climate Change (MoCC) through GCISC has been prepared using IPCC 2006 Guidelines. This report presents the inventory of Pakistan for the year 2017-18 (herein called as 2018). This is third such effort by the Centre.

2. Greenhouse Gas Emissions in 2018

2.1. Activity Data, Emission Factors and Methodological Tier

Using IPCC 2006 Guidelines, the inventory includes four sectors including: Energy including Transport; Industrial Processes & Product Use (IPPU); Agriculture, Forestry & other Land Use (AFOLU); and Waste. The activity data have been taken from the following sources:

1. Pakistan Energy Year Book (2017-18);
2. Economic Survey of Pakistan (2019);
3. Agriculture Statistics of Pakistan (2017-18);
4. State of Industries Report (2018);
5. FAO Stat 2018;
6. Pakistan Forestry Sector Review (FAO 2020);
7. Pakistan Country Report (FAO-Smog Report 2019);
8. National Forest and Rangeland Resource Assessment Study (NFRRAS 2004); and
9. Maanics Report on Supply & Demand of Fuel Wood & Timber for Household & Industrial Sectors & Consumption Pattern of Wood & Wood Products in Pakistan (2003-2004).

Year	Developed by	Total	Sectoral GHG Emissions (%)				
		Mt CO2e	Energy	Agriculture	Industrial processes	LUCF	Waste
1994	M/s Hagler Bailly (based on 1996 IPCC Guidelines)	374.1	45.8	43.5	5.2	2.6	2.8
2008	ASAD/PAEC (based on 2006 IPCC Revised Guidelines)	329.5	51.1	38.2	5.6	2.8	2.2
2008	ASAD/PAEC (based on 2006 revised guidelines)	309.4	50.7	38.8	5.8	2.9	1.8
2012	GCISC (developed indigenously based on 2006 revised guidelines	181.7	47.2	39.4	7.3	3.6	2.5
2015	GCISC (developed using GHG Inventory Software, Version 1.3.2)	408.1	45.5	42.7	5.4	2.5	3.8

Table 2.1: Summary of Inventory Development Process in Pakistan

2.2. Summary

The total estimated emissions in terms of CO2e for the year 2018 show an increase in total GHG emissions when compared with the previous (1994, 2008, 2012 and 2015) inventories. Total estimated GHG emissions for the year 2018 are 489.87 Mt CO2e contributed by: i) Energy sector 218.94; ii) Industrial processes 25.76; iii) AFLOU 223.45; and, iv) Waste 21.72 Mt CO2e respectively. Table 2.2 summarizes sectoral GHG emissions.

2.3. Energy Sector

Energy sector is considered one of the most important sectors contributing in GHG emissions. Generally, its contribution in CO_2 emissions is more than 90% while in total GHG emissions it is 75%. When combustion of hydrocarbon takes place, CO_2 emissions are produced as a result of the oxidation of carbon in fuels during combustion. Fossil fuel combustion is a key element of the energy systems for most of the countries.

Stationary combustion and mobile combustion (transport) are two major categories in the energy sector fuel combustion. Stationary combustion category includes energy industries, manufacturing industries and construction sectors such as commercial / institutional / residential. Whereas, Mobile combustion category includes trucks, buses, motorcycles, etc., rail transport, domestic aviation, national navigation, transportation (e.g. gas pipeline transport) falls in mobile fuel consumption.

There are two major categories in the energy sector related to fuel combustion:

- Stationary Combustion
- Mobile Combustion (Transport)

These two components include various source categories that emit GHGs. Under stationary combustion category, Energy Industries includes activities such as energy extraction, energy production and transformation, electricity generation, petroleum refining, etc. Manufacturing Industries and

Sector	Sub-Sector	Emissions	Total Emissions
		Mt CO2e	Mt CO2e
Energy	Energy Industry Manufacturing Industries and Construction Transport Others (Commercial, Residential, agricultural) Fugitive Fuel Emissions	53.40 66.20 51.34 44.06 3.94	218.94
IPPU	Mineral Industry Chemical Industry Non-Energy Fuel and solvent Use Product Other (Pulp and paper, Food and Beverages	22.75 2.71 0.10 0.20	25.76
ALFOU	Livestock Land Managed Soils Rice Cultivation	109.12 31.52 74.98 7.83	223.45
Waste	Solid Waste Disposal Waste Incineration and Open Burning Wastewater Treatment and Discharge	10.23 0.09 11.40	21.72
		Total	489.87

Table 2.2: Summary of Sectoral GHG Emissions

Construction, which include activities such as iron and steel production, non-ferrous metal production, chemical manufacturing, pulp and paper, food processing, beverages and tobacco, etc. Other Sectors such as Commercial Institutional, Residential, and Agriculture/ Forestry/ Fisheries.

Mobile Combustion source categories include:

- Road transport (cars, light and heavy- duty trucks, buses, motorcycles, etc.)
- Rail Transport
- Domestic Aviation
- National Navigation
- Other transportation (e.g. gas pipeline transport)

Emissions from international transport activities bunker fuels are estimated and reported separately. These estimates are excluded from the national totals as per 2006 IPCC Guidelines.

2.3.1. Greenhouse Gases in Energy Sector

Energy systems are for most economies largely driven by the combustion of fossil fuels. The key greenhouse gases of concern are Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). During combustion the carbon and hydrogen of the fossil fuels are converted mainly into CO_2 and water (H_2O), releasing chemical energy in the fuel as heat.

In the case of fuel combustion, the emissions of these non-CO_2 gases contain very small amounts of carbon compared to the CO_2 estimate and, as such, at Tier 1, it is more accurate to base the CO_2 estimate on the total carbon in the fuel. This is because the total carbon in the fuel depends on the fuel alone, while the emissions of the non-CO_2 gases depend on many factors such as technologies, maintenance etc. which, in general, are not well known.

2.3.2. Methodology, Activity Data, and Emission Factors

The IPCC software version 2.69 has been used to implement Tier1 methodologies in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for the preparation of GHG inventory. The activity data for the year 2017-18 in terms of consumption of various fossil fuel types has been taken from Pakistan Energy Year Book 2018 an annual energy statistics publication released by Hydrocarbon Development Institute of Pakistan (HDIP). The data in this year book is presented as top-down and is ideally suited for use in IPCC GHG emission estimation methodology. Default emission factors available in IPCC software are used under different categories and sub-categories.

2.3.3. Overview of Energy Sector Emissions

Table 2.3 summarizes the GHG emissions from different categories in the Energy Sector.

Categories	Emissions (Mt CO2e)			
	CO_2	CH_4	N_2O	Total
Energy Industries	53.27	0.03	0.10	53.40
Manufacturing Industries and Construction	65.86	0.11	0.24	66.20
Transport	49.57	0.56	1.20	51.34
Other Sectors	31.41	2.23	0.46	34.11
Non-Specified	9.90	0.02	0.01	9.93
Fugitive emissions from fuels	0.01	3.93	0.00	3.94
Total	**210.02**	**6.88**	**2.01**	**218.91**

Table 2.3: Summary of GHG Emissions from the Energy Sector in 2018

Source: GCISC, 2021

It can be seen that the Sector emitted 218.91 Mt CO2e i.e., about 45% of the total national emissions of 489.9 Mt CO2e (see Table 2.2). Energy Sector emissions mainly consist of CO_2 (210.02), CH_4 (6.88) and 2.01 N_2O Mt CO2e. The Energy Industry category which consists of fossil fuels combusted in power generation and petroleum refining produced 53.40 Mt CO2e emissions. The manufacturing, industries and construction category consists of iron and steel, non-ferrous metals, chemicals, pulp paper and print, food processing and beverages, non-metallic minerals, transport equipment, machinery, mining and quarrying, wood and wood products, construction, textile and leather and some non-specified industries. The fuel combustion activities in iron and steel, chemicals, pulp paper and print, food processing and beverages, construction, textile and leather, and some non-specified industries emitted 66.20 Mt CO2e. This contains 65.86 Mt CO2e of CO_2, 0.11 Mt CO2e CH_4, and 0.24 Mt CO2e of NO_2. The emissions from transport consist of 51.34 Mt CO2e. Similarly, emissions from other sectors, non-specified sectors and fugitive emissions are 34.1 Mt CO2e, 9.91 Mt CO2e and .9 Mt CO2e respectively.

2.3.4. Energy Industries

Energy industries release emissions produced as a result of fossil fuel combustion for electricity generation (Table 2.4) and solid fuel manufacturing. The natural gas used in gas processing plants has also been included in the category of electricity generation. However, information on the use of fossil fuels for solid fuel manufacturing is not available in Pakistan; this category has not been included in the national totals. Energy Industries category which consists of fossil fuels combusted in power generation and petroleum refining emitted 53.40 Mt of CO2e (Figure 2.1).

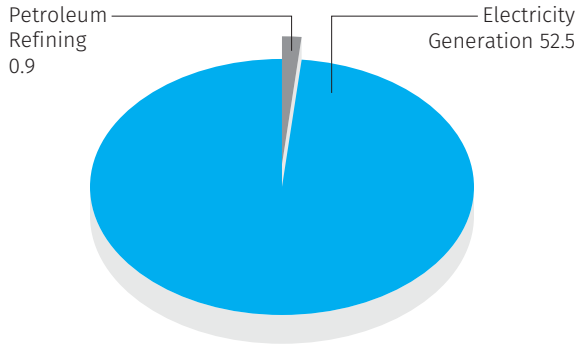

Figure 2.1: GHG Emissions from Power Generation & Petroleum Refining

Source; GCISC, 2021

2.3.5. Energy for Manufacturing and Transport

GHG emissions from fossil fuel combustion in cement, iron and steel, chemicals, brick kiln, and other non-specific industries have been considered here. Of the total CO2e emissions from the manufacturing industries due to fossil fuel combustion, 65.86 Mt was emitted as CO_2, 0.11 Mt as CH_4, and 0.24 Mt was emitted as N_2O. Table 2.5 summarizes the GHG emissions for different components of construction and manufacturing units.

Construction: The emission from construction industry mainly includes emissions from coal use in brick kilns and cement industry. It is assessed that 82.5 billion

Fuel	Electricity Generated (GWh)	Share (%)
Gas	29,695.47	32.25
RLNG	21,173.32	22.99
RFO	28,207.47	30.63
HSD	788.18	0.86
Coal	12,224.50	13.27
Total	**92,088.94**	**100.00**

Table 2.4: Thermal Electricity Generation by Fuel in 2017-18 (Gwh)

Source: NEPRA, 2018

Manufacturing Industries & Construction	CO_2	CH_4	N_2O	Total
Iron and Steel	1.779	0.002	0.001	1.782
Chemicals	3.247	0.002	0.004	3.253
Pulp, Paper and Print	2.461	0.001	0.002	2.464
Food Processing, Beverages and Tobacco	4.656	0.002	0.006	4.664
Construction	45.536	0.097	0.215	45.848
Textile and Leather	4.894	0.002	0.003	4.899
Non-Specified Industry	3.285	0.003	0.006	3.294
Total	**65.858**	**0.109**	**0.237**	**66.204**

Table 2.5: Overview of Manufacturing Industries and Construction by Gases (Mt CO2e)

Source: GCISC, 2021

fired bricks were produced in 2018 through various sorts of kilns, utilizing various types of fuels and fuel mix like indigenously produced lignite coal, rice husk, and other agricultural residues, rubber tires, plastics, and different industrial waste, which ultimately produce highly toxic gases. It is estimated that 13 Mt coal is consumed for firing bricks, where 70% of energy needs is fulfilled by coal and 30% by biomass. As per an estimate there are 18,000-20,000 brick kilns in Pakistan and most of them use Fixed Chimney Bull's Trench Kiln technology; however, 150 of them use zig-zag technology. Zig-zag kilns have been given significant importance in the context of Nationally Determined Contributions and made part of the National Action Plan for SE4ALL (ICIMOD, 2019).

Manufacturing: Pakistan's fertilizer production capacity is over 6.4 Mt per year by 21 manufacturing plants, and the main fuel used for fertilizer production is natural gas. In 2018, total fertilizer production of all kinds (urea, super phosphate, ammonium nitrate, and nitro- phosphate) was 6.2 Mt (MoF, 2018).

Pakistan's cement industry contributes considerably in the economy of the country. With 29 cement plants it contributes significantly to the national GDP (MoF, 2018). The major fuel consumption in the manufacturing of cement in Pakistan is coal and about 90% of the total coal requirement is being achieved through imported coal (MoF, 2018).

Pakistan steel industry has recovered from a contractionary phase that started with the closure of operations of Pakistan Steel Mills in FY15, and posted an encouraging growth of over 20% during FY17 and FY18 (State Bank of Pakistan, 2018). However, the utilization of coke and pig iron remained zero in in FY18 (MoF, 2018). The emissions from combustion of fossil fuels in iron and steel category are estimated as 1.8 Mt CO2e in the year 2017-18.

Chemical industry is the 4th largest sector in international trade and contributes 7% to the global GDP. While, the chemical sector of Pakistan contributes around 3% in export and its share in imports is 16%, they play vital role in the development of forward linked industries like textile, leather, footwear, furniture, automobile, food and beverages. Chemical products are also used in backward linked industries such as surfactants which are used by oil refineries and oil extracting companies. The energy utilized in this sector contributes 3.3 Mt CO2e of GHG emissions in the year 2017-18.

Paper industry of Pakistan is an important industry and serves primarily the domestic market. The energy consumption in pulp, paper and print industry emit 2.5Mt CO2e emission in the atmosphere. Similarly, food processing, beverages and tobacco, textile and leather and non-specified industries emit 4.7Mt CO2e, 4.9Mt CO2e and 3.3Mt CO2e emissions respectively to fulfil their energy requirements.

2.3.6. Transport

Pakistan's transport system is one of the largest sectors of economy. All GHG emissions produced as a result of combustion of fossil fuel through road transport, aviation, railways, and navigation are included in the transport sector. It has been observed during the last two decades that demand for road transport services, holding share of 13% in Pakistan's GDP, has grown manifold (MoF, 2018). In Pakistan, registered road vehicles have increased from 2.71 million in 1990 to 23.6 million in 2018. Cars and two wheelers represent approximately 87% of the total road vehicles (MoF, 2019) and use around 65% of the total liquid fuel consumed in the country. About 78% of fuel used in this sector is oil-mainly gasoline and diesel. Compressed natural gas (CNG) and electricity meets the remaining 22% requirements of the transport sector (HDIP, 2018).

The total GHG emissions from the transport sector in 2018 were 51.34 Mt CO2e. This is 23.4% of the total CO2e emissions from the energy sector and is 10.14% of the total GHG emissions in 2018. Of the total CO2e emissions from the transport sector in 2018, 49.57 Mt were emitted as CO_2, 0.56 Mt as CH_4, and 1.2 Mt as N_2O.

Light duty trucks, cars, motorcycles railways, and heavy-duty trucks and buses are the contributors in transport sector GHG emissions. In addition to this domestic aviation and pipeline transport of natural gas also contribute in the national total of GHG emissions of transport. Under 2006 IPCC Guidelines in cars and light-duty trucks emissions associated with catalytic converter and without catalytic converter is used.

Figure 2.2 shows the GHG emissions from the Transport Sector in the FY 2017-18.

2.3.7. Emissions from Other Sectors

Other sector emissions comprise of commercial, residential and agriculture sectors. Cooking, lighting, space heating/cooling, refrigeration, and pumping activities characterized in the residential, commercial, and agriculture sectors are included in this category. The fuels consumed are: electricity (for lighting, heating, cooling, and pumping); LPG (for cooking); kerosene (for lighting and cooking); diesel (for generating power for pumping and lighting); and, coal/ charcoal / fuel wood (for sessions due to grid use of electricity). Almost 55.8% of the total GHG emissions from this category are from the residential sector (19.0 Mt CO2e). The residential sector has a rural and urban

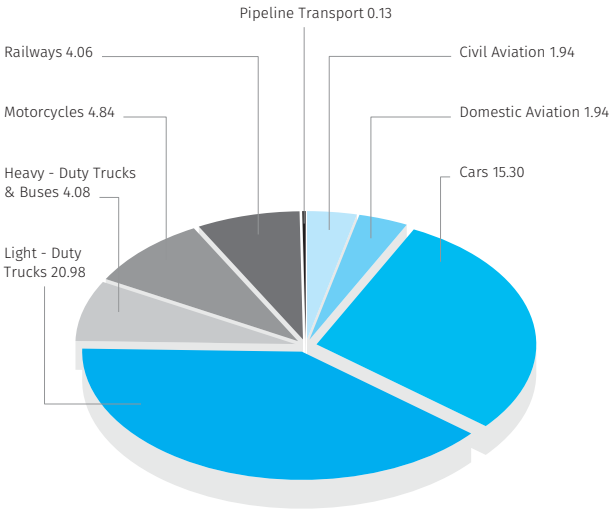

Figure 2.2: Emissions from Transport Sector (Mt CO2e)

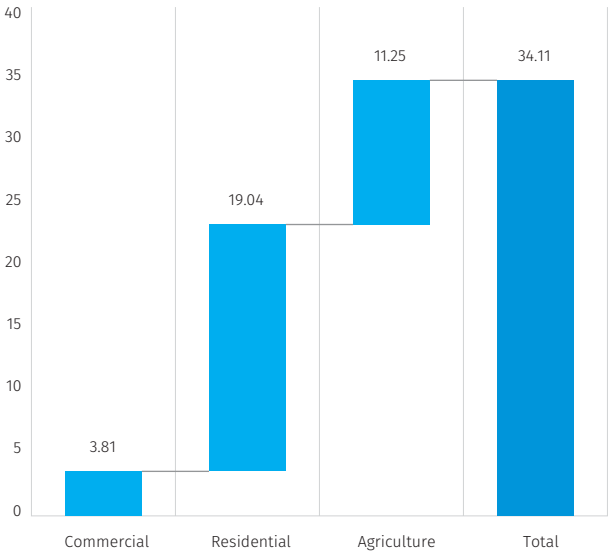

Figure 2.3: Emissions from Other Sectors (Mt CO2e)

spread, where it combusts both fossil fuel as well as biomass. Biomass still contains substantial amount of fuel mix used in rural Pakistan. CH_4 from biomass combustion in the residential sector is reported in the energy sector; however, CO_2 from biomass is reported as a memo item and is not included in the national totals in accordance with the IPCC Guidelines. The commercial, residential, and agriculture sectors also witness extensive use of captive power generated from diesel use. This source is scattered and a systematic collection could not be carried out. The fuel consumption in these private generator sets could be substantial. Lack of data for this consumption is a gap area that requires further research and capacity to improve the inventory estimates in Pakistan.

More than half of population in Pakistan lives in rural areas; however, urbanization trend is also highest in the region. The major portion of rural population is linked to agriculture related activities directly or indirectly. Therefore, the emissions from the energy consumption in the agriculture sector are 11.3 Mt CO2e. The urban population is connected to the gas infrastructure so the emissions from the energy consumption in residential sector is 19.0 Mt CO2e. Similarly, the emission due to energy consumption in commercial sector are 3.8 Mt CO2e.

2.3.8. GHG Emission from Non-Specified Sources

Emissions in this category from fuel combustion are from mainly stationary sources that are not specified elsewhere. In Pakistan informal economy is poorly reflected in official measures of aggregate income and product of a country. The remaining 9.9 Mt CO2e is from non-specified emissions.

2.3.9. Fugitive Emissions

The GHG emissions from this category in the energy sector have been divided further into two main sub-categories: 1) Solid fuels (primarily coal mining), and 2) Oil & natural gas systems. The dominant GHG emitted from all of these fugitive source categories is CH_4. For solid fuels, venting and disposal of coal- bed is the primary source of fugitive emissions. Most of these emissions occur at the mine with some residual emissions occurring from post-mining handling/ processing activities. The extraction, production, processing, or transportation of fuels involve substantial quantity of methane emissions to the atmosphere. Oil and natural gas systems are potentially very complex and diverse. Two major issues concerning the reported fugitive emissions from oil and gas systems are: (i) the generally poor quality and completeness of available venting and flaring data; (ii) the fact that much of the infrastructure contributing to equipment leaks is at minor facilities for which statistics are either unavailable or incomplete (e.g. well site facilities and field facilities). Fugitive emissions consist of CH_4 mostly however CO_2 is also emitted from the coal mines. It is the first time that the government actually started to use coal for electricity generation. It was assumed that in 2017-18 most of the coal mines were underground (80%) and 20% coal was extracted from the surface mines. There are oil and gas production, processing, transmission and distribution activities so around 3.29 Mt CO2e emission from oil and gas related infrastructure. Figure 2.4 shows the fugitive GHG emissions.

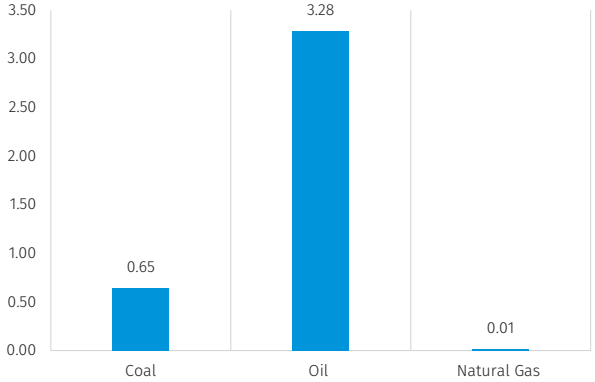

Figure 2.4: Fugitive GHG Emissions (Mt CO2e)

2.4. Industrial Processes and Product Use (IPPU)

The industrial processes sector includes emissions from various processes. The emissions associated with the energy input are not regarded as industrial process sector emissions, therefore, are not included in the emission factor estimation. They are accounted for under a source category "Manufacturing industries and construction" in the energy sector. To avoid double counting, the Non- Energy Use (NEU) related

emissions reported in the industrial processes sector are calculated based on the use of reducing agents, particularly for the source categories in metal production.

According to IPCC, the source categories covered under industrial processes sector are:

- Mineral Industry - Cement, lime, limestone and dolomite use, soda ash production, and glass.
- Chemical Industry - Ammonia, nitric acid production, carbide production, titanium dioxide production, methanol production, ethylene oxide.
- Metal Industry - Iron and steel, ferro- alloys production, aluminum, lead, zinc, copper, and magnesium.
- Other - Pulp and Paper Industry, Food and Beverages Industry

In 2018, the industrial processes sector in Pakistan emitted 25.76 Mt of CO2e as illustrated in Figure 2.5. In current GHG Inventory of 2017-18 the major contributor was mineral sector with 88% of the total CO2e emissions followed by chemical industry (10.5%). Minerals like cement production, limestone, dolomite use and glass production emitted 22.76 Mt CO2e, out of which the cement production led to an emission of 21.3 Mt CO2e, lime production and dolomite use emitted 1.25 Mt CO2e. Chemical industry includes GHG emissions totaling 2.7 Mt CO2e which are produced during the processes involved in the production of chemicals (such as ammonia).

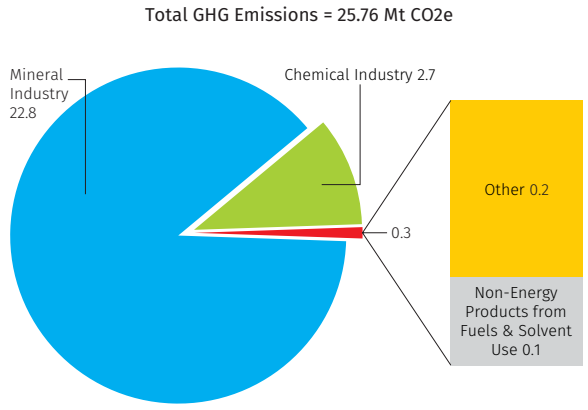

Figure 2.5: GHG Emissions from Industrial Processes by Categories

2.4.1. Methodology, Activity Data & Emission Factors

To estimate GHG emissions from the industrial processes, the 2006 IPCC Guidelines have been used for each of the categories mentioned above. Activity data for industrial processes is taken from Pakistan Economic Survey (MoF, 2018). These data include production in mineral and chemical industries. Mineral industry includes production of limestone, cement, and dolomite while chemical includes production of ammonia, urea, iron. The total quantity of cement production in Pakistan during the year 2018 was 41.148 million Mt while of limestone and dolomite were 1.55 and 0.10 million Mt.

2.4.2. Mineral Industry

The focus of this category is on CO_2 emitted from calcination of carbonate materials in the production and use of a variety of mineral industry products. There are two broad pathways for the release of CO_2 from carbonates: (i) calcination and (ii) the acid-induced release of CO_2. The primary process resulting in the release of CO_2 is the calcination of carbonate compounds, during which a metallic oxide is formed through heating. The processes included here are the production of cement, limestone and dolomite use, and use of asphalt for road paving. The most important source of non-energy industrial process emissions is the cement production.

In 2018, CO2e emissions from the cement production were 21.3 Mt of CO_2, which is 92.5% of the total CO2e emissions from the mineral industries, followed by limestone and dolomite use (5.4%), and use of asphalt for road paving (1%). With an annual production of over 41.1 Mt cement, Pakistan's cement industry contributes significantly in the country's GDP. The major fuel consumption in the manufacturing of cement is imported coal to fulfil the total coal requirements of manufacturing units (MoF, 2018). Figure 2.6 shows the emissions from the mineral industries.

2.4.3. Chemical Industry

The chemical industry covers the production of ammonia, nitric acid, carbide, titanium dioxide, methanol, ethylene, etc. Ammonia is a major industrial chemical and the most important nitrogenous

material produced. Ammonia gas is used directly in fertilizer production; heat treating and paper pulping; manufacturing of nitric acid, nitrates, nitric acid ester, and nitro compound; and in refrigeration system. In 2018, a total of 2.7 Mt CO2e was emitted by this sector. Pakistan's fertilizer production capacity is over 6 Mt per year, and the main fuel used for fertilizer production is natural gas. Total fertilizer production of all kinds (urea, super phosphate, ammonium nitrate, and nitro-phosphate) in 2018 was 5.4 Mt. Considering that ammonia production industry is the only major emitter within the industrial processes sector, further efforts should be made to determine the emission factor of CO_2 from ammonia production process.

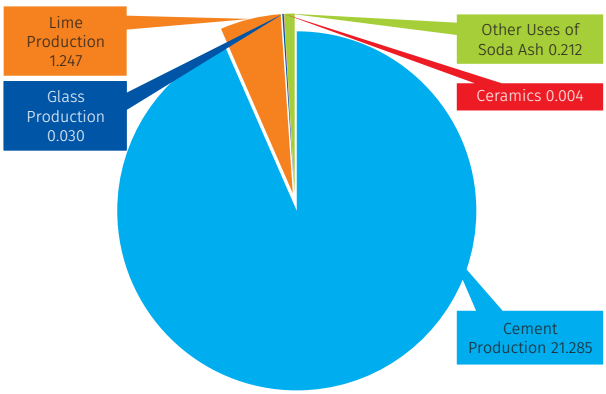

Figure 2.6: GHG Emission from the Mineral Industry in 2017-18

2.5. Non-Energy Products from Fuels & Solvent Use

Apart from fuels, refineries and also coke ovens produce some non-energy products which are used directly (i.e., without chemical conversion) for their physical or diluent properties or which are sold to the chemical industry as chemical intermediate. Lubricants and greases are used in engines for their lubricating properties; paraffin waxes are used as candles for paper coating etc.; bitumen on roofs and roads for its waterproofing and wear qualities. Refineries also produce white spirits, which are used for their solvent properties. Generally, the methods for calculating CO_2 emissions from non-energy product uses follow a basic formula, in which the emission factor is composed of a carbon content factor and a factor that represents the fraction of fossil fuel carbon that is "Oxidized During Use" (ODU), e.g., actual co-combustion of the fraction of lubricants that slips into the combustion chamber of an engine). This concept is applied to oxidation during first use only of lubricants and paraffin waxes and not to subsequent uses. In the 1996 IPCC Guidelines, use of lubricants were coved in the Energy sector; however, in the 2006 IPCC Guidelines use of non-energy products from the fuels and solvent use are covered in IPPU sector. In 2018 the use of lubricants emitted 0.01 Mt CO2e and asphalt, bitumen etc. Other categories emitted 0.08 Mt CO2e.

2.6. Other Category

This category covers the GHG emission from mainly the following two following industries:

- Pulp and Paper
- Food and Beverages (F&B)

Carbon emissions from the pulp and paper industry in developing countries have not been well studied. Generally, pulp and paper production involves pulping and paper making processes. Depending on the type of raw materials, paper pulp can be classified into 3 main types: wood pulp, non-wood pulp, and waste paper pulp. In 2017-18 pulp and paper industry produced over 0.7 Mt of pulp and paper and 18.77 Mt of F&B.

The F&B category includes GHG emission from facilities that manufacture food products by transforming livestock or agricultural products into products for intermediate or final consumption by humans. This is first time that these categories are reported in GHG inventory of Pakistan. The data for these categories were acquired from Ministry of Industries and Production. For the year 2017-18 food and beverages industry emitted 0.05 Mt CO2e.

Figure 2.7 shows GHG emissions from paper and food related industries.

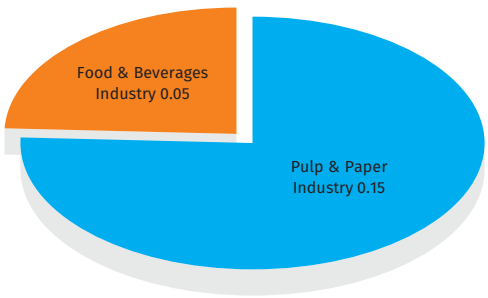

Figure 2.7: GHG Emissions from Paper & Food Related Industries in 2017-18

2.7. Agriculture, Forestry & Other Land Use (AFOLU)

The AFOLU Sector integrates agriculture, forestry and other land use emission and removal categories. This integration identifies that the underlying processes responsible for GHG emissions and removals, as well as the different forms of terrestrial carbon stocks, can occur across all types of land. This integration approach ensures consistency and completeness in the estimation and reporting of GHG emissions and removals (IPCC, 2006).

The key GHGs emitted from the AFOLU Sector include CO_2, N_2O and CH. The CO_2 changes between the atmosphere and ecosystems are mainly controlled by its uptake by plants during photosynthesis and releases in processes including plant respiration, decomposition and combustion of organic matter (IPCC, 2006). N_2O emissions from ecosystems are mainly in the form of by-product of nitrification and denitrification process, while CH_4 emissions occur through different processes including anaerobic methanogenesis in the soil and manure management systems by methanogenic bacteria, enteric fermentation by livestock, and incomplete combustion of organic matter (IPCC, 2006).

In this GHG Inventory, the emissions and removal of CO_2 and non-CO_2 GHGs from the AFOLU sector are estimated separately for each of the six land-use categories. While other CO_2 and non-CO_2 emission categories including livestock related emissions and soil emissions from Nitrogen management, lime and urea application, are estimated at national scale using aggregated national data. The data-sets used in these GHG estimations are mainly taken from published national and international sources including Agriculture Statistics of Pakistan 2017-18 (MoNFSR, 2018); Pakistan Economic Survey 2017-18 (MoF, 2018) and Food and Agriculture Organization of the United Nations (FAOSTAT, 2018).

2.7.1. Overview of the AFOLU Sector Emissions

The AFOLU Sector emitted 223.45 Mt of CO2e emissions, constituting 45% of the total national emissions (Table 2.6).

In AFOLU emissions, CH_4 emissions are 109.75 Mt CO2e followed by 80.75 Mt N_2O and 32.95 Mt CO_2. The Livestock Sector emitted 109.12 (48.3%) Mt CO2e emissions followed by 74.98 Mt (33.6%) from Managed Soils, 31.52 Mt (14.1%) from Land and 7.83 (3.5%) from Rice Cultivation.

2.7.2. Livestock

Livestock is an important component of Pakistan agriculture. It is one of the drivers of the socio-economic development of the country which contributes significantly to the rural economy as source of income and employment. On the other side, livestock production systems, particularly those with ruminants, are significant sources of CH_4 emissions through enteric fermentation in their digestive systems. Manure management practices regarding its disposal and storage affect CH_4 and N_2O emissions through its decomposition by methanogenesis and nitrification / denitrification, respectively. Furthermore, NH_3 and NO_X losses from manure management systems and soils through volatilization and leaching result in indirect GHG emissions.

Source Category	CO_2	CH_4	N_2O	Total
Livestock	-	99.99	9.13	109.12
Land	28.70	1.94	0.89	31.52
Managed Soils	4.25	-	70.73	74.98
Rice Cultivation	-	7.83	-	7.83
Total	**32.95**	**109.75**	**80.75**	**223.45**

Table 2.6: Summary of GHG Emissions from the AFOLU Sector (Mt CO2e)

Source: GCISC, 2021

Livestock types including cattle, buffaloes, sheep, goats, camels, horses, mules, donkeys, and poultry are considered for GHGs quantification from enteric fermentation (except poultry which is used for manure management.

Emission estimates show that the Sector emitted 109.12 (48.3% of national emissions) Mt CO2e including 92.17 Mt from enteric fermentation and 16.95 Mt from manure management.

Enteric Fermentation: Livestock population with respective enteric CH_4 emissions are shown in Figure 2. Emission data of different livestock types in Pakistan show that total enteric CH_4 emissions are 92.17 Mt CO2e constituting 84.5% and 41.3% of total livestock and national emissions respectively.

Buffalo is the first largest emitter of CH_4, emitting 43.87 Mt CO2e which is 47.6% of the total enteric CH_4 emissions. Other Cattle is the second largest emitting category after buffalo emitting 18.42 (20%) Mt of CH_4, followed by dairy cows 16.56 (18%) Mt, goats 7.78 (8.4%) Mt and sheep 3.2 (3.5%) Mt of enteric CH_4 emissions. Remaining 2.34 (2.5%) Mt of enteric CH_4 emissions are from camels, horses and mules & asses.

Figure 2.8 shows livestock population in the country and enteric ethane emissions. The data-sets are taken from Agriculture Statistic of Pakistan 2017-18 (MoNFSR, 2018).

Manure Management: Livestock population with corresponding manure CH_4 emissions are shown in Figure 2.9. Emission estimates of different livestock types considered for quantifying emissions from manure management, show that total manure CH_4 emissions are 16.95 Mt of CO2e constituting 15.5% and 7.6% of total livestock and national emissions respectively.

Buffalo is the first largest emitter of CH_4, emitting 6.79 Mt CO2e constituting 40.1% of the total manure CH_4 emissions. Dairy cows are the second largest emitting category after buffalo emitting 3.92 Mt (23.1%) CH_4, followed by other cattle 3.76 Mt (22.2%), goats 0.81 Mt (4.8%), poultry 0.74 Mt (4.4%) and sheep 0.70 Mt (4.1%) of manure CH_4 emissions. Rest 0.24 Mt (1.4%) emissions are from camels, horses and mules & asses.

2.7.3. Land

In the preparation of GHG-I, land is represented and categorized on the basis of its use and management systems as well as stratification of land area by climate, soil and other environmental strata. The estimation is done in accordance with 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006).

The six land-use categories viz. Forest Lands, Croplands, Grasslands, Wetlands, Settlements, and Other Lands. Each land-use category has been further subdivided into land remaining in that category (e.g.,

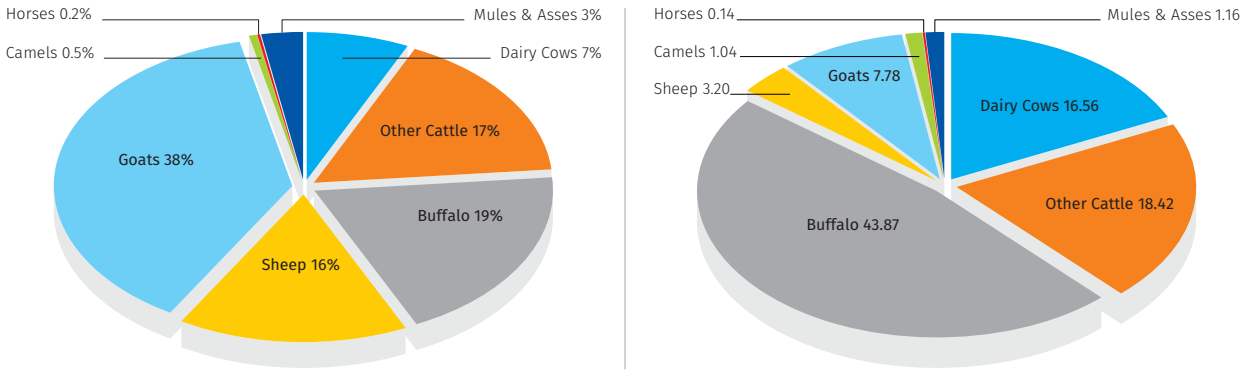

Figure 2.8: Animal Population & Enteric Methane Emissions

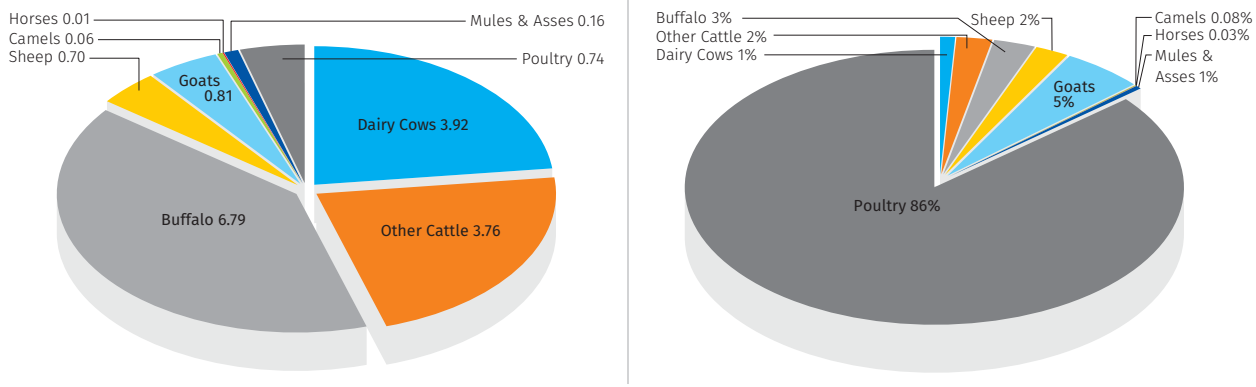

Figure 2.9: Animal Population & Manure Management Emissions

Forest Land Remaining Forest Land). Whilst, land converted from one category to another (e.g., Forest Land converted to Cropland) is not considered in the GHG-I preparation. The area of land under each land-use class is shown in Figure 2.10.

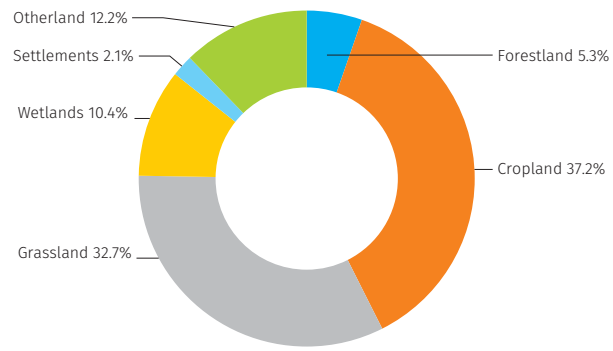

Figure 2.10: Land Use Classification

GHG emissions and removals including CO_2 and non-CO_2 emissions are determined for each specific land-use category. CO_2 is estimated on the basis of carbon stock changes from biomass, dead organic matter and soils, whilst non-CO_2 emissions are estimated from biomass burning.

Overview of Land Sector Emissions: Land Sector emitted 31.52 M CO2e constituting 14.1% of the total national emissions. Net CO_2 emissions are 28.70 Mt followed by 1.94 Mt CH_4 and 0.89 Mt N_2O CO2e as shown in Table 2.7.

Land Class	CO_2	CH_4	N_2O	Total
Total	28.70	1.94	0.89	31.52
Forestland	24.86	0.12	0.10	25.08
Cropland	3.43	1.80	0.69	5.92
Grassland	-	0.01	0.02	0.03
Wetlands	0.41	-	0.09	0.50

Table 2.7: Summary of GHG Emissions from Land Sector (Mt of CO2e)

Source: GCISC, 2021

Forest Land is found as GHG major emitting land-use class among all land classes contributing 25.08 Mt of CO2e (79.6% of total land emissions). Croplands emitting 5.92 (18.8%) Mt emissions is second major emitting class, followed by Wetlands contributing 0.50 (1.6%) Mt and Grassland contributing 0.03 (0.1%) Mt of CO2e emissions.

All CO_2 and non-CO_2 emissions from Land Sector are from four land-use classes only. Although 2% and 12.2% area of Pakistan is under Settlements and Other Land-Uses respectively, but contribution of these land use classes to land emissions is nil.

Forest Land: Forestry Sector plays an important role in the national profile of GHG emissions, while contributing and regulating country's total emissions. For estimating GHG emissions and removals as a result of changes in biomass, dead organic matter and soil organic carbon on Forest Land, carbon stock changes on managed forests due to human activities such as afforestation / reforestation and deforestation,

commercial harvesting and fuelwood cutting in addition to natural disturbances by fire, storms, insects, diseases and other disturbances are taken into account.

For GHG-I purposes, countries are required to consistently apply national definition of managed forests over time covering all forests under influence of human interventions including all forest management practices ranging from forest protection measures, afforestation measures, promotion of natural regeneration, commercial timber production, fuelwood cuttings and abandonment of managed land (IPCC, 2006).

GHG emissions and removals per hectare vary according to site factors, forest or plantation types, stages of stand development and management practices. It is good practice to stratify Forest Land into various sub categories to reduce uncertainty associated with the variation in forests growth rates and other parameters (IPCC, 2006). As a default, the 2006 IPCC Guidelines for National GHG Inventories, use the FAO developed most recent ecological zones and forest cover classification (IPCC, 2006). However, countries are encouraged to use their own detailed classifications subject to the availability and suitability of national data.

For quantifying GHGs emissions and removals from the Forest Land, forests of Pakistan are classified into different types based on classification of Forestrypedia of Pakistan in lines with the FAO classification parameters, in addition to our own national definitions of managed forests. According to Forestrypedia, classification of forests and forest types of Pakistan is done on the bases put forward by FOSBERG 1958 including Physiognomy, Structure, Function, Floristics, Dynamics, Environment and History (Figure 2.11 and Table 2.8).

Forest information, in terms of classification/types, area data, is needed along with climatic region, soil type; ecosystem type; plantation types; stage of stand development and management practices to define forest classes in order to estimate the carbon stocks, and the emission and removal of GHGs associated with Forest Land activities. This information is collected from various national and international sources including Forest Reference Emission Levels/Forest Reference Level and National Forest Monitoring System, Measurement, Reporting and Verification System for REDD+ (MoCC, 2019); Agriculture Statistics of Pakistan 2017-18 (MoNFSR, 2018), Food and Agriculture Organization of the United Nations (FAOSTAT, 2018) and Forestrypedia of Pakistan.

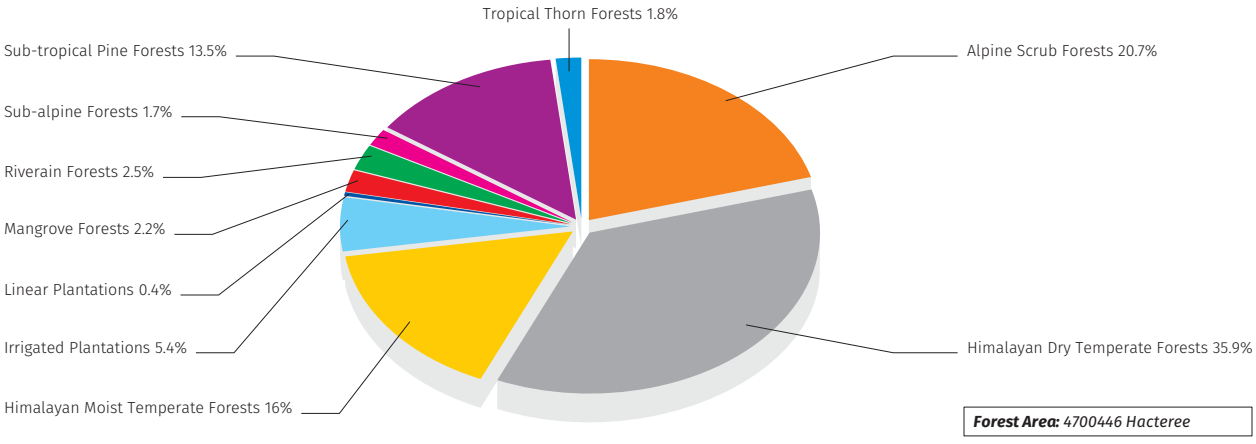

Figure 2.11: Forest Land Use Classification of Pakistan

Forest Types	General Characteristics
Tropical Thorn Forests	These are pronouncedly xerophytic forests occupying an area of 83858 hectares of the whole of the Indus plain except the driest parts. The major tree species are Prosopis cineraria (Jhand), Capparis decidua (Karir, Karil), Zizyphus mauritiana (Ber), Tamarix aphylla (Farash) and Salvadora oleoides (Pilu, wan). Soil texture varies, from flat deep alluvial soils to heavy clays, loams and sandy loams. The climate varies from semi-arid (250-750 mm rainfall) to arid (less than 250 mm rainfall). The summer temperature in this tract is as high as 50° C.
Sub-tropical Pine Forests	These are open inflammable pine forests covering 634387 hectares of land. This type consists of Chir pine (Pinus roxburghii) forests found between 900 m and 1700 m elevation in the Western Himalayas within the range of the south-west summer monsoon. Soil is sandstone and limestone. The rainfall varies from 30 to 50 inches mainly from monsoon in July and August.
Himalayan Moist Temperate Forests	These are evergreen conifers occurring on 750025 hectares between 1500m-3000m elevation in the Western Himalayas. Cedrus deodara (Deodar, diar), Pinus wallichiana, Picea smithiana and Abies pindrow (Partal). The soil is loamy and acidic due to being humus rich. The climate is long and severe winters but short summers.
Himalayan Dry Temperate Forests	These are open evergreen forests on 1686338 hectares at the height of 5000-10,000 feet. Both coniferous and broad-leaved species are present. Dry zone deodar, Pinus gerardiana (Chalghoza) and/or Quercus ilex are the main species. The climate is with long severe winters, snow and hailstorms but with mild summers. The mean annual rainfall varies from 13 to 20 inches.
Sub-alpine Forests	These evergreen conifers with broad-leaved trees are occurring on 80911 hectares throughout the Himalayas at about 3,350 m. Abies spectabilis and Betula utilis are the typical species with dwarf junipers. Climate is cold with rainfall ranges between 660mm and 900mm.
Alpine Scrub Forests	These shrub formation forests are extending 150 m or more above the sub-alpine forests on an area of 971949 hectares. The characteristic genera are Salix, Lonicera (Phut), Berberis (Sumbul, Sumblue), Cotoneaster with Juniperus and occasionally Rhododendron or Ephedra (Asmania). The climate is similar but more severe than sub-alpine forests with heavy snow.
Riverain Forests	Riverain forests are located in the floodplains of major rivers of Sindh and Punjab Province on an area of 119337 hectares. Dalbergia sissoo, Morus alba and Cannabis sativa are the dominant species of Punjab. Whilst, Acacia nilotica, Prosopis spicigera, Populous euphratica and Tamarix aphylla are dominant species in Sindh. The soil is moist, deep and loamy. Climate is hot throughout the year.
Irrigated Plantations	These plantations are on 253900 hectares' area over the plains of Pakistan. Dalbergia sissoo, Acacia nilotica, Morus alba, Populus deltoids, Eucalyptus camaldulensis, Ailanthus excelsa/Altisima, Albizzia lebbek and Cedrela toona are main species. The soil varies from sand dunes to heavy clay. The climate is extremely dry hot with average annual rainfall below 10 inches.
Mangrove Forests	These mangroves forests cover 102741 hectares in the Arabian sea around the coast of Karachi and Pasni in Balochistan. The main species is Avicennia marina (99%). The soil is soft and silty. The climate is humid with average rainfall is 221.2 mm falls in Monsoon season.
Linear Plantations	These are roadside, canal side and railway tract plantations covering 17000 hectares of land. The choice of species is made on the basis of the ecological zones and availability of water. White-stemmed trees e.g. Albizia procure or Terminalia arjuna are dominant species.

Table 2.8: Forest Types and Characteristics

Based on the collected information, IPCC provides guidance on the use of three generic approaches. Approach 1 classifies the total area for each individual land-use category within a country, but does not provide detailed information on the nature of conversions between land uses. Approach 2 introduces tracking of conversions between land-use categories. Approach 3 extends the information available in Approach 2 by allowing land-use conversions to be tracked on a spatially explicit basis (IPCC, 2006). Parties may use any or mix of Approaches for different regions over time.

In case of Pakistan, Approach 1 is used in making best use of available data and reducing, as far as practicable, possible overlaps and omissions in emission and removal estimations and their reporting. Approach 1 allows appropriate use of data of different forest types for preparing GHG-I of Pakistan.

Overview of Forest Land Emissions: Forest Land emitted 25.08 Mt of CO2e emissions, constituting 79.6% of the total land emissions. Total CO_2 emissions are 57.54 Mt with removals of 32.68 Mt of CO2e. Net CO2e (after removals) are 24.86 Mt followed by CH_4 emissions of 0.12 Mt and N_2O emissions of 0.10 Mt of CO2e (Table 2.9).

Linear Plantation is found as major emitting forest type contributing 10.59 Mt of CO2e emissions, constituting 42.2% of total forest land emissions. Riverain Forests emitting 10.26 (40.9%) Mt emissions is second major emitting type, followed by Tropical Thorn Forests contributing 8.68 (34.6%) Mt, Irrigated Plantations contributing 6.17 (24.6%) Mt, Alpine Scrub Forests contributing 4.50 (17.9%) Mt, and Sub-alpine Forests contributing 0.81 (3.2%) Mt of CO2e emissions. In case of removals, Himalayan Dry Temperate Forests is the forest type contributing major share of 9.95 Mt of CO2e, constituting 30.4% of total removals (32.68 Mt) followed by 3.67 Mt (11.2%) by Himalayan Moist Temperate Forests, 1.67 Mt (5.1%) by Sub-tropical pine forests and 0.64 Mt (1.96%) by Mangrove Forests.

Forestland CO_2 Emissions and Removals: CO_2 emissions and removal estimated on the basis of carbon stock changes are shown in Figure 6. All forest types in the Forest Land emitted 57.54 Mt of CO_2 emissions and removed 32.68 Mt of CO_2 with net CO_2 emissions of 24.84 Mt. Linear Plantations forest type is again ranked first in emitting higher CO_2 emissions of 10.58 Mt accounting for 42.6% of total net-CO_2 emissions (24.86 Mt), followed by 10.26 Mt (41.3%) by Riverain Forests, 8.67 Mt (34.9%) from Tropical Thorn Forests, 6.13 Mt (24.6%) from Irrigated Plantations, 4.43 Mt (17.8%) from Alpine Scrub Forests, and 0.81 Mt (3.3%)

Forest Type	CO_2	CH_4	N_2O	Total
Total	24.86	0.12	0.10	25.08
Alpine Scrub Forests	4.428	0.040	0.033	4.50
Himalayan Dry Temperate Forests	-9.997	0.024	0.020	-9.95
Himalayan Moist Temperate Forests	-3.694	0.011	0.009	-3.67
Irrigated Plantations	6.126	0.025	0.020	6.17
Linear Plantations	10.584	0.002	0.001	10.59
Mangrove Forests	-0.637	-	-	-0.64
Riverain Forests	10.262	0.001	0.001	10.26
Sub-alpine Forests	0.811	0.001	0.001	0.81
Sub-tropical Pine Forests	-1.689	0.009	0.007	-1.67
Tropical Thorn Forests	8.669	0.007	0.006	8.68

Table 2.9: Summary of GHG Emissions and Removals from Forest Land (Mt of CO2e)

from Sub-alpine forests. In case of removals, Himalayan Dry Temperate Forest type is ranked first in sequestering CO_2 emissions of 9.99 Mt accounting for 30.6% of total CO_2 removals, followed by 3.69 Mt (11.3%) from Himalayan Moist Temperate Forests, 1.69 Mt (5.2%) from Sub-tropical Pine Forests and 0.64 Mt (1.9%) from Mangrove Forests.

Forestland Non-CO_2 Emissions: Non-CO_2 emissions of 0.22 Mt of CO2e (including CH_4 and N_2O) estimated from biomass burning of each forest type in the Forest Land are shown in Figure 2.13. All forest types except Mangroves contributed in non-CO_2 emissions from their biomass burning.

Figure 2.12: Forest Land CO_2 Emissions and Removals (Mt of CO_2)

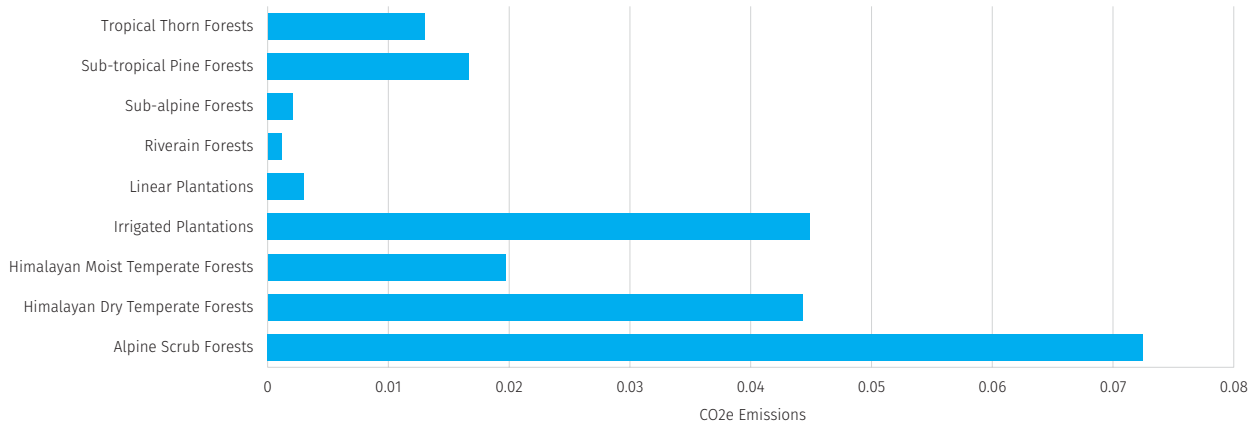

Figure 2.13: Forest Land Non-CO_2 Emissions (Mt of CO2e)

Alpine Scrub Forest type is ranked first in emitting non-CO_2 emissions of 0.072 Mt of CO2e accounting for 33.4% of total non-CO_2 emissions. Irrigated Plantation type is ranked second emitting 0.045 Mt (20.7%) followed by 0.044 Mt (20.4%) from Himalayan Dry Temperate Forests, 0.02 Mt (9.1%) from Himalayan Moist Temperate Forests, 0.017 Mt (7.7%) from Sub-Tropical Pine Forests and 0.013 Mt (6%) from Tropical Thorn Forests. The remaining 0.006 Mt (2.8%) are from Linear, Sub-alpine and Riverain Forests.

2.7.4. Croplands

Croplands comprise of arable and tillable land, rice fields, and agroforestry systems where the vegetation structure falls below the thresholds used for the Forest Land category, and is not expected to exceed those thresholds at a later time (IPCC, 2006). All types of annual and perennial crops as well as temporary fallow land are included in Cropland. Annual crops include cereals, cash crops, pulses, condiments, oils seeds, vegetables, root crops and forages. The arable land which is temporarily being used for forages or grazing as part of annual crop-pasture rotation is also included in annual crops. Whilst, perennial crops are trees and shrubs, in combination with herbaceous crops (known as agroforestry) or as orchards, vineyards and plantations such as tea and bananas.

For estimating the carbon stocks, and the emissions and removals of GHGs associated with Cropland activities, the Cropland of Pakistan is classified into different types based on: climatic region; soil type; ecosystem type; plantation type; stage of stand development; and, management practices (Figure 2.14).

Crop information / data are needed in terms of classification / types, climatic region, soil type and ecosystem type. GHG estimation process consists of data collected from various national and international sources including Agriculture Statistics of Pakistan 2017-18 (MoNFSR, 2018) and Food and Agriculture Organization of the United Nations (FAOSTAT, 2018).

Overview of Cropland Emissions: Cropland emitted 5.92 Mt of CO2e emissions, constituting 18.8% of the total land emissions. Total CO_2 emissions are 3.43 Mt followed by CH_4 emissions of 1.80 Mt and N_2O emissions of 0.69 Mt of CO2e (Table 2.10).

Crop Type	CO_2	CH_4	N_2O	Total
Total	3.43	1.80	0.69	5.92
Agroforestry Systems	0.18	-	-	0.18
Fruit Orchards	2.89	-	-	2.89
Banana Plantation	0.12	-	-	0.12
Tea Plantation	0.25	-	-	0.25
Crop Residue Burning	-	1.80	0.69	2.49

Table 2.10: Summary of GHG Emissions & Removals from Cropland (Mt of CO2e)

Source: GCISC, 2021

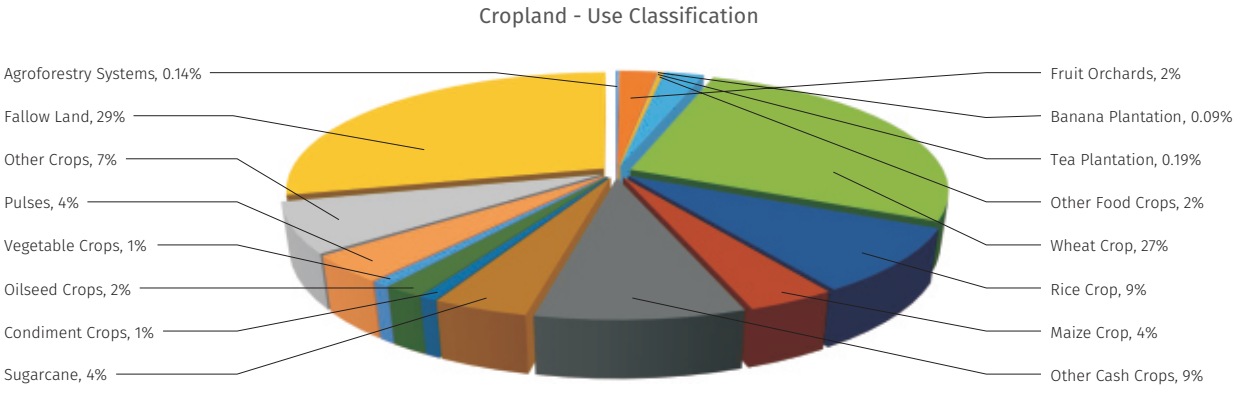

Figure 2.14: Cropland Classification of Pakistan

Fruit Orchards are ranked first in emitting major chunk of emissions from Cropland, i.e., 2.89 Mt of CO2e emissions, constituting 48.8% of total Cropland emissions. Crop Residue Burning emitting 2.49 Mt (42.1%) is the second major emitting type followed by Tea Plantation emitting 0.22 Mt (4.2%), Agroforestry Systems emitting 0.18 Mt (3%) fand Banana Plantation emitting 0.12 Mt (2%) of CO2e emissions.

Cropland CO_2 Emissions: CO_2 emissions estimated on the basis of carbon stock changes are shown in Figure 2.15. All crop types in the Cropland emitted 3.43 Mt of net-CO_2 emissions. Fruit Orchards is the higher emitting type (84.3%) of total CO_2 Cropland emissions, followed by 7.3% from Tea Plantations, 5.25% from Agroforestry Systems and 3.5% from Banana Plantation.

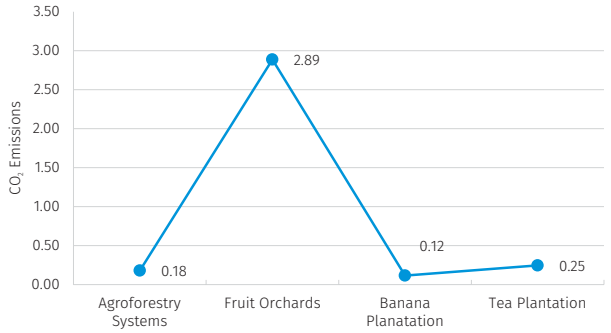

Figure 2.15: Cropland CO_2 Emissions and Removals (Mt of CO2e)

Cropland Non-CO_2 Emissions: Non-CO_2 emissions of 2.49 Mt of CO2e (including CH_4 and N_2O) estimated from residual burning of four crop types in the Cropland including wheat, rice, maize and sugarcane are shown in Figure 2.16.

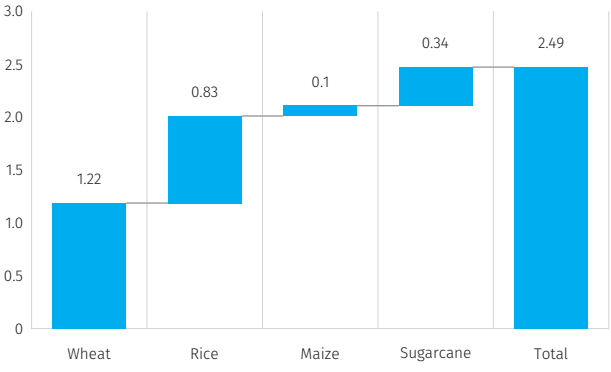

Figure 2.16: Cropland Non-CO_2 Emissions (Mt of CO2e)

Wheat crop contributed major share to the emissions from burning of crop residues by emitting 1.22 Mt of CO2e, accounting for 49% of the total emissions from residue burning. Rice after Wheat is the second largest contributor by emitting 0.83 Mt (33%) of emissions followed by 0.34 Mt (13.6%) of emissions from sugarcane and 0.10 Mt (4%) of emissions from maize crop.

Grasslands: Grasslands are the ecosystems with tree canopy cover less than a threshold defined for forests, which varies under changing climate of different regions. Grasslands can be classified on their degree and intensity of management, ranging from extensively managed rangelands and savannahs with animal stocking rates and fire regimes as management variables, to intensively managed pasture lands. Grasslands can be recognized with perennial grasses as dominant vegetation cover and grazing as land use (IPCC, 2006).

For Grasslands remaining under land-use of grasslands for more than 20 years, carbon emissions and removals are based on estimating the effects of changes in management practices on carbon stocks. Therefore, preparing a GHG-I for the land-use category Grassland Remaining Grassland involves estimation of changes in carbon stock from carbon pools under the effect of different management practices. The principal sources of emissions and removals of greenhouse gases in this category are associated with grassland management and changes in management (IPCC, 2006).

For estimating the carbon stocks, and the emissions and removals of GHGs associated with Grassland activities, the Grasslands of Pakistan are classified into different types based on climatic region, soil type, vegetation type and management practices. The important rangelands and pastures of Pakistan are further subdivided as degraded and non-degraded (ND) which include Alpine Pastures, Degraded and ND Rangelands of Punjab, Sindh, Khyber Pakhtunkhwa (KP), Balochistan, Gilgit-Baltistan (G-B) and Azad Jammu & Kashmir (AJ&K) (Figure 2.17).

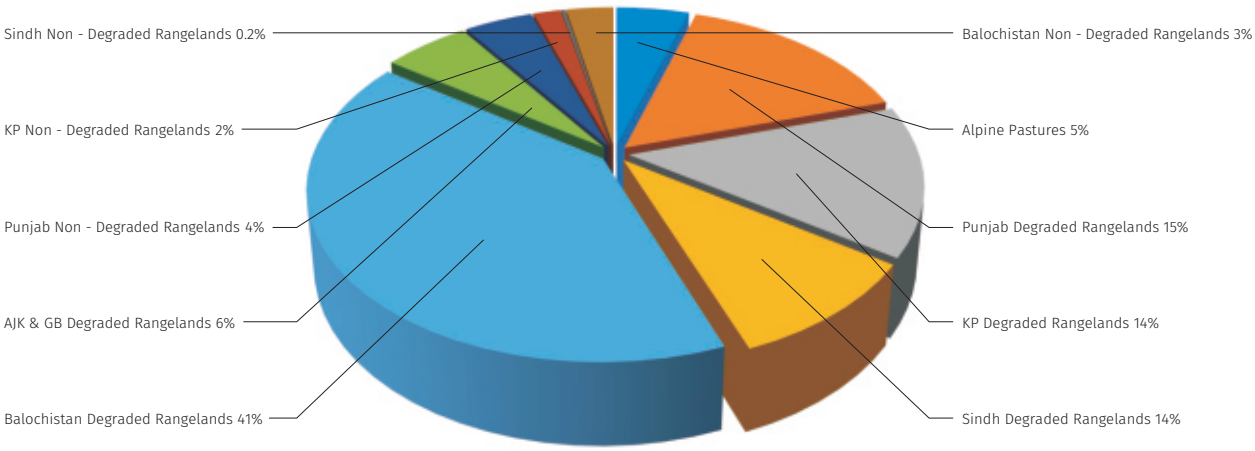

Figure 2.17: Grassland Classification of Pakistan

Grassland information, in terms classification/types, area and biomass burning data along with climatic region, soil and vegetation type for GHG estimation process is collected from FAO's Forestry Sector Review of Pakistan (FAO, 2019) and FAOSTAT (FAOSTAT, 2018).

Overview of Grassland Emissions: Grassland emitted 0.028 Mt of CO2e emissions, constituting 0.09% of the total land emissions. All emissions are non-CO_2 including CH_4 emissions of 0.012 Mt and N_2O emissions of 0.016 Mt of CO2e. The net CO_2 emissions from Grassland are zero as the CO_2 emissions as grass cutting in one year equals CO_2 removals due to growth in the following year (Table 2.11).

Grassland Type	CH_4	N_2O	Total
Total	**0.012**	**0.016**	**0.028**
Alpine Pastures	0.00007	0.00009	0.0002
Punjab Degraded Rangelands	0.00385	0.00518	0.0090
Sindh Degraded Rangelands	0.00385	0.00518	0.0090
Baluchistan Degraded Rangelands	0.00385	0.00518	0.0090
KP Degraded Rangelands	0.00007	0.00009	0.0002
AJK & G-B Degraded Rangelands	0.00007	0.00009	0.0002

Table 2.11: Summary of GHG Emissions from Grassland (Mt of CO2e)

Source: GCISC, 2021

All non- CO_2 emissions are estimated on the basis of biomass burnt by wildfires under each grassland type. Area of the rangeland burnt under temperate climatic region for the GHG-I year is equally allocated to three grassland types falling under this climatic region including Alpine Pastures, KP Degraded Rangelands and AJK & G-B Degraded Rangelands; therefore, these three Grassland types emitted equal quantity of non-CO_2 GHGs. Each of these types contributed 0.0002 Mt of CO2e emissions to the aggregated emissions of 0.0006 Mt by these three types, which accounts for 2.14% of total emissions from Grassland.

Similarly, total area of Savanna, Open Shrubland, Closed Shrubland and Woody Savanna burnt under tropical and subtropical regions of the country including Punjab, Sindh and Balochistan is equally allocated to the Punjab Degraded Rangelands, Sindh Degraded Rangelands and Balochistan Degraded Rangelands. Therefore, each of these Grassland types emitted 0.009 Mt of CO2e emissions to the aggregated emissions of 0.027 Mt by these three types, which accounts for 94% of total emissions from Grassland of Pakistan (Figure 2.18).

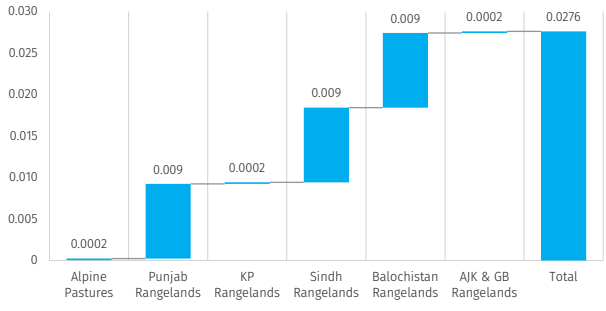

Figure 2.18: Grassland Non-CO_2 Emissions (Mt of CO2e)

2.7.5. Wetlands

Wetlands include any land saturated with water for all or part of the year. Wetlands are ecosystems which emit and remove GHGs as a result of the bio-geochemical processes taking place in them. The oxygen availability or water saturation as well as climate and nutrient availability affect the GHG emissions by controlling these bio-geochemical processes (IPCC, 2006). The aerobic conditions by wetland drainage promotes CO_2 (due to increased oxidation of organic matter) and N_2O emissions and reduces CH_4 emissions. Whilst, wetlands creation results in increased CH_4 emissions (due to anaerobic conditions) and reduced CO_2 emissions (IPCC, 2006). Therefore, Wetlands can result in the emission of both CO_2 and CH_4 depending on climatic conditions and reservoir characteristics.

According to Ramsar Convention (Ramsar, 1996), wetlands can be classified on ecological basis. This classification may include even those lands as wetlands which are disturbed by human activities or artificially built. The wetlands classification adopted by the Ramsar Convention is widely used to address management issues.

The Pakistan Wetlands Programme has classified all wetlands into five major categories based on the classification of Ramsar Convention (Figure 2.19). These classes include Inland Waters (85%), Lakes & Reservoirs (5%), Fish Farms & Ponds (4%), Delta Marshes (3%), and Swamps (3%).

Overview of Wetlands Emissions: Wetlands emitted 0.5 Mt of CO2e, constituting 1.57% of the total land emissions. In Wetland emissions, CO_2 emissions are 0.41 Mt and N_2O emissions are 0.09 Mt of CO2e.

Lakes and Reservoirs are major contributor emitting 0.17 Mt of CO2e emissions that account for 34% of total Wetland emissions. Fish Farms and Ponds are ranked second highest emitting category with 0.12 Mt (24%) of emissions followed by Delta Mashes with 0.11 Mt (21.7%) and Swamps with 0.10 Mt (20%) of CO2e emissions

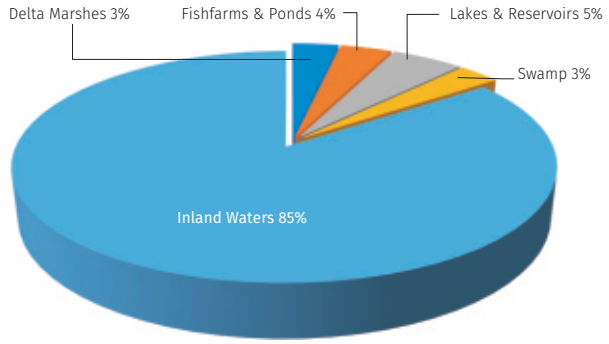

Figure 2.19: Wetland Classification of Pakistan (% Area)

Wetland Type	CO_2	N_2O	Total
Total	**0.41**	**0.09**	**0.5**
Fish Farms and Ponds	0.10	0.021	0.12
Lakes and Reservoirs	0.14	0.03	0.17
Delta Marshes	0.09	0.019	0.11
Swamp	0.08	0.018	0.10

Table 2.12: Summary of GHG Emissions from Wetlands (Mt of CO2e)

Source: GCISC, 2021

Wetlands CO_2 Emissions: CO_2 emissions of 0.41 Mt estimated from Wetlands are shown in Figure 2.20. Lakes & Reservoirs have major share of emissions by emitting 0.14 Mt of CO_2 emissions that account for 34% of the total CO_2 emissions from Wetlands. Fish farms & Ponds after Lakes & Reservoirs is the second largest emitting category contributing 0.10 Mt (24.4%) of emissions followed by Delta Marshes with 0.09 Mt (22%) and Swamps with 0.08 Mt (19.5%) of CO_2 emissions. Inland Waters categorized as flood lands are not contributing any emission.

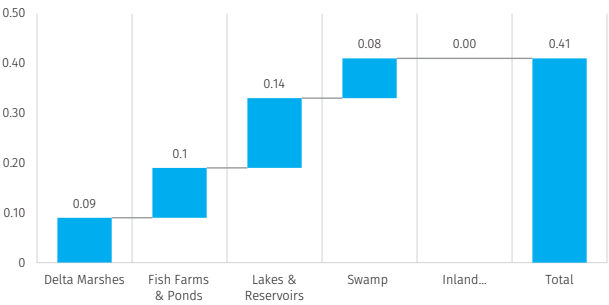

Figure 2.20: CO_2 Emissions (Mt) from Wetlands

Wetlands Non-CO_2 Emissions: Wetlands' non-CO_2 emissions of 0.088 Mt CO2e are estimated from different types of wetlands as shown in Figure 2.21.

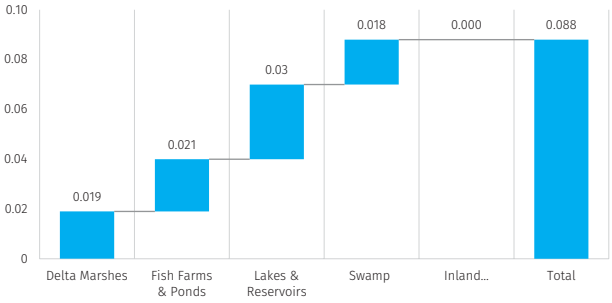

Figure 2.21: Wetlands Non-CO_2 Emissions (Mt of CO2e)

In case of non-CO_2 emissions, Lakes & Reservoirs are again major contributor with 0.03 Mt of CO2e, which accounts for 34% of total N_2O emissions from Wetlands. Fish Farms & Ponds, Delta Marshes, and Swamp are second, third and fourth major emitters, respectively contributing 0.02 (23%), 0.019 (21.6%) and 0.018 (20%) Mt of CO2e emissions of N_2O.

2.7.6. Managed Soils

Managed Soils are all soils on land, including Forest Land, Cropland, Grassland and Agricultural Soils. Managed Soils are a source of GHG emissions including direct & indirect N_2O emissions from additions of N to land due to deposition and leaching, and emissions of CO_2 following additions of liming materials and urea-containing fertilizer.

The emission of these GHGs from Managed Soils depends on the way they are being managed. N_2O is produced naturally in soils through the processes of nitrification and denitrification. One of the main controlling factors in this reaction is the availability of inorganic N in the soil, which is either due to human-induced additions (in the form synthetic or organic fertilizers, deposited manure, crop residues, sewage sludge), or of mineralization of N in the soil organic matter following drainage/management of organic soils, or cultivation/land-use change on mineral soils (IPCC, 2006). The emissions of N_2O from human-induced N additions or its mineralization occur through both direct and indirect pathways. Direct emissions are from the soils to which N is added/released, while indirect emissions occur through two different pathways: i) following volatilization of NH_3 and NO_X from Managed Soils and from fossil fuel combustion and biomass burning, and the subsequent redeposition of these gases and their products NH_4+ and NO_2- to soils and waters; and (ii) after leaching and runoff of N, mainly as No_3, from managed soils (IPCC, 2006).

As Managed Soils are all soils on land, therefore the GHGs quantification methods are based on carbon pools and fluxes that can occur in all the different land-use categories. In Pakistan, like many countries, only national aggregate (i.e., non-land use specific) data are available, therefore methodology based on generic information at national level is applied in this GHG-I compilation. The aggregated national data of amount of lime, dolomite and urea application along with synthetic fertilizers consumption are taken from Pakistan Economic Survey 2017-18 (MoF, 2018), Agriculture Statistics of Pakistan 2017-18 (MoNFSR, 2018) and FAO (FAOTSTAT, 2018).

Overview of Managed Soils Emissions: Managed Soils with 74.9 Mt of CO2e emissions constitute 33.5% of the total emissions from the AFOLU Sector, of which 4.25 Mt are CO_2 and 70.7 Mt are N_2O emissions as shown in Table 2.13.

Source/Emission Type	CO_2	N_2O	Total
Total	**4.25**	**70.7**	**74.9**
Urea Application	4.25	-	4.25
Direct N_2O Emissions	-	45.7	45.7
Indirect N_2O Emissions	-	25.0	25.0

Table 2.13: Summary of GHG Emissions from Managed Soils (Mt of CO2e)

Source: GCISC, 2021

It can be seen that direct N_2O emissions are 45.7 Mt of CO2e which accounts for 61% of the total emissions from Managed Soils followed by Indirect N_2O emissions of 25 Mt (33.4%) and 4.25 Mt (5.7%) of CO_2 emissions from Urea application (Figure 2.22).

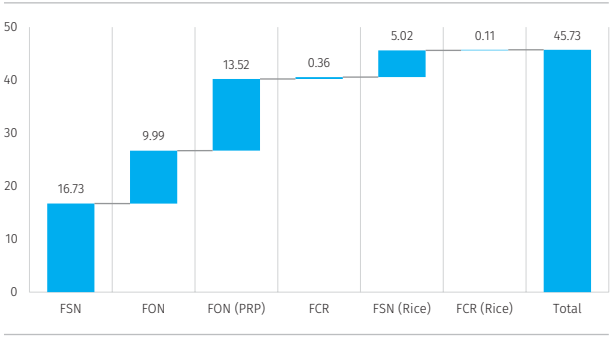

Figure 2.22: Direct N_2O Emissions (Mt) from Managed Soils

Non-CO_2 Emissions from Managed Soils: Managed Soils emit a major chunk of non-CO_2 emissions including both direct and indirect N_2O emissions.

Direct N_2O Emissions from Managed Soils: Direct N_2O emissions from Managed Soils are 45.73 Mt of CO2e constituting 61% of total soil emissions (Figure 2.22). Nitrogen applications including Inorganic N (from synthetic N fertilizers), Organic N (from manure), Animal N (from pasture, range and paddock and N from Crop Residues etc., on the Managed Soils are the major source of direct N_2O emissions.

Synthetic N Fertilizers (FSN) emitting 16.73 Mt of N_2O emissions are the highest emissions contributor which accounts for 36.6% of total direct emissions from Managed Soils. Organic N Fertilizers, FON (PRP), from grazing animals on pastures are the second highest emissions contributor which emit 13.53 Mt (29.6%) of N_2O emissions followed by Organic N Fertilizers (FON) from animal manure contributing 9.99 Mt (21.8%) of emissions. Remaining 5.49 Mt (12%) are from application of synthetic N fertilizers and crop residue in rice fields and other managed soils.

Indirect N_2O Emissions from Manure Management and Managed Soils: Indirect N_2O emissions from Managed Soils due to manure management and other sources are 25 Mt of CO2e constituting 33.4% of total soil emissions). They occur in two pathways.

i. From atmospheric deposition of N volatilized from agriculture inputs of N (synthetic N fertilizers; organic N applied as fertilizer; urine and dung N deposited on pasture, range and paddock by grazing animals).

ii. From N leaching/runoff (i.e. synthetic N fertilizers; organic N applied as fertilizer; urine and dung N deposited on pasture, range and paddock by grazing animals; N in crop residues and N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils).

Indirect emissions from Manure Management occur due to N loss from Manure Management Systems in the form of N volatilization, leaching and runoff. (Figure 2.23).

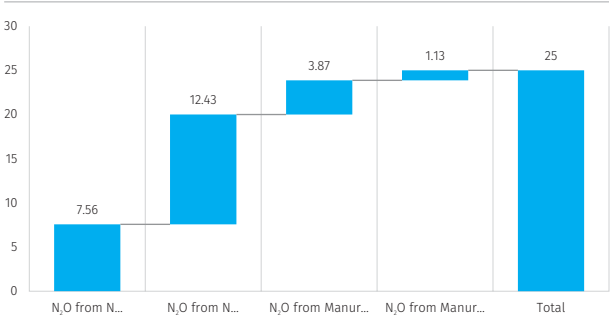

Figure 2.23: N_2O Emissions from Managed Soils & Manure Management (Mt)

N_2O emissions from Managed Soils due to N-leaching/runoff are highest indirect emissions accounting for 12.43 Mt (49.7% of total indirect emissions) of CO2e followed by N-Atmospheric deposition with emissions of 7.56 Mt (30%). In case of Manure Management, N-Volatilization with emission of 3.87 Mt (15.5%) is the major source of N_2O emissions followed by N-Leaching and Runoff with emissions of 1.13 (4.5%) Mt of CO2e.

2.7.7. Rice Cultivation

Rice cultivation is source of CH_4 emission through anaerobic decomposition of organic material in flooded rice fields by methanogenic bacteria. This methanogenic process is called as methanogensis. The CH_4 produced during this process escapes to the atmosphere primarily by transport through rice plants (i.e., diffusion). Some CH_4 also bubbles out directly from impounded water in the rice fields.

The annual amount of CH_4 emitted from a given area of rice is a function of the number and duration of crops grown, water regimes before and during cultivation period, and organic and inorganic soil amendments. Soil type, temperature, and rice cultivar also affect CH_4 emissions (IPCC, 2006).

The CH_4 emissions from rice cultivation in Pakistan, are estimated by multiplying the seasonally integrated emission factor for continuously flooded rice without organic amendment from 2006 IPCC Guidelines for GHG inventories (IPCC, 2006) by the annual harvested rice area.

In 2017-18, rice was cultivated on 2.90 million hectares using water management practices, where rice is intermittently flooded and aerated singly, producing CH_4 emissions of 7.83 Mt of CO2e accounting for 3.5% of total emissions from the AFOLU Sector.

2.8. Waste Sector

The Waste Sector is responsible for emission of CO_2, CH_4 and N_2O from following categories:

- Solid waste disposal
- Biological treatment of solid waste
- Incineration and open burning of waste
- Wastewater treatment and discharge

Typically, CH_4 emissions from solid waste disposal sites (SWDS); wastewater handling (Treatment) & discharge and incineration and open burning of waste are the largest among GHG emissions from the Waste Sector. Incineration and open burning of waste, besides producing CH_4 and N_2O, is the source of CO_2 emissions especially when waste with fossil carbon (plastics) is burnt. The other sources of CO_2 emissions may also include SWDS, wastewater treatment and burning of non-fossil waste. But this CO_2 is not reported due to its biogenic origin. N_2O is mostly produced during solid and wastewater treatments, where it depends on the type and conditions during the treatment (IPCC, 2006).

Some other gases including non-methane volatile organic compounds (NMVOCs), NO_x and CO as well as NH_3 can also be produced during waste and wastewater treatment and discharge. However, specific methodologies for the estimation of these gases are not included in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. These NO_x (produced during waste burning) and NH_3 (produced during waste composting) can be the source of indirect N_2O emissions, but overall, the indirect N_2O from the Waste Sector are likely to be insignificant, therefore not reported usually (IPCC, 2006).

In Pakistan for the year 17,931,360 tonnes of solid waste is generated at the rate of 0.65 kg/capita/day, of which 10,758, 810 (60% of generated waste) tonnes is deposited to SWDS. The percentage of solid waste generated and sent to SWDS is assumed to be 60 percent (Kawai and Tasaki, 2016 and GCISC, 2015).

2.8.1. Overview of GHG Emissions from The Waste Sector

Waste Sector produced 24.17 Mt of CO2e emissions constituting around 5% of the total national emissions, of which 19.29 Mt are CH_4, 2.45 Mt are N_2O and 0.07 Mt are CO_2 emissions (Table 2.14).

Source Category	CO_2	CH_4	N_2O	Total
Total	0.070	19.20	2.45	21.72
Solid Waste Disposal	-	10.23	-	10.23
Waste Incineration & Open Burning	0.070	0.005	0.017	0.092
Wastewater Treatment & Discharge	-	8.962	2.44	11.40

Table 2.14: GHG Emissions from Waste Sector

Source: GCISC, 2021

Wastewater Treatment & Discharge is the dominant source of emissions producing 11.40 Mt CO2e, which accounts for 52.5% of total waste's emissions, followed by 10.23 (47.1%) Mt from Solid Waste Disposal (SWD). The remaining 0.092 (0.42%) Mt CO2e emissions are from Waste Incineration & Open Burning (Figure 2.24).

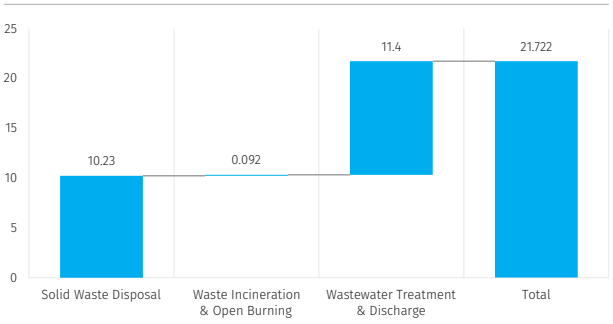

Figure 2.24: CO2e Emissions from the Waste Sector (Mt)

2.8.2. Solid Waste Disposal

This corresponds to the solid waste disposed to SWDS. The SWDS are the main source of CH_4 generation and emission through anaerobic decomposition of solid waste. In Pakistan, Municipal Corporations systematically collect almost 60% of urban waste (called as Municipal Solid Waste) and disposed at SWDS, where its decomposition by anaerobic reactions results in CH_4 emissions. While, in rural areas, waste is neither collected nor dumped, but scattered by the rural people in their fields. As scattered waste is decomposed in aerobic conditions, therefore no CH_4 is produced. Municipal Solid Waste in urban Pakistan is disposed in landfills by means of open dumping and burning.

The rate of generation and disposal of MSW varies in different cities. The estimation of CH_4 emissions from MSW at national level is uncertain due to lack of year wise data on MSW generation. In the present methodology of GHG estimation, total annual MSW generation has been estimated by multiplying MSW generation rate (which is 0.65 kg/capita/day) with urban population.

2.8.3. Incineration and Open Burning of Waste

Waste usually burned either to generate energy or to manage. This burning of waste results in the emissions of GHGs, of which emissions from waste burned as a management practices are only included in the Waste Sector. Whilst, those produced from waste burned for energy purposes are reported in the energy sector. Three main GHGs that are produced in this burning process include:

- CO_2, which is a result of burned waste with fossil carbon (plastics)
- CH_4, which is a result of incomplete combustion process
- N_2O, which is produced indirectly at low combustion temperatures

In the quantification of GHG emissions from incineration and open burning of waste, it is assumed that 10% (909,853.75 tonnes) of the waste generated by nine major cities of Pakistan (including Karachi, Hyderabad, Lahore, Rawalpindi, Multan, Gujranwala, Sialkot, Bahawalpur and Faisalabad, where waste is collected and managed by waste management companies) is incinerated. In case of open burning, it is assumed that 10% (717,254.2 tonnes) of the uncollected urban waste is openly burned.

2.8.4. Overview of GHG Emissions from Waste Incineration and Open Burning

Incineration and Open Burning of Waste produced 0.0927 Mt of CO2e emissions constituting 0.42% of total emissions from the Waste Sector, of which 0.070 Mt are CO_2, 0.005 Mt are CH_4 and 0.017 Mt are N_2O emissions (Table 2.15).

Source Category	CO_2	CH_4	N_2O	Total
Total	0.0708	0.005	0.017	0.0928
Waste Incineration	0.0707	0.0045	0.017	0.092
Waste Open Burning	0.0001	0.0003	0.0001	0.0005

Table 2.15: Summary of GHG Emissions from Waste Incineration & Open Burning (Mt of CO2e)

Source: GCISC, 2021

Waste Incineration is the dominant source of emissions producing 0.092 Mt CO2e, which accounts for 99.1% of total waste's emissions from incineration and open burning, followed by 0.0005 (0.54%) Mt from open burning of waste.

In 0.0005 Mt emissions from open burning, CH_4 with 0.0003Mt emissions is found as major GHG followed by CO_2 with 0.0001 Mt and N_2O with 0.0001 Mt of CO2e emissions (Figure 2.25). The 0.092 Mt of emissions from waste incineration include large quantity of CO_2 emissions (i.e., 0.071 MT) followed by 0.017 Mt of N_2O and 0.005 Mt of CH_4 emissions (Figure 2.26).

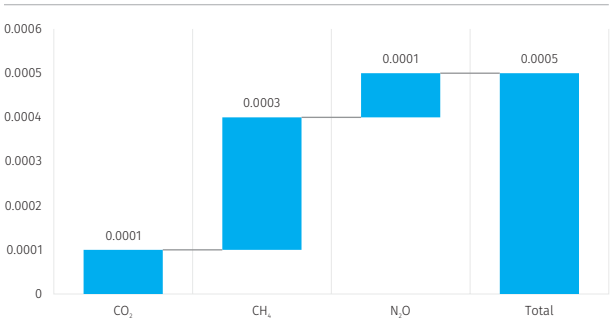

Figure 2.25: Emissions from Open Burning of Waste

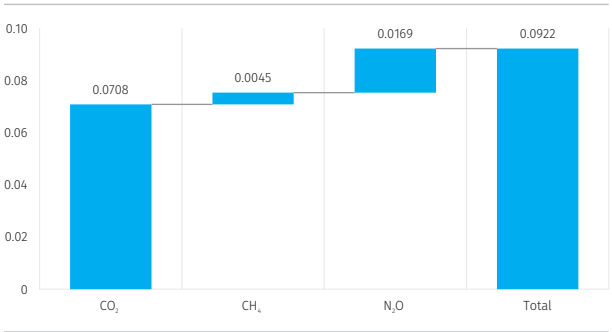

Figure 2.26: CO2e Emissions from Waste Incineration

2.9. Wastewater Treatment and Discharge

In Pakistan, domestic, commercial and industrial sector uses produce large quantities of wastewater on daily basis. This wastewater may be treated on site without collection, collected at centralized plant for treatment or disposed as untreated. When wastewater is treated or disposed anaerobically, CH_4 is produced. In this category, following estimates have been made:

- CH_4 and N_2O emissions from domestic wastewater
- CH4 emissions from industrial waste water

2.9.1. Overview of GHG Emissions from Wastewater

Wastewater & discharge is responsible for 11.40 Mt CO2e emissions accounting for 47.2% of total emissions from the Waste Sector, of which 8.96 Mt are CH_4 and 2.44 Mt are indirect N_2O emissions (from wastewater containing human sewage) (Table 2.16).

Activity	CH_4	N_2O	Total
Total	**8.96**	**2.44**	**11.40**
Domestic Wastewater & Discharge	7.34	2.44	9.78
Industrial Wastewater & Discharge	1.62	-	1.62

Table 2.16: Summary of GHG Emissions from the Wastewater (Mt of CO2e)

Source: GCISC, 2021

Domestic wastewater & discharge is responsible for emitting 9.78 (85.8%) Mt CO2e emissions followed by 1.62 (14.2%) Mt emissions from industrial wastewater & discharge. Major chunk of CH_4 emissions after SWD is from domestic wastewater & discharge (7.34 Mt CO2e). Industrial wastewater & discharge produce very little CH_4 emissions (1.62 Mt CO2e).

3. Future Perspective

3.1. GHG MRV System (Emission Factors – Switching to Tier 2 & Tier 3)

Though the present inventory has been developed using the more elaborate and refined IPCC 2006 Guidelines in the light of Katowice decision yet the country faces the challenges of incomplete data lacking credibility data. Further the country- specific GHG emission factors (Tier 2 and 3) are not available which are essential to get the precise estimates of GHG emissions in the country. However, the studies are going on particularly for Methane emissions from rice and Livestock sectors. Pakistan has recently submitted the Forest Reference Emissions Levels (FRELs) to UNFCCC. Still a lot needs to be done for the development of Tier 2 & 3 GHG emission factors.

3.2. GHG MRV System

A national GHG inventory is a central tool for planning and tracking overall national mitigation measures, combined with integrated projections and scenario analysis efforts to predict baselines, formulate mitigation measures, and track mitigation policies and NDCs. All these components are a part of or coupled with a national GHG MRV system. A national GHG inventory system incorporating all the legal, institutional, and procedural elements will be useful in estimating, reporting, and archiving GHG emissions and sinks.

Currently, a coherent GHG Inventory preparation system does not exist in the country, though five GHG-I preparation efforts have been carried out till 1994 and the sixth one is in the offing. A coherent and sustainable GHG inventory preparation system is direly needed for which Global Change Impact Studies Centre (GCISC) is carrying out efforts under the patronage of Ministry of Climate Change with the technical assistance of GIZ and CITEPA France to establish GHG inventory management and MRV system.

An overarching objective for mitigation MRV is to ensure that estimates are consistent and captured within the national inventory, BTR reporting, and fed into the Paris Agreement's Global Stock take. Therefore, a broader GHG MRV system is being developed to establish historical baselines, validate data quality, analysis of mitigation policies implementation and reporting compliance.

3.3. Capacity Building

Till the last inventory (2016) was prepared, there were a few professionals in the country capable of preparing the inventory. In the last couple of years, Government has given due consideration towards creating a mass of GHG inventory compilers. Capacity building trainings have been organized by GCISC professionals and with the support of UNFCC and GIZ, professionals have been trained in the use of latest IPCC 2006 Guidelines. More efforts for capacity building of the existing and new national GHG experts on updated / refined IPCC Guidelines and reporting formats, including the description of the procedures for preparing GHG inventories and the documents of data sources, methodological choice, assumptions, quality assurance, quality control (QA/QC) measures, and legal and institutional mechanisms for ensuring periodic reporting of data will be crucial.

Chapter No. 3

Gender & Climate Change

Chapter No. 3

Gender & Climate Change

1. Overview

Climate change is a horrendous reality; its consequences are affecting the lives of all the living creatures on the Earth. When it comes to variable rain patterns, droughts, floods, and tsunamis, every catastrophe, irrespective of its magnitude, affects the vulnerable community. Here the fact is that one cannot undo the reality of climate change, but one can transform lives in a manner to adapt the climate change.

Gender equality means the absence of discrimination based on sex/gender. It means equal rights in social, economic, political life and respecting the human rights of both women and men, as well as the ability to fully develop their potentials and interests, regardless of gender stereotypes and roles, and living in a free and supportive environment. The adverse impacts of climate change continue to burden the poorest and the most vulnerable, especially poor women. Despite growing recognition of gender equality, women continue to have less economic, political and legal influence in most developing societies. One cannot deny the fact that women are powerful agents of change and continue to make increasing and significant contributions to sustainable development despite existing structural and sociocultural barriers.

Unfortunately, due to various social barriers, gender stereotypes are grown with their roots deepen in the soil of culture, religion, family, society and system. Such stereotypes restrict the abilities of a person to fully bloom and they impede the strengths of a human being to be skillful enough to tackle the challenge of climate change. Hence the whole system pretends normal to gender inequality, European Institute for Gender Equality states gender inequality as “Legal, social and cultural situation in which sex and/or gender determine different rights and dignity for women and men, which are reflected in their unequal access to or enjoyment of rights, as well as the assumption of stereotyped social and cultural roles.”

UNDP considers freedom as the principal aspect to achieve sustainability in development. In a system with gender inequality, freedom compromises its strengths and the agenda behind sustainability remain unfulfilled. The climate crisis displays that the price of inaction compounds over time as it feeds further inequality, which in turn, makes action more difficult. Inequalities in human development upset societies and destroy social cohesion and people's hope in governmental bodies, institutions and each other. The combination of climate crisis and gender inequality introduces declining economies, eventually preventing people from reaching their full potential at work and in life. Then it becomes very difficult for political decisions to deliver as per the aspirations of the whole society and to protect our planet, as the few pulling ahead flex their power to transform decisions primarily in their interests. Inequalities in human development are a defining bottleneck in achieving the 2030 Agenda for Sustainable Development. As policies matter for inequalities and inequalities matter for policies, inclusion of climate change in such policies can bring prolific results.

This Chapter briefly outlines the social norms in Pakistan's patriarchal society and a look at the gender inequality statistics. It also provides an analysis of national policies and finds that, while identifying women as vulnerable groups, the policies are silent on participation in climate actions. The Chapter discusses the institutional mechanism for dealing with gender and climate change aspects and climate change variability and impacts on gender. The Chapter also includes the section on conclusions and

recommendations to help outline a Gender Action Plan to promote gender equality while keeping all the social and political constraints in mind.

2. Social Norms

Pakistan is a patriarchal society where women are supposedly considered to gain respectful status while still remaining under men. Under this system only male members of the family decide whether female should pursue higher education, go abroad for higher studies, or seek employment after studies; the underlying idea is to save them from the skeptical world outside. Under these circumstances, many women sacrifice skill set building opportunities in order to preserve the dignity and honor thus lagging behind in the economic strata of society. Hence there is a dire need to empower female stratum to streamline the efforts against climate change. Some previous decades have shown the tremendous effort women made to break the conventional decorum and prove that women can lead a nation.

3. Gender Inequality Statistics

According to Pakistan Social and Living Standards Measurement (PSLM), variability in gender control occurs in household systems. In the case of unmarried household heads, 2-3 % are men and a little over 1% are women. However, in the scenario of married persons, about 90% are male heads of households as compared to 3-7% female household heads. The incorporation of birth rate, and demographic representations of gender, marital status, employability and literacy reveals the structure of gender imbalance in Pakistan (Pakistan Bureau of Statistics, 2019). Pakistan is also facing gender inequality with an index of 0.547, ranking it 136 out of 162 countries in the 2018 index (Human Development Report, 2019).

Pakistan grades third-to-last, at number 151, on the 2020 Global Gender Gap Index (GGGI). The country has managed to reduce the gender gap by 56 per cent, said World Economic Forum (WEF) in its report. Pakistan's Human Development Index (HDI) value for 2018 is 0.56 which places the country in the average human development category locating it at 152 out of 189 countries. The Gender Development Index (GDI) is calculated for 166 countries. The 2018 female HDI value for Pakistan is 0.464 in contrast with 0.622 for males, resulting in a GDI value of 0.747.

In Pakistan, 20% of parliamentary seats are held by women, and 26.7% of adult women have acquired secondary level of education as against 47.3% by their male counterparts. For every 100,000 livebirths, 178 women expire from pregnancy related reasons; and the adolescent birth rate is 38.8 births per 1,000 women of ages 15-19. Female contribution in the labor market is 23.9% compared to 81.5 for men. The most recent (2017/2018) data on Multidimensional Poverty Index (MPI) estimates 38.3% of population as multidimensionally poor while an additional 12.9% are classified as vulnerable to multidimensional poverty. The deprivation (intensity) in Pakistan, which is the average deprivation score experienced by people in multidimensional poverty, is 51.7%. The MPI, which is the share of the population that is multidimensionally poor, adjusted by the intensity of the deprivations, is 0.198 (UNDP, 2019). It is obvious that along with climate crisis, Pakistan is victim of poverty and gender imbalance which makes it more vulnerable economically, socially and environmentally.

4. Policy Analysis from Gender Perspective

The need for identifying women's roles, functions, and perspective in climate change mitigation and adaptation actions can only be strengthened through inclusive policies. The analysis of Pakistan's policies does identify women and children as vulnerable groups; however, their active involvement and participation in climate mitigation and adaptation actions is missing. The role of women in policy making and planning is currently unreported in the country; however, Pakistan Health Vision 2016-2025, National Food Security Policy 2018, Climate Change Act 2017, National Biodiversity Strategy and Action Plan 2017-2020, and the National Climate Change Policy 2012 with the Framework (2014-2030) for implementation clearly chart out policy measures that empower women to enhance their role in the planning and implementation process. Pakistan Health Vision and

	National Climate Change Policy 2016	Pakistan Nationally Determined Contributions 2016	National Disaster Response Plan 2019	Pakistan Health Vision 2016-2025	National Food Security Policy 2018	National Biodiversity Action Plan 2017 - 2020
Gender analysis on climate risks, impacts and vulnerability	√	X	X	√	√	√
Identification of gender/ vulnerable groups or youth	√	√	X	√	√	√
Direct benefits to women, youth or vulnerable groups	√	X	X	√	√	√
Participation and empowerment of women and youth	√	X	X	√	√	√
Capacity building, training and enhancing education	X	X	X	√	√	X

Table 3.1: Coverage of Gender Related Aspects in National Cross Sectoral Policies

National Food Security Policy also include holistic strategy to cater to climate change impacts and capacity building of women to adapt to the direct and indirect effects.

5. Institutional Mechanism – Gender and Climate Change Aspects

Historically Pakistan has struggled to choose a governance structure in a dwindling path between autocratic and democratic rule. The current governance structure has followed a democratic path for the last 12 years, which has given a chance of public policy making to strive in a better direction inclined with public gains. The governance structure in Pakistan rests on three main pillars viz. the Executive, the Parliament, and the Judiciary. All three pillars play an important role in policy making and its implications. The Executive consists of the Prime Minister at the Federal level and Chief Ministers at the provincial level with respective Cabinets of ministers and advisors; these teams impart functionality and quality to the governance system in the Country. The Parliament constitutes the President, Senate and the National Assembly; it plays a crucial role in the formation and modification of Constitution and Legislation. The Judiciary includes the Supreme Court and other federal and provincial courts; they play an imperative role in regulation and enforcement of laws necessary to maintain governance decorum in the country. It is in this context that the institutional mechanism for gender and climate change aspects is discussed.

5.1. Gender Aspects

The institutional mechanism adheres to curb the gender gap and to assist the process of women empowerment in Pakistan. Pakistan is currently ranked 153rd out of 156 countries on the gender parity index (WEF, 2021). However, it is striving hard to incorporate gender equality with special attention towards women empowerment and equal rights. National Commission on the Status of Women (NCSW) was established in 2000 to keep a resourceful eye on women rights. It has done various amendments relative to the right of nationality, rape victim liability and has done research on the issue of inheritance. The Country now has a dedicated ministry for women development and empowerment.

The National Policy for Women's Development and Empowerment 2002 has played a pivotal role in floating the idea of gender equality to empower women irrespective to caste, creed and color. The Ministry of Women Development (MoWD) is the executing agency for national policy for women empowerment, keeping an eye on gender gaps the major reform program. The Gender Reform and Action Plan was executed at the provincial level in 2008. Afterwards, Rural Support Programs (RSPs) were initiated to provide financial and technical services to communities including rural females to enhance their financial capacities (FAOa, n.d.).

Pakistan has ratified the Convention on the Elimination of all forms of Discrimination against Women (CEDAW) in 1996, which supports the realm 'end gender-based discriminations'. Pakistan has also adopted the International Covenant on Economic, Social and Cultural Rights (ICESCR) and International Covenant on Civil and Political Rights (ICCPR) in 2008, to regulate with international standards on women rights (FAOb n.d.). It can be seen that even in the 21st century, Pakistan is struggling to achieve the goal set forth in the CEDAW. Because of certain socio-religious barriers as well as financial and infrastructure related impediments, the process is progressing somewhat slowly.

The Ministry of Human Rights (MoHR) is playing a central role to ensure gender equality. The human rights awareness program was initiated in February 2019 to raise awareness among urban and rural population on their basic human rights and to promote inter-faith tolerance and respect between communities (GOP, MoHR, n.d.)

Provincially Punjab Women empowerment initiative 2017 is addressing the practical implications towards women development through entrepreneurship, IT trainings and Women Business Incubation Centers to assist women empowerment in the country. Punjab Day Care Fund Society was initiated to assist working women to serve with diligence without any stress of motherhood responsibilities (GoPb, WDD, 2018).

International efforts for promotion of rights for all in Pakistan are applaudable. According to UN women (UN Women, Asia and the Pacific, n.d.), Pakistan has taken few steps in women empowerment like national commitments in place include a National Policy for Development and Empowerment of Women, Protection against Harassment of Women at Workplace Act, Criminal Law (Amendment - Offences in the name or pretext of Honor) Act, Criminal Law (Amendment - Offences Relating to Rape) and a National Plan of Action on Human Rights. Local commitments adopted include Gender Equality Policy Frameworks and Women's Empowerment Packages and Initiatives. Despite these efforts, gender gap in the country persists. International organizations are now providing technical assistance with the motto "Leave no one Behind" (UN Women, Asia and the Pacific, n.d.). The NDMA have also established a Gender and Child Cell with the assistance of UNICEF to provide safe and secure environment to vulnerable gender of community in case of any natural hazard.

There are various societies in Pakistan which are working independently or mutually with a prospective of women empowerment in the society. The Aurat Foundation, Pattan Tarraqiati Tanzeem, and Roots for Equity are working to advocate women rights in Pakistan. Their much-admired services highlight one of the most important issues like gender inclusive land inheritance legislation by government, rehabilitation of flood affected people and raising awareness on the rights of rural women employed in sunflower farms in Sindh.

5.2. Climate Change Aspects

Climate change is a serious matter equivalent to the national security issue. It may lead to loss of billions when combined in economic fractions translated from the loss of biotic and abiotic assets. In April 2012, the nomenclature of Ministry of National Disasters and Management was changed to Ministry of Climate Change MoCC). Pakistan now views climate change as a serious global issue and is ready to play its part in curbing this issue by integrating with various international treaties and protocols. In 2012, National Climate Change Policy, highlighting all the major sectoral issues relevant to climate change, was approved. The policy outlines two types of interventions – adaptation and mitigation – to address

environmental issues. the adaptation type includes the sectors of water resources, livestock, forestry, health, vulnerable ecosystems, disaster preparedness and socioeconomics, while energy, transport, forestry, town planning and waste management were included in mitigation policy intervention, whereas the sector of agriculture was included in both adaptation and mitigation intervention. Pakistan is working with international organizations under various international treaties and protocols (Kiran, A. and Q. Ain, 2017).

During disaster related emergencies, responsibilities of women for bringing stability to the home including dependent children is disproportionately high. Vulnerability, from this perspective, is primarily cultural and organizational. Refugee women and girls with disabilities are at higher risk of violence due to misconceptions, negative attitudes and social exclusion (NDMA, n.d.). MoCC has extended the scope of research and development through GCISC to build the capacity in integrating climate change with socio-economic sectors.

5.2.1. Enhancement of Technical Capacity

Enhancing technical efficacy to deal with disasters is very important to create gender inclusive climate change adaptation plan. The National Disaster Risk Reduction (DRR) Policy recognizes that DRR needs of women and children, in particular the poor, are often overlooked perpetuating patterns that lie at the heart of their current vulnerability and lead to greater disaster losses in Pakistan. While mechanisms need to be culturally appropriate, DRR requires the involvement of women as stakeholders to build resilient communities. It is apparent that for combating disasters, the technical efficacy relates to both PMD and NDMA, the latter playing role as a centralized institution to tackle aftermath of climate-based calamities.

PMD is the satellite eye of Pakistan for weather forecasting and climate data collection and keeping watch on seasonal changes and their impacts on biotic and abiotic assets. After 2010 super floods, JICA and UNESCO have collaborated with Pakistani government to introduce Strategic Strengthening of Flood Warning and Management Capacity of Pakistan, which has entered in the second phase of implementation. A Specialized Medium Range weather Forecasting Centre (SMRFC) has been installed with grant aid of JICA to strengthen the weather forecasting system in Pakistan along with building short and medium range forecasting capacities. A Weather Surveillance Radar project in Karachi is in the final stage of completion. along with its future projections in Multan and Sialkot. Similarly, a meteorological office has been established at Islamabad International Airport with modern equipment; the system has been extended to Faisalabad Airport. For seismic activity monitoring, there are 20 remote seismic monitoring stations with the capability to disseminate information within 3 minutes of earthquake. Marmara Research Centre, Turkey is assisting PMD to develop tsunami early warning systems, deployment of 5 GPS systems along Makran Coastline, and installation of 3 sets of classified sites for risk assessment. There are various other projects under implementation (NDMA, n.d.).

5.2.2. Gender Mapping

Gender mapping helps understand societal behavior towards different genders. NDMA has completed gender mapping in Pakistan with the help of Gender Task Force. The mapping report spells out on how women form vulnerable gender in Pakistan and reports that one out of 3 women face physical or sexual violence in their lifetimes. In case of emergencies, women become more vulnerable because of the high ratio of dependent children. Girls with disabilities face greater risk because of ill intentions and social exclusion. Gender Task Force has led to assistance of UNWOMEN and UNFPA to address the issues relevant to gender inequality. In this process, various national and international NGOs have played their part to develop a database on gender vulnerability and its possible solutions by introducing a draft on Inter Agency Standing Committee Gender Alert.

The gender mapping has provided a clear-cut view of challenges including the need for gender sensitized trainings, civil-military coordination in this context, and capacity building of trainers along with smooth platform for genders with disabilities (NDMA, n.d.). There are various other institutes like Alternate Energy

Development Board (AEDB), National Energy Efficiency & Conservation Authority (NEECA), National Climate Change Authority, Pakistan EPA, Provincial EPDs and various associated departments which can play a determined role in bringing gender components in decision making. The design of institutional frameworks raises the question on percentage of women contributing their services in environment and climate change and whether women are theoretically or practically able to impart their services. The delightful and optimistic view can make one see that in the current government, the minister of climate change is a woman, Ms. Zartaj Gul thus representing women on the governmental platform of decision making.

In Pakistan, various institutions are playing their role in advocation of gender equality and climate change effects on gender, yet their efforts are not channelized thus creating a mild effect to culminate the issue of gender vulnerability in terms of climate change. The National Network on Climate Change (NNCC) can be utilized in the specific scenario to involve multi-sectoral network to channelize the database and policy implications to have an enhanced effect of gender sensitive approach regarding climate change adaptation and mitigation.

6. Climate Variability and its Impacts on Gender

6.1. Climate Change Threats

The variable climate of Pakistan makes the country more vulnerable to climate change impacts. There are various climate threats to Pakistan, which briefly are:

- Increased frequency of extreme weather changes, erratic monsoons, flash floods and regional droughts.
- Apprehended decrease in Hindukush-Karakoram-Himalayan glaciers due to global warming.
- The elevation in temperature leading to water stressed conditions and reduced agricultural productivity.
- Salinity of Indus River Delta with its negative impacts on agriculture, fisheries, and mangroves cover.
- Threatening situations on coastal areas due to elevation in sea level, and climate induced migrations.

Almost every year climate extreme events like intense heat waves, urban flooding or flash flooding occur. Besides causing material loss, these events result in heavy sufferings for humans and damage to fauna and flora. According to earth observatory NASA, in 2020 a heavy monsoon caused fatal flooding which resulted in 400 deaths, 400 injuries and 200,000 houses damage. Sindh province, being in southeastern part of Pakistan near the coast, was most affected against the general belief that areas near coastlines make climatic conditions less variable. Karachi, Hyderabad and Mirpur Khas districts of Sindh were declared as calamity hit areas, breaking 89-year record. The victims (mostly female) were exceeded 2 million in Sindh province with almost 68,000 displaced finding refuge in relief camps. Besides, the unprecedented monsoon season in Sindh province has led to the loss of one million acre of crops causing huge reduction in agricultural production.

Due to regional variation in climate change phenomenon, its impact also varies greatly in different geographical regions of Pakistan. According to United Nations there are three main factors that define and affect gender vulnerability to climate change. These are: (1) Access to opportunities and resources; (2) Control over resources and opportunities; and, (3) Role in Decision Making process. Access to opportunities and resources defines gender roles and is also a reason of gender gaps in the society. While control over resources and opportunities are the defining moments, gender gaps arise when the vulnerable groups are not included in the crucial decision-making process. Consider a hypothetical, not uncommon in Pakistan, case when a woman holds legal rights of land ownership and has access to seek fruit from it, but she lacks control on what to sow and at what time, because of lack of technical knowledge. Thus, despite of being an owner, under the reign of patriarchy, she surrenders her right of decision making. Such gaps in access, control or decision making hinder vulnerable gender to show progression.

> "We will be in a very bad state if the floods come again," she says. "I don't know what we will do. I don't know where we will go. We are poor. My husband cannot find work."
>
> *A Housewife in Dadu Sindh, Pakistan speaking to IFRC Team.*
>
> *Source: Mueller, K., 2011. Families prepare to face the oncoming monsoon season in Pakistan. IFRC.*
>
> *Available at: https://www.ifrc.org/fr/nouvelles/nouvelles/asia-pacific/pakistan/families-prepare-to-face-the-oncoming-monsoon-season-in-pakistan*

According to IPCC fifth assessment, for the Asia region, sensitivity to climate change threats in agriculture dependent economies (such as Pakistan) arises from their distinct geography, demographic trends, socioeconomic factors, and lack of adaptive capacity that when taken together, determine the vulnerability profile by perpetuating a vicious cycle of poverty (Chaudhry, 2017).

6.2. The Provincial Context

While considering the provincial context of gender related climate change, it is important to note that gender roles may vary depending upon the literacy rate and exposure. Pakistan is quite vulnerable to climate-induced natural disasters like floods, droughts, tsunamis, cyclones, windstorms etc. The floods of 2010 and 2011 in Sindh had led to the displacement of 7.2 million people and 9.3 million respectively and had affected 11,992 villages and 38,347 villages respectively. Furthermore, drought and salinity problems are also the biggest concerns of the affected population. Concerning gender roles, women are actively playing their roles in agriculture, livestock and dairy, poultry, fishing along with satisfactory management of household chores (Kayani, 2017). The drought period urges women labour to work on low wages as compared to men. According to FAO, the representation of women as labour in the climate-sensitive sector of agriculture is 48.2% in winter harvests and 48.6% in summer harvests, yet the land ownership resides only to 5% of women (FAO, 2015). The discrimination can be observed when it comes to land inheritance and land ownership due to social customs, women face denial of their rights and hence they do not play a direct role in decision making (Hamid et al., 2013). Conferring to Overseas Development Institute, Pakistan has lost 4,324 people in various catastrophes between 2012 and 2018. The figures of affected people may incline in the future if the issue of climate change remains unaddressed (Hayat, 2019). Flood induced migrations compel women to live under poor quality circumstances, with food shortage, polluted water and the continuous menace of assault and abduction due to poor safety conditions (Salik et al., 2020).

Gender and Climate Change – Some Facts

- Pakistan is a victim of climate change.
- Gender inequality is quite prevalent, because of socio-economic and cultural system.
- Climate change does not affect everyone in similar ways; for vulnerable gender, its impact may vary from place to place.
- Climate vulnerability depends upon place, gender accessibility over resources and awareness regarding climate change.

According to the IUCN report on climate change and its impact on gender in rural areas, the women have observed a substantial increase in temperature, and its effects are multiplied because of acute water shortage, no electricity and regularity of domestic chores amidst scorching high temperatures (Noshriwani, 2016). Due to poverty, lack of health facilities, poor access to education, unequal distribution of wealth and no access to justice in rural areas, women are at the highest verge of climate change vulnerability (Kayani, 2017).

Similarly, research has shown that agricultural dependent communities near the upper Indus basin in times of climatic stress send their male members to big cities in search of alternate livelihood while the women carry the responsibility of household work along with farming and dairy development. In the upper Indus basin, the genders have an egalitarian affiliation as compared to downstream Indus basin. In case of any natural calamity like floods, women store the food items for the family while men play their part in the maintenance of physical infrastructure and the

safety of their family. While in mid-stream, women also carry the responsibility of water management for their household and livestock along with their share in farming practices. Sociocultural barriers obstruct their decision-making power and their right to own the land. The women downstream of the basin are heavily dependent on male members of society due to the socio-cultural system and less representation in decision making. Hence, It cannot be denied that lack of access to updated information halts women to learn new skills; expand their livelihood approaches and avail better economic advantages (Abbasi et al., 2019).

Furthermore, even in the urban scenarios, due to extremity in weather patterns and natural calamities, daily wage men lose their jobs and remain confined at home, that led to emotional frustration, which eventually results in fights and domestic violence. Women often have to contribute far beyond their capacity in water management and in taking care of their children due to impoverished facilities provided in urban underprivileged areas (Sawas et al., 2020).

Pakistan is trying to address the issue of gender vulnerability, as one section of National Climate Policy 2012 affirms that women are likely to be strongly affected by climate change as the majority of rural women are engaged in agricultural jobs, which is highly climate sensitive. The policy has understood that how climate change is increasing the workload based on various sustenance activities like collecting water, fuel wood and performs domestic chores with children's responsibility. It has also been found that the strength of women to cope with the stress of climate change lies in their age, educational and employment status, their enhanced technical efficacy in farming practices, their land rights and livestock ownership along with their higher knowledge of weather interpretation(Batool et al., 2018). National Climate Change policy affirms that women are the powerful agent of change and it is essential to utilize their gender strength. Thus, few policy measures represented in National Climate Change Policy 2012 are as follows:

- Mainstream gender perspectives into climate change efforts at national and regional levels.
- Take steps to reduce the vulnerability of women from climate change impacts, particularly about their critical roles in rural areas in providing water, food, and energy.
- Recognize women's contribution to the usage and management of natural resources and other activities impacted by climate change.
- Undertake a comprehensive study of the gender-differentiated impacts of climate change with a particular focus on the gender difference in capabilities to cope with climate change adaptation and mitigation strategies in Pakistan.
- Develop gender-sensitive criteria and indicators related to adaptation and vulnerability, as gender differences in this area most crucial & most visible.
- Develop and implement climate change vulnerability-reduction measures that focus particularly on women's needs.
- Incorporate an appropriate role for women into the decision-making process on climate change mitigation and adaptation initiatives.
- Develop climate change adaptation procedures on local and indigenous knowledge particularly held by women. (GCISC, 2012).

The root of gender discrimination concerning climate change mainly starts when a vulnerable gender is at risk of changes imposed by climate. The risk may lead to negative impacts if a vulnerable gender is not educated, skilled or fully aware of the consequences associated with climate change. Gender roles may vary from area to area but a study conducted in Karachi, Pakistan states that the high literacy rate of both men and women tends to counter the stereotypical system (Ali et al., 2011). Unfortunately, Pakistan is lagging in terms of women education despite out of various solutions, 32% of girls are still out of school in primary education as compared to 21% of boys (HRW, 2020). Empowering women physically, technically, and financially can enhance their resiliency against the consequences of climate change. Similarly, equivalent access to a comprehensive knowledge of Early Warning Systems to all the genders can reduce the apprehension of vulnerability in future (Mustafa et al., 2015).

7. Conclusion and Recommendations

Pakistan is committed to prioritize gender inclusion in climate change adaptation; though considerable attention is needed to draft an action plan for effective implementation. A continuous stratum of funding, planning, monitoring and reporting is required to have an effective plan against gender vulnerability to climate change. Despite growing recognition of differential vulnerabilities as well as the unique experiences and skills women and men bring to development and environmental sustainability efforts, women still have less economic, political and legal clout and are hence less able to cope with – and are more exposed to – the adverse effects of the changing climate. On the other hand, women are powerful agents of change and continue to make increasing and significant contributions to sustainable development, despite existing structural and socio-cultural barriers.

Following are recommendations based on comprehensive study on gender and climate change in Pakistan.

- Gender Action Plan as an adaptive strategy to climate change should be formulated.
- Gender responsive or gender transformative approaches should be applied based on the vulnerable place and gender as per affected area.
- Gender responsive climate change financial plan should be devised and implemented in climate change vulnerable areas.
- The concept of reaction before action should be introduced in disaster prone areas.
- Early warning systems should have localized language portfolio to aware people about any calamitous element.
- Religious integration is needed to promote the concept of gender equity in the society.
- Modern social systems should be used as a tool to promote gender equity in the society along with awareness on climate change.
- There is a need of synchronization between academia, international and national institutes to solve the pertinent issue of data gap.
- Engage the WASH unit to develop guidance for mainstreaming gender in WASH projects, and for collecting gender disaggregated data This in turn would allow for the MRV system to also present disaggregated data and track gender wise progress (Shafique et al., 2021).
- Risk assessment of risk prone areas is mandatory which must highlight that which gender is most affected.
- Training of vulnerable gender either academically or vocationally is must to sustain their livelihoods even after the climate calamity.
- Gender and climate change focal person should be appointed to act as a liaison between the institutions working on gender equity, disaster preparedness, and climate change.
- Modified curriculum per area should be introduced so that the young girls and boys remain fully aware that how climate change can affect their lives.
- To assist the smooth working of action plan in terms of trainings, there must be rebirth of girls' guide and scout boys with specifications to deal with climate induced changes.
- There must be an equal opportunity approach in every sector to reduce gender gaps.
- Gender responsive budgeting should be initiated to empower the vulnerable gender to cope with climate change phenomenon.
- Professional training for climate change should be given to those who are going to head the trainings of public.
- R&D should be promoted in every variable geographic zone to inaugurate an adaptive plan for that area.
- Basic awareness regarding climate change and natural calamities should be added as an integral part to the core syllabi of academia along with technical education in climate vulnerable areas.
- International reporting mechanism should be revised annually to showcase the efforts of Pakistan at the global level in the domain of mitigation of climate change along with the efforts against gender inequality.

Chapter No. 4

Nationally Appropriate Mitigation Actions

Chapter No. 4

Nationally Appropriate Mitigation Actions

1. Overview

This chapter gives brief introduction of mitigation potential and mitigation actions in key sectors of the economy to curb green-house gas (GHG) emissions in Pakistan by sectors and by sources. The information on mitigation actions and their effects have been documented, to the extent possible, following the guidelines on BUR, including the associated methodologies and assumptions. Wherever possible, information on steps taken or envisaged to achieve mitigation is reported. However, there are capacity building needs in reporting mitigation actions. These are highlighted in this document at various places.

The chapter provides an update on mitigation potential and actions in line with Pakistan's Second National Communication (SNC) for sustainable development. The mitigation actions included in this chapter take into account the specific national development priorities, objectives, and circumstances, in accordance with Article 12, paragraph 1(b) of the UNFCCC[4]. The Chapter outlines Pakistan's commitment to address the challenges of climate change through its Framework for Implementation of Climate Change Policy 2014-30 (FICCP).

2. Climate Change Mitigation: National Context

Pakistan's response to the challenges of climate change has already been incorporated in its commitment to Sustainable Development Goals (SDGs), and objectives of the Convention on Climate Change. Adoption of the National Climate Change Policy, 2012 (NCCP) and National Disaster Risk Reduction Policy, 2013 (NDRRC) provides a comprehensive framework for policy goals and actions towards mainstreaming climate change. It specifically addresses the economically and socially vulnerable sectors of the economy. A follow-up to these policies was the launch, in 2013, of the FICCP, which outlines the vulnerabilities of various sectors to climate change and identifies appropriate adaptation and mitigation actions. The Framework serves as a catalyst for mainstreaming climate change concerns into decision-making at national and sub-national levels and to create an enabling environment for an integrated climate-compatible development process. It provided impetus to prepare the National Adaptation Plan (NAP), Nationally Appropriate Mitigation Actions (NAMAs), future National Communications to the UNFCCC as well as detailed sub-national adaptation action plans (MoCC, 2013).

Pakistan has considerably improved and strengthened its climate governance structure over time to achieve the objectives of different policy initiatives. Climate Change and Environmental Protection have been extensively recognized in national medium and long-term plans, annual Economic Surveys of Pakistan, provincial annual budgets, and federal level Public Sector Development Programmes (PSDPs). Budgetary allocations have been made at national and sub-national levels for execution of the FICCP. Although, climate change has become a provincial subject after 18th Amendment to the Constitution, some of the associated activities and responsibilities relating to climate change concerns are coordinated by the Ministry of Climate Change (MoCC) at the national level with corresponding support from sub-national governments.

The MoCC also works in close collaboration with the federal authorities, research institutions, universities

4 A general description of steps taken or envisaged by the Party to implement the Convention.

and private sector organizations and is responsible for supervising and controlling several attached departments and implementation agencies, which include: Global Change Impact Studies Centre (GCISC); National Disaster Management Authority (NDMA); Pakistan Environmental Protection Agency (Pak-EPA); and Zoological Survey Department of Pakistan (ZSD).

MoCC has specialized wings to deal with matters relating to Environment and Forestry. At the operational level, frequent interaction is maintained with the Pakistan Meteorological Department (PMD), Pakistan Agricultural Research Council (PARC), Federal Flood Commission (FFC), Indus River System Authority (IRSA), Water and Power Development Authority (WAPDA), National Energy Efficiency & Conservation Authority (NEECA) Alternative Energy Development Board (AEDB), Civil Society Organizations and the private sector.

The National Climate Change Policy and its Framework for Implementation make key recommendations relating to mitigation measures in different sectors including energy, agriculture and forestry. The documents provide policy framework on adaptation measures with particular focus on water, agriculture and livestock, coastal areas, Indus deltaic region, forests and other vulnerable ecosystems.

The following sections present the GHG emission profile of Pakistan in brief and discuss the climate change mitigation potential and the status of actions taken by the Energy, Industry, Transport, Building, Forest, Agriculture, and Solid Waste Management Sectors of economy.

3. Pakistan's GHG Emission Profile-Sectoral Analysis

Pakistan's latest GHG Inventory reports increase in emissions by all sectors of economy. Pakistan's 2018 GHG Inventory estimated 489.87 MT CO2e emissions from all the major sectors of the economy, an increase of 200% during the period 1994-2018. The energy and agriculture sectors predominated the emissions and account for over 90% of the total emissions.

Figure 4.1 shows emissions for 1994, 2018 and 2030 (projected) for different sectors. It can be observed that total emissions are projected to increase by 300% during the period 2018-2030, which is due to ambitious government plans to boost economic activities by investing in communication, energy and industry infrastructure.

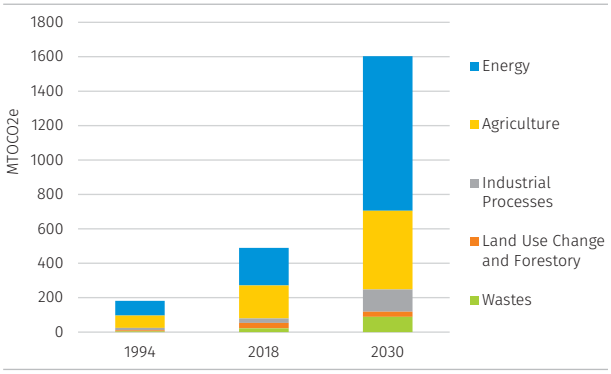

Figure 4.1: Emissions Trend during 1994-2030

3.1. Energy Sector

3.1.1. Overall

According to Pakistan Energy Year Book 2018, Pakistan's primary commercial energy supplies have increased to 86 Million Tonne Oil Equivalent (MTOE) as shown in Table 4.1. The existing primary commercial energy supply mix during 2017-18 has increased by 8.4% compared to the previous year. The share of oil and gas is 31.2 and 34.6 % respectively, followed by 12.7% from coal and 8.7% from imported LNG. The share of nuclear energy, renewable electricity, hydro-electricity, and imported electricity is 2.7, 1.1, 7.7, and 0.2% respectively. A comparison of the data from 2015 shows that Pakistan energy mix has diversified over the last five years.

Oil, gas and electricity, coal and liquid petroleum gas (LPG) are the major sources for energy consumption as detailed in Table 4.2. Analysis shows that around 33.6% of primary energy consumption is lost while conversion to final energy[5].

5 Pakistan Energy Year Book 2018: Difference (%) between primary energy supply vs Energy Consumed.

Source	Tonne Oil Equivalent (TOE)	Share (%)
Oil	26,903,431	31.2
Gas	29,849,030	34.6
LNG Import	7,492,597	8.7
LPG	1,054,006	1.2
Coal	10,925,200	12.7
Hydro Electricity	6,665,328	7.7
Nuclear Electricity	2,358,200	2.7
Renewable Electricity	920,580	1.1
Imported Electricity	132,559	0.2
Total	86,300,931	100.0

Table 4.1: Primary Energy Supply by Source (2018)

Source: Pakistan Energy Year Book 2018

Source	Tonne Oil Equivalent (TOE)	Share (%)
Oil	19,964,954	35.0
Gas	16,693,880	30.4
Coal	8,940,477	16.3
Electricity	8,708, 151	15.8
LPG	1,385,427	2.5
Total	54,992,889	100.0

Table 4.2: Final Energy Consumption by Source 2018

Source: Pakistan Year Book 2018

Sectoral yearly trend in energy intensity[6] (which is taken as a measure of energy efficiency) from 2004-05 to 2017-18 is presented in Table 4.3; the computations provide only an approximation of energy intensity.

Overall energy intensity declined by about three-quarters of one percent annually between 2005-06 and 2015-16. The fastest per annum reduction in energy intensity was witnessed in Industry (2.5%) followed by Agriculture (2.25%) and Domestic sector (1.6%). Data also shows that energy intensity increased by 0.7% and 0.3% respectively in commercial activities and Transport sector. Conversely, these numbers show that by 2015-16 Pakistan's industries had improved their energy use efficiency by about 25%, relative to 2005-06. Corresponding improvements in agriculture and in domestic energy use were about 22% and 16% respectively. By contrast, energy use efficiency had declined by about 4% in commercial activities and in the transport sector.

With this energy intensity trend, the energy sector emitted 218.9 million tons (Mt) of CO2e emissions. It comprised of 44% of the total GHG emissions in Pakistan. The major gas emitted from energy processes is carbon dioxide (CO_2) which is

Sector	Domestic	Commercial	Industrial	Agriculture	Transport	Other Govt.	Total
2005-06	11.22	0.54	9.07	0.41	9.89	1.79	4.40
2006-07	11.57	0.56	9.07	0.42	9.48	1.70	4.42
2007-08	11.61	0.56	8.90	0.43	10.69	1.68	4.61
2008-09	10.96	0.58	8.29	0.41	10.00	1.70	4.35
2009-10	10.70	0.60	8.43	0.44	9.96	1.54	4.40
2010-11	10.48	0.58	7.73	0.39	10.03	1.49	4.26
2011-12	10.56	0.60	7.58	0.35	10.02	1.21	4.23
2012-13	10.85	0.59	7.13	0.31	9.74	1.12	4.09
2013-14	9.97	0.57	6.59	0.34	9.54	1.18	3.90
2014-15	9.79	0.56	6.75	0.31	9.54	1.20	3.95
2015-16	9.37	0.58	6.85	0.32	10.24	1.35	4.08
Reduction in Energy Intensity during 2005-2016 (%)	-1.62	+0.67	-2.52	-2.52	+0.31	-2.53	-0.67

Table 4.3: Sectoral Trend in Energy Intensity (TOE)

Source: Planning Commission of Pakistan: SE4ALL, National Action Plan-2019

6 Energy intensity is computed as Tonne of Oil Equivalent (TOE) of energy used for producing one million PKR of sectoral output (or, in case of the Domestic sector, as TOE of energy used per million PKR of private consumption).

7 Another way of stating this is "0.67% less energy was used (per annum) to produce each unit of national output or GDP".

8 While energy intensity was also reduced by around 2.5% per annum in the Other Government sector, this activity accounts for a relatively small share of energy use/consumption – therefore the impact of this reduction was relatively minor.

approximately 210.01 Mt CO2e followed by 6.88 Mt CO2e of Methane (CH_4) and 2.02 Mt CO2e of Nitrous Oxide (N_2O). Further, industrial, manufacturing and transport sector are the major emitter of GHGs which usually involves the combustion of fossil fuel. The GHG emission from energy sector are given in Figure 4.2.

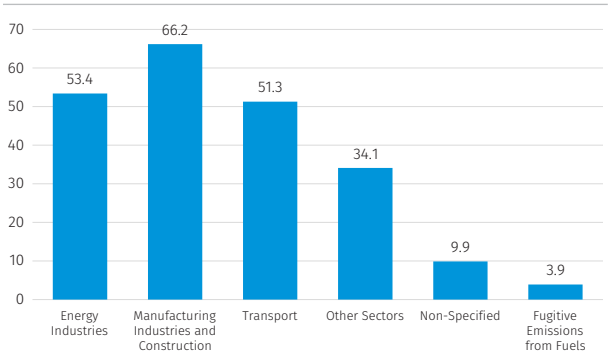

Figure 4.2: GHG Emissions from Energy Sector

3.1.2. Transport

In the year 2018, the total energy consumption by transport sector was 33.89%. High speed diesel makes the major contribution in the energy mix, about 45.8%. The next highest contribution is 42.1% and 8.8% by motor spirit and natural gas respectively.

In the transport sector, there are plans to adopt latest technologies, such as Combine Cycle Natural Gas (CCNG) that has energy conversion efficiency over 60%. By efficient designing of the trucks, they can be made efficient as 26% energy saving can be achieved. NEECA has also been mandated to work on improving fuel efficiency. There are plans on initiating mass transit projects in different cities. Hybrid and EV vehicles are also given priority by encouraging the manufacturing and import of such cars using energy efficient policy. Railway transport will be utilized in transportation of fuels as it is 80% cheaper than road transportation. There are plans to transport 15% of fuels using railways instead of roads.

3.1.3. Energy Use in Residential/Domestic Sector

The energy consumption (in year 2018) in the residential sector of Pakistan is 21.20% of total 54.9 million TOE energy. This energy is used by over 29 million households. However, in the year 2013, the energy consumption was 25.18% of the total energy consumption. The energy mix in domestic sector shows highest contribution by natural gas about 57.4% with next highest contribution by electricity about 38%. As of year 2018, the electricity consumption was highest in residential sector (50.5%), followed by industrial sector (25.7%) and agricultural sector (9.5%). Despite this, still a large population relies on traditional biomass (animal dung, firewood, etc.) to meet the energy requirements.

3.1.4. Energy Use in Industrial and Commercial Sectors

Industrial sector being the highest energy consuming sector using about 37.46% of total final energy in 2018, its energy mix is predominantly coal (43.4%) and natural gas (37.1%). Energy consumption has increased by 2% since year 2013. It is the second highest consumer of electricity after residential sector, consuming about 25.7% of total 106,927 GWh. About 18% of the greenhouse gas emissions are from this sector. Commercial sector uses 3.65% of the total final energy. The main energy uses in this sector are LPG, natural gas and electricity, making up 27.8%, 37.4% and 34.9% respectively.

3.1.5. Energy Use in Agricultural Sector

As of year 2018, agricultural sector makes up 1.53% of the final energy consumption. Oil and Electricity are the main energy sources in this sector, after excluding the sources used in transportation. In the year 2018, oil usage was 1.8% while electricity dominated with 98.2% of the total consumption in agriculture.

In the agriculture sector, future plans include giving incentives to farmers to replace their inefficient pumps. Additionally, there is a program to replace 30,000 biodiesel pumps with solar pumps. To reduce energy losses during transmission and distribution, smart metering technology will be introduced that will not only reduce losses but also give accurate measurements and billings. The energy savings in the building will be achieved using the energy provision given in the Building Code of Pakistan-2011, which is developed by PEC. It is believed that for proper enforcement, Pakistan Green Building Council is needed. The NTDC's Expansion Plan also involves improvement and strengthening of grid stations by 2019-2020.

3.1.6. Renewable Energy Targets

The Government of Pakistan has been endeavoring to bring in transformational changes in power system in order to ensure affordability, sustainability, energy security and energy access for all. In this regard, the Government is emphasizing on utilization of indigenous and environmentally clean energy generation resources and the promotion of alternative and renewable technologies is amongst the top priorities of the Government.

Alternative Energy Development Board (AEDB) has been mandated by the Government to act as a "One-Window Facilitator" on behalf of the Government of Pakistan to promote, encourage and facilitate the private investments in the ARE sector of Pakistan under the Government policies. AEDB has been promoting and facilitating the development and deployment of alternative and renewable energy technologies in the country. The development of renewable energy-based power generation projects is being pursued on IPP mode through private sector investors under the GOP policies. The status of RE power projects is given below:

A total of 40 ARE based projects of 2024 MW cumulative capacity are operational that include; Twenty-six (26) wind power projects of 1335 MW. o Six (06) solar projects of 430 MW.

Eight (08) sugar mill-based bagasse co-generation projects of 259.1 MW.

Several ARE projects, initiated under the RE Policy 2006, are in pipeline. These include ten (10) wind projects of 510 MW cumulative capacity and four (04) solar projects of 250 MW cumulative capacity that are under construction and are expected to be completed by 2nd Quarter of 2022.

Due to concerted efforts, the share of AREs has already exceeded to 5% of the power generation mix, however; ARE promises a higher proportion of the national energy supply mix and can help ensure universal and affordable access to electricity in all regions of the country. For the same reason, Government has set the target of achieving 60% share of its generation capacity through indigenous clean energy technologies (ARE & hydro) by 2030 on the basis of outputs of Indicative Generation Capacity Expansion Plan (IGCEP).

The IGCEP 2021, recently approved by the Regulator, provides the following capacity additions from wind and solar energy by 2030:

Years	Capacity Addition through Wind Energy	Capacity Addition through Solar Energy	Cumulative Capacity Addition
2024	1000	1000	2000
2025	1000	1000	2000
2026	1000	1000	2000
2027	62	1000	1062
2028		1000	1000
2029		1000	1000
2030		1000	1000
Cumulative Capacity Addition			10,062

Table 4.4: Solar and Wind Capacity Addition and Projection by 2030

4. Mitigation Potential and Actions

4.1. Energy Sector

4.1.1. Mitigation Potential

The energy saving potential in the country is about 11.09 MTOE if energy efficient practices are adopted. According to the European Commission, the cost of generating a megawatt-hour is greater than cost of a negawatt-hour, which is a measure of energy that is saved owing to the conservation and energy efficient practices undertaken. In domestic sector, apart from electricity savings by using efficient fans, lights refrigerators etc., there is great potential of saving natural gas by utilization of improved space heating and improved cooking stoves. The industries that have high energy saving potential include textile, cement, sugar, leather, fertilizer, paper and pulp, and brick kiln. In textile industry, energy savings will be achieved through installation of meters and controls, and proper maintenance. In sugar industry High Pressure Generation (HPC) will be adopted that produces same amount of electricity as the conventional technology by using 46% less bagasse. In cement industry, energy savings can be achieved by improving technology and equipment. The leather industry despite having less energy saving potential can still have energy savings by using efficient lighting, installing controls for

compressed air, metering and insulation. The fertilizer sector and paper and pulp industries also have energy saving potential by adopting efficient technologies. The brick kiln by utilizing 'Zig Zag' technology can save up to 30-40% energy and reduce emissions by 70%.

4.1.2. Mitigation Actions

4.1.2.1. National Energy Efficiency and Conservation Authority (NEECA)

In 2016, the National Energy Efficiency and Conservation Act was passed, under which NEECA has the full duty to execute the Act. NEECA is presently involved in various efficiency and conservation activities all over the country, so far, there have been many achievements in short time span since birth. The country has started a program on Energy Efficiency Standard & Labelling (EES&L) which aids the consumer to take informed decision prior to their purchase on the energy saving potential of the product. This program by reducing the energy consumption, benefits the environment as a result of reduced greenhouse gas emissions. On 24 May 2016 this labelling scheme was launched. The Minimum Performance Energy Standards (MEPS) are being developed with involvement of designated provincial agencies and various other stakeholders. In case of electric fans, MEPS have been developed by Pakistan Standard & Quality Control Authority (PSQCA) after testing of the fans available in market in accredited lab in Pakistan Council of Scientific and Industrial Research (PCSIR) Complex Lahore. The manufacturers have started seeking issuance of labels and developing fans according to the requirements. The label stickers given so far are 348,500 to 16 fan manufacturers that have registered 27 fan models. Accredited labs are now also available for LED lights & Refrigerators at PCSIR, Lahore. Pakistan's first ever public sector air-conditioning unit testing lab is being established in Lahore by Punjab Energy Efficiency and Conservation Agency (PEECA) through provincial Energy Department which will ensure the adoption of appropriate standards and labelling schemes for air conditioners to help bring down carbon emissions and energy consumption.

Presently, the most noteworthy success of NEECA is the GEF funded project developed in collaboration with United Nations Environment "Delivering the transition to Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors of Pakistan". The main activities of this project include National Energy Efficient Lighting Strategy leading to development of MEPS; Strengthening Monitoring, Verification, and Enforcement (MVE); Environmentally Sound Management (ESM); and, promoting the benefits of high efficiency LEDs through communication and distribution campaigns. Establishment of a Revolving Loan Fund (RLF) in order to accelerate the transition to efficient lighting products is also a mandate of this project. In industrial sector, 287 GWh savings have been achieved on voluntary basis by reducing energy usage, which benefited showing 381 million cost savings.

At regulatory level, NEECA in coordination with Ministry of Energy and Ministry of Law and Justice to establish Energy Conservation Tribunals. NEECA is also working to support provincial governments to establish provincial designated agencies. It is also facilitating the provinces with the technical support of the World Bank Group (WBG) to formulate their provincial action plans to improve energy efficiency and to contribute in reduction of GHG emissions.

NEECA Strategic Plan: NEECA has developed its Strategic Plan (2020-23). This plan intends to achieve 3 MTOE energy saving by 2023 through various energy efficiency initiatives in five key sectors of the economy viz. industry, transport, buildings, power and agriculture. Industrial, transport and the building sectors respectively are the most energy-intensive because of high energy losses, wastage in the supply chain, and lack of investment in replacing obsolete technologies, and overall aging infrastructure. Saving 3 MTOE energy in next three years can be translated as the reduction in emissions by 6.4 MT CO2e with an accelerated energy efficiency of 3.5%. In short, implementation of this plan in true spirit can contribute approximately 6.5% of the total emission reduction by 2023 for Pakistan.

National Energy Efficiency and Conservation Policy (NEEC Policy): The draft of Energy Efficiency and Conservation Policy is being prepared in order to promote, structure and regulate energy conservation practices in the country. This policy is being drafted with the involvement of all the relevant key players and stakeholders. NEECA with the financial and

technical support of the World Bank Group is preparing the NEEC Policy. The policy will focus on regulatory and institutional framework to exploit the 14-16% of the energy efficiency potential in the energy system of Pakistan. NEECA and WBG have conducted a detailed consumption profile of the major sectors to clearly set the targets for next five to ten years. It is expected that policy will be launched by the end of this year with clearly defined targets to save the energy.

MEPS for Electric Motors: NEECA in collaboration with Collaborating Labeling and Appliances Standards Program (CLASP) has developed MEPS for electric motors. The electric motors including tube wells highz energy saving potential. These MEPS when implemented will help to replace the inefficient motors to minimize the carbon prints. Similarly, in order to make energy intensive agricultural consumers self-sufficient for their energy needs and concurrently combat climate change in agricultural sector, PEECA is intending to replace grid connected agricultural tube-wells in Punjab with solar tube-wells. This will also decrease cultivation cost, enhance farm returns, and uplift economy of small farmers and the country overall.

Capacity Buildings and Awareness Raising: NEECA has taken several initiatives as a part of its long-term plan to ensure energy efficiency and conservation in major sectors of the economy. Taking measures to mitigate climate change through policy making and project execution alone may not help. The key to have a productive outcome is collaboration. NEECA has developed following programs to enhance the capacity of the national and provincial level stakeholders. These programs are the part of NEECA's Strategic Plan and are expected to be implemented by the end of this year;

- Energy Auditors and Manager Program will be launched.
- Industrial Assessment Centers with collaboration of HEC will be developed and launched.
- NAVTEC/TEVTA training program will be launched.
- Full bright program will be engaged with NEECA to brief professors from world class academics institutions on sabbatical for research, similarly students from international universities will be offered internship to work on NEECA's different projects.
- International Donor Organizations will be engaged for capacity building of NEECA's staff regarding Electric Vehicles, Public Private Partnership Building Codes / Designs, Energy Audits of power plants and developing infrastructure mechanism for promotion of Energy Service Companies (ESCOs).

In addition to this NEECA has launched awareness campaigns at various level as a part of its strategic communication component.

- Awareness through schools program & PTV Tele school channels.
- Awareness of Chamber and Commerce, Manufacturer Associations and other key stakeholders.
- NEECA's designated agency PEECA is conducting awareness campaigns all over Punjab to help people understand the impact of energy inefficiency on climate and quality of life and kindle a sense of responsibility among them. Through various workshops and seminars PEECA is striving to encourage the masses to adopt a pro-climate behavior and understand the climate change and its relation with energy to achieve sustainability and energy security.

4.1.2.2. NTDC Expansion Plan

Energy Infrastructure directly affects a country's economy. Pakistan's decades old infrastructure needs improvement to attain energy efficiency and reduced carbon emissions from production end till the user end. NTDC Expansion Plan has been devised to cater for transmission of power from upcoming generation power plants by up-grading and strengthening its current system. 3 new grid stations at 500 kV level were installed by 2017 adding capacity of 3,750 MVA, while the fourth 500 kV grid station that will add additional 1500 MVA to the system completed by the end of 2020. At 220 kV level, 8 new grid stations with a cumulative transformation capacity of 5750 MVA will be added in the system. Similarly, one overloaded 500 kV grid station will be strengthened, while six such grid stations at 220 kV level be improved by 2019-20 (Ministry of Planning, Development & Reform, 2019).

4.1.2.3. Energy Efficiency Project by DISCOs

The Government, through the power Distribution Companies (DISCOs) implemented a program to support the transition to more efficient forms of lighting. Specifically, about 30 million CFLs were procured under a project financed jointly by the Asian Development Bank (ADB) and Agence Francaise de Development (the French development agency – AFD). These CFLs were provided free of cost to consumers who returned an equal number of incandescent bulbs to the DISCOs. This activity was also supported by a Clean Development Mechanism (CDM) project, implemented by the Ministry of Environment. Energy savings under this program were estimated to exceed 2000 GWh p.a. This Project also improved the consumers' awareness about energy saving opportunities, and performance standards for energy efficient equipment and appliances. For example, CFLs procured under this project had a guaranteed life of 10,000 hours (the first time such high quality CFLs were made available in Pakistan), a High-Power factor.

4.1.2.4. Improved Cooking Stoves (ICS) Target

Access to alternate source of electricity will be given to about 14.03 million households over the next 15 years to reduce reliance on traditional sources of energy.

4.1.2.5. Reducing Gas Consumption

Sui Northern Gas Pipeline Ltd. is targeting to convert 2 million gas geyser consumers to solar water heaters and it is facilitating this by providing on bill financing. By now it has sold almost 2,000 units through easy installments.

4.1.3. Renewable Energy Actions

The different renewable energy sources utilized in Pakistan include biomass, solar energy, wind energy, hydel energy, and small hydro; however, there is great potential for sources such as biofuels, nuclear energy and geothermal energy. Identification of ESCOs done by PEECA through which multiple renewable energy projects are planned to be executed.

4.1.3.1. Bio-Energy

Biomass is a comparatively cleaner fuel that is utilized mainly in rural areas as an alternate to LPG, kerosene, coal and diesel. It is estimated that approximately 12 million cubic meters of biogas can be generated from 150 million kg of biomass collected from agriculture and animal related activities. This source is mainly utilized in households, industry, transportation and electricity generation in rural areas. According to the Energy Control Centre (ECC) approved Policy Framework for Power Cogeneration 2013 (Bagasse/ Biomass), companies have to be issued Letter of Intent (LOI). The Commercial Operation Date (COD) is given to eight projects with installed capacity of 259.1 MW. There are 16 projects under Letter of Support (LOS) stage with installed capacity of 490 MW. The projects under Letter of Intent (LOI) stage are nine in number with installed capacity of 314.5 MW.

4.1.3.2. Solar Energy

In Pakistan, COD is given to 556.8 MW solar plants. There are 24 plants that are at various stages of development. Of those given LOI, only seven have received LOS by AEDB and four of these have received tri-partite LOS with Punjab government. NEPRA has given upfront tariff to eight of them, the seven projects (72.48 MW) are in process for financial close and three of them that are operational since 2016 have signed power purchase agreement with Central Power Purchasing Agency (CPPA-G). In May 21, 2015, the required amendment in the RE Policy 2006 was approved by ECC which also approved the Facilitation Agreement, Coordination Agreement and Template of LOS. The project “Solarization of Public Universities on ESCO Model in Punjab” under PEECA has been initiated and a pilot project “Solarization of University of Engineering & Technology, Lahore” is underway.

Several other solar energy projects in the pipeline that will be completed soon include:

1. Off-grid areas to be provided with solar products under pay-as-you-go schemes. Non-Governmental Organizations' (NGOs) and ESCO will deal with the distribution.
2. Primary school solarization, in which standalone solar will be used with a backup system to run six LED lights and two fans.
3. Distribution of 200-Watt panels to low-income households to power three to four LED lights, one fan and few mobile charging slots.

The government intends to solarize the schools and colleges that do not have access to electricity. After identification of the targets schools and colleges, an appropriate financial mechanism will be utilized and Third-Party Company will have the responsibility and maintenance of the solar systems. Net metering mechanism will be used when energy is not being consumed. There are plans to meet energy demands of regions using solar water heaters that do not have access to piped gas network. The government also intends to promote PV solar powered water pumps that will aid to reduce demand for grid electricity.

Government of Pakistan is also encouraging utilization of renewable energy technology at consumer ends across domestic, commercial, industrial sectors. AEDB has been promoting the renewable energy-based net-metering deployments under the NEPRA (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulations, 2015. AEDB has also been carrying our certification of service providers / installers of solar systems under AEDB (Certification) Regulations, initially formulated in 2018. The regulations were revised in August, 2021 with the aim of simplification under Government's vision of 'Ease of Doing Business'. As of 31 January 2022, the number of net-metering based solar installations had reached 19,227 with a cumulative capacity of 326.54 MW.

4.1.3.3. Wind Energy

The installed capacity of wind generated in Gharo-Keti Wind and Jhampir corridor in southern part of Sindh is 1326 MW. However, a potential of 1,000 MW has been identified in Rajanpur region in 2016 by Danish Company Vestas. It is planned that four pilot project of 250 MW will be developed with the help of Punjab government. A 450 MW project is also under construction and apart from this a 1224 MW wind plant has been approved in Jhampir region. Sindh government has issued LOIs for a 625 MW plant that is now in pipeline. Hence, it is expected that by 2019-2030, a total of 7000 MW will be harnessed from wind power project. As of 2020, about 19 projects have received COD since 2015, and Zephyr Power Pvt. Limited is under construction, and four plants are in LOI stage. The plants in LOI stage are Burj Wind Energy Pvt. Ltd (14 MW), Western Energy Pvt. Ltd (50 MW), Trans-Atlantic Energy Pvt. Ltd (50 MW) and Shaheen Renewable Energy-1 Pvt. Ltd (51 MW) (Alternative Energy Development Board, no date).

4.1.3.4. Hydel Energy

Hydropower being a major energy contributor still has 89% of its production potential untapped. There are plans underway to initiate micro/ mini Hydro (less than 50 MW) in different regions such as Punjab, Azad Jammu and Kashmir (AJK), Khyber Pakhtunkhwa (KPK) and the northern mountains. There are also immense opportunities for small hydro in the country. In KPK, Pakhtunkhwa Energy Development organization is working on eight small public sector and 377 small private sector projects with combined capacity of 271.2 MW and 1679 MW respectively. In Punjab, letter of intent has been issued to 11 projects by Punjab Power Development Board, and development of ten projects with 230 MW combined capacity is underway.

4.1.3.5. Biofuel Energy

Being an agriculture economy, investing in biofuels will help to strengthen the farmers and the agricultural sector. There are two ongoing activities on biofuels in public sector. The first one deals with blending of biofuel diesel and petroleum diesel in order to have 10% share by volume of total diesel consumption in country by 2025. Pakistan State Oil (PSO) will be involved to proceed the National Biodiesel Program. The second activity involves increasing the cultivation of biodiesel through private sector engagement. The private sector involvement has shown good results such as 6 MW coal and biomass plant, a project awarded by Nishat group to Descon Engineering Ltd. Another project is expected to soon start in Sheikhupura, and the feasibility study of 25 MW plant using municipal waste for this project has been completed. Another success by the private sector is the Biogas project at Cattle Colony in Karachi. Karachi Organic Energy Limited (KOEL) is in charge to utilize the waste collected in this area to produce 22 MW electricity and 100,000 tons of organic fertilizer per year. Another project by private sector will be in Mirpurkhas, Sindh that will produce 12 MW energy from biomass.

4.1.3.6. Geothermal Energy

Geothermal energy is another important resource that can be utilized in Pakistan owing to its large generation potential at cheap cost (100,000 MW generation potential). Different regions in Pakistan have shown geothermal indices such as Karachi, Hyderabad, North Areas and Chagai Area. The promotion of this resource is also a part of Renewable Energy for Power Generation 2006 policy. Hence, AEDB is conducting feasibility study and planning to conduct a 100 MW pilot project.

4.1.3.7. Nuclear Energy

In this sector, besides renewable, nuclear power of 2430 MW (325x2+340x2+1 100), a low carbon energy source, is contributing for mitigating GHG emissions in Pakistan. Another 1 100 MW nuclear power plant will be completed in 2022 which will further mitigate GHG emissions while generating low carbon electricity. "Planning the necessary expansion of nuclear power for Pakistan's energy security" is included in Pakistan SNC as a GHG mitigation action under Strategy 1.4 of Energy sector. It is further mentioned to estimate effect of GHG mitigation that one 1000 MW nuclear power plant mitigates 6 million tonnes of CO_2 annually with reference to a coal power plant of same capacity.

5. Industrial Sector

5.1. Mitigation Potential

The industrial sector of Pakistan is highly energy intensive as its intensity stands at 0.117 kgoe[9]/$GDP (PPP) versus 0.08 kgoe/$GDP in the Europe. Industrial sector accounted for 20.3% (Ministry of Finance, 2019) of the GDP and 43.5% of employment in 2018-19. It is the biggest energy consumer with 37.5% of total final energy consumption in 2018 (Ministry of Energy, 2018) and contributing over 18% (Stiebert, 2016) of overall GHG emissions in the country. The major industries in Pakistan include textile, fertilizer, sugar factories, and cement, steel and large, petro- chemical plants. These industries contribute significantly to the total GHG emissions of the country due to the industrial processes in use, in addition to being responsible for more than a quarter of the emissions attributed to the energy sector.

A huge potential for investment exists in the industrial sector. According to a study conducted by IFC, over 4 billion USD can be absorbed in energy efficiency improvements in the industrial sector of Pakistan with a typical payback of around 5 years (International Finance Corporation, 2014). It can be achieved by employing a broad range of energy management, efficient technologies, and practices to reduce overall energy consumption.

- Textile Sector (accounting for 27.6% of the overall electricity consumed by industries & 40 % of the Natural Gas) offers the highest efficiency gains with a total energy saving potential of 2,150 GWh by improving the efficiency of compressors, heat transfer & recovery systems, lights, motors, power factor correction panels, process control, steam system optimization and Variable Frequency Drives (VFDs).
- Cement Sector (accounting for 68.9% of the total coal consumption by industries) has significant energy saving potential.
- Steel sector which has the worst energy benchmarks in the region can be tap for gaining high energy savings.
- The Sugar mills in Pakistan have a high specific energy consumption of over 1250 MJ/ton which is much higher than the average value of 935 MJ/ton for the regional sugar sector. The high value in Pakistan can be attributed to the use of antiquated sugar manufacturing systems and inefficient boilers. Sugar industry has a saving potential of 138.35 GWh per year.
- The leather industry has saving potential of 17 GWh per year from heat transfer and recovery systems, motors, general process, and steam system optimization.
- Electric Motor Driven Systems (EMDS) in the industrial sector consume almost half of the total electricity. The cost effective potential to improve the EE of electric motors is about 20 to 30%.
- Informal energy intensive industries energy optimization programs would be low hanging fruits to focus on e.g. Introducing Zig Zag

9 Kgoe is Kilogram Oil Equivalent – unit for normalized unit of energy equivalent to the approximate amount of energy that can be extracted from one kilogram of crude oil.

technology in Brick Kilns, installation of APFC units in cottage industries, etc.

Table 4.4 summarizes the energy saving potential in the industrial sector of Pakistan.

Industry	Energy Savings Potential (%)
Textile Spinning	3.5
Textile Processing	18.4
Sugar	3.6
Leather	6.9
Pulp & Paper	6.3
Total	38.7

Table 4.5: Energy Saving Potential in the Industrial Sector

Source: Planning Commission of Pakistan (2019). SE4ALL-Nation Action Plan

Majority of small and medium size industrial units use standby generators as a backup option in case of the power outages from the grid, while many units do not even rely on grid electricity and they have their power generation units for self-generation (Mustafa, 2014) which is more commonly known as captive generation capacity. According to an estimate, the import of backup generators exceeds USD 1 billion per annum (Energy Saving in Pakistan, 2016). Diesel and natural gas are two sources of fuel for local industry while some units, especially textile mills, are beginning to use imported Liquefied Natural Gas (LNG) from Qatar. Cement & brick industries meet their fuel needs primarily through local or imported coal. Energy shortages and rising energy prices are driving industries to takes significant measures and reduce energy consumption on a voluntary basis. Some industrial units have already achieved savings of 15% of current electricity requirement. Such energy saving measures were achieved in the textile and sugar industry.

5.2. Mitigation Actions

5.2.1. NEECA Initiatives

NEECA arranged training, education, outreach, and awareness programs for the general public and specific energy users. NEECA also engaged private engineering consulting firms to conduct "energy audits" and provide energy conservation advisory support in the industrial, agricultural, transportation, and construction sectors (Church, Kumar and Sowers, 1993).

In the industrial sector, NEECA conducted the tune up of 600 boilers and 72 furnaces in 387 companies with average efficiency improvement of 6.3%. Steam system diagnostic surveys were carried out in 84 units with 8% of realized efficiency improvement. For electrical system efficiency improvement 40 firms were audited and average efficiency improvement of 5% was realized.

In 2015-16, NEECA[10] in collaboration with WWF, conducted awareness raising sessions for schools with the participation of 5000 to 6000 students. Recently, NEECA, in collaboration with the Pakistan Engineering Council (PEC), conducted a special course on industrial energy audits in almost all main engineering universities in Pakistan. Various technical manuals, such as Energy Efficiency in Electrical Systems, Improving Energy Efficiency in Boilers and Tube wells, have also been upgraded to reduce carbon dioxide emissions from the industrial processes used in Pakistan's major industries.

Recently, NEECA has identified several industrial sector improvement programs as part of its strategic plan 2020-23. Most energy efficiency gains can be achieved by implementing the most fundamental measures which are as follows:

- Improvement in Process Operation, e.g. proper metering in the textile and sugar industry can reduce the energy consumption significantly;
- Replacement of low pressure boilers with high pressure boilers to increase the energy efficiency in the sugar industry;
- Installation of VFD on pumps and motors;
- Installation of Heat Recovery Systems (HRS) to exhaust flue gases in sugar and paper industry;
- Thermal insulation of steam lines and valves can reduce the energy losses in almost all the industrial units;
- Improvement of Maintenance Operation, i.e. reduction of air leakages; and Proper maintenance and operation of electrical motors.

10 It was ENERCON at that time.

- Besides, EMDS in the industry consume almost half of the total electricity. The cost effective potential to improve the energy efficiency of EMDS in the industrial sector is roughly about 20% to 30%.

Promising options for improving energy efficiency in various industry sub sectors include:

- For the cement industry, convert from single stage dry kilns to high efficiency multi stage kilns, many waste heat recovery and power generation projects have been installed in the cement sector.
- For bricks manufacturing, convert from existing bull trench / clamp kilns to zig zag or other modern designs;
- In textiles and various other industries promoting thermal efficiency improvements, introducing energy audits and periodic inspections of manufacturing processes, energy management practices, etc.;
- Promoting the use of bagasse for electricity generation in the sugar industry; and,
- Requiring industries to demonstrate regular maintenance of boilers and other machinery and replacing them with more efficient and high performance equipment.

The above mentioned options are directly applicable to large and medium sized firms and plants, because such establishments have or can access resources (HR, managerial and financial) that enable them to upgrade their manufacturing processes and equipment. The government's role (complemented by private sector involvement in auditing and inspection) will mainly be to ensure that firms acknowledge the beneficial impact of energy savings and the implied reductions in emissions and invest in adopting energy efficiency as a key objective. For the small scale and cottage industry segment, the government's engagement will be two fold: a) Provide skill upgrading opportunities through fiscal or other incentives for such firms to upgrade their labour and production skills; and b) Motivate banks and other financial institutions to provide finances to firms that express an interest in energy efficiency investments.

5.2.2 International Donors Supported Actions

EU funded project title" Implementation of Resource & Energy Efficient Technology" (IREET) is being implemented in the Sugar Sector of Pakistan. The overall objective of the IREET programme is to promote sustainable production of sugar in the Pakistan Sugar Industry, through:

- The reduction in specific energy consumption of the sugar mills;
- The promotion of sustainable consumption of bagasse by supporting sugar mills in adopting energy efficient (technical innovations), and resource efficient technologies; and,
- Adopting latest technology advances and standardization techniques and programmes.

In this regard the first stage of the programme is to ascertain energy saving potential in the industry, by carrying out detailed audits of the sugar mills. These will be used to determine their actual energy consumption and the opportunities that exist to improve this, together with the technological requirements needed to achieve the improvements.

The detailed Resource and Energy Efficiency audit have been carried out by international R&EE audit expert for the following sugar mills:

- Shahtaj Sugar Mills Limited, Mandi Bahauddin
- Kashmir Sugar Mills Limited, Shorkot
- Ashraf Sugar Mills Limited, Bahawalpur
- Faran Sugar Mills Limited, Tando Muhammad Khan
- Dewan Sugar Mills Limited, Sujawal

The typical measures suggested by the International Energy Audit Expert to reduce energy consumption in sugar mills are as follows:

- Reduce the secondary juice temperature to the flash tank from 107 to 103 °C
- Increase the syrup brix from 66 to 68%
- Reduce the movement water on all Continues Vacuum Pans s to 10% of the evaporation rate
- Increase 'A' Massecuite Exhaustion to Target Levels
- Switch the B Continues Vacuum Pans and C Continues Vacuum Pans steam supply to Vapor 3

- Switch the A Continues Vacuum Pans from Vapor 2 to Vapor 3
- Switching the first stage secondary juice heating from Vapor 2 to Vapor 3
- Achieve better regulation of Exhaust Steam pressure & increasing it to 1.2 kg/cm^2
- Switching the Primary Juice heaters from Vapor 3 to Vapor 4
- Switching the direct contact heater from Vapor 1st to Vapor 2
- Increase 'A' Massecuite Exhaustion to Target Levels.

In industrial sector, US Agency for International Development (USAID), Japan International Cooperation Authority (JICA), European Union (EU), United Nations Industrial Development Organization (UNIDO), GIZ and United Nation Environment Program (UNEP) have implemented various energy efficiency initiatives. Most of these projects / programs have been implemented as a long-term initiative to support Pakistan's industry. As reported in SNC Report, "U.S.-Pakistan Centre for Advance Studies in Energy (USPCAS-E)", has been carried out to focus on applied research relevant to Pakistan's energy needs and help produce skilled graduates in the energy field. Similarly, the SMEDA and Ministry of Industries and Production of Pakistan started the implementation of a 22-month JICA funded "Energy Efficiency Management Project (EEMP)" for Industrial Sector in Pakistan in 2015. The EU under the Switch Asia Program supported a four program for high-pressure cogeneration projects for the sugar sector of Pakistan in 2014. UNIDO implemented a four-year project in the industrial sector entitled "Sustainable Energy Initiative for Industries in Pakistan". The project, funded by the Global Environment Facility (GEF), is aimed at stimulating investments in EE projects in industry. Since 2005, GIZ's Renewable Energy and Energy Efficiency (RE&EE) project has been implemented in 42 units in the textile sector, 5 units in the foundry sector, 2 units in the steel re- rolling sector, 4 units in the edible oil sector, 1 unit in the dairy sector and in 8 hospitals which resulted in overall energy savings of 9,340 ToE (GIZ, 2015).

6. Transport Sector

6.1. Mitigation Potential

Transport itself contributes 22.3% of the services sector GDP and accounts for approximately 6% of the nation's total employment (Board of Investment, no date). The total road network is about 264,401 km, including national highways, motorways, expressway and strategic routes. Transport sector accounted for 32% of total final energy consumption in 2018 (Ministry of Energy, 2018). With a contribution of over 13% to Pakistan's GDP, oil (liquid fuels) dominates in the transport energy consumption mix, while the share of natural gas is about 10% (Ministry of Energy, 2018).

Pakistan Transport Plan Study (PTPS), a comprehensive transportation master plan for Pakistan for the period from 2005 to 2025, suggests the initiatives required to counter the environmental adverse effects of transport. Nearly 60,000 people die each year from air pollution related diseases in Pakistan and all large cities in Pakistan have severe air pollution problems (World Health Organization, 2016). The transport sector currently contributes about one quarter of the country's CO_2 emissions and requires urgent addressing ('National Transport Policy 2018', 2019).

Pakistanis travel nearly 400 billion passenger kilometers (pkm) each year and this is expected to rise to 1,000 billion pkm by 2030 (estimates based upon Pakistan Economic Survey, 2017). Interurban passenger and freight transport in Pakistan is primarily via road (94% of all pkm and 98% of freight tonne kilometers (tkm), wherein 80% is via the National Highway Network and rail (5% of all pkm and 2% of all tkm) (estimates based upon Pakistan Economic Survey, 2017) ('National Transport Policy 2018', 2019). Urban transport is dominated by the road sector. Lahore, Islamabad-Rawalpindi, Multan, Karachi and Peshawar have developed, or are implementing bus rapid transit systems.

Urbanization calls for a more diverse transportation demand. To address this issue in a big city like Lahore, government of the Punjab started Orange Line Train project for the fast and reliable commute of the local public. The train takes its fuel from electricity and backup units in case of power failure. Each day, the

Orange Line train project is estimated to consume over 100s of Megawatts of electricity to power the trains along with backup generators in case of power failure. This is a huge financial burden on the provincial government. The situation can be mitigated if rooftops of 24 out of 26 terminals are solarized, concurrently reducing estimated GHG emissions by 1568.6 MT of CO_2.

The country also has two BRT corridors in Lahore and another in Islamabad-Rawalpindi. They are 27 and 23 km in length respectively. The Lahore BRT is busier and, in 2018, carried about 180,000 passengers per day. The Islamabad-Rawalpindi carried about 125,000 passengers per day (Lahore Metrobus System, no date). Now Pakistan has 5 BRT corridors which are operational.

Oil pipelines carry about 37% of all petroleum products, rest being carried by road and rail ('National Transport Policy 2018', 2019). Oil pipeline connections exist to the ports and the refineries; however, they are not yet fully utilized. The implementation of new pipeline infrastructure has commenced at Port Qasim refinery facilities. Several gas pipeline connections are currently under development

Pakistan railways have a 7,791 km route length as of FY 2017-18, which has been constant over a decade. 55.20 million Passengers travelled in FY 2017-18, showcasing a rise of 1.2% over the previous year. The total freight handled in FY 2017-18 grew more than three times in two years to 5 million tonnes, majorly driven by transportation of public goods ('Chapter 14 Transport and Communications', 2008).

Airline passenger numbers have grown slowly compared to global trends 19.7 million international and domestic passengers in 2016-2017 (Pakistan Civil Aviation Authority, 2018). Pakistan International Airlines (PIA), the flagship carrier, has 60% of the domestic market share and 27% of the international market, is facing several challenges, including financial problems and an inability to compete as shown by its declining market shares. Airports of Karachi, Lahore and Islamabad account for 80% of the total aviation market (Pakistan Civil Aviation Authority, 2018). The limited growth in aviation volume is a result of protectionary policies, high taxation levels, and declining tourism. In addition, relatively high freight charges coupled with inadequate cargo facilities at certain airports, have also limited the ability to expand the air cargo market. Major infrastructure development and upgrading of existing airports are well underway to address these concerns.

It is estimated that 17,715,428 motor vehicles will be registered by 2015, of which only 2.2% are buses, taxis and metro cabs used for mass transportation. Detailed breakup of energy consumption in transport and the registered vehicles in 2018 is depicted respectively in Figures 4.3 and 4.4.

6.2. Mitigation Actions

Much of this gasoline demand comes from increasing number of motor cars and motorcycles that have been growing at an excessive rate of 10% (World Energy Council, 2020). According to a study conducted by Canadian researchers, the proper training and driver monitoring can achieve 10% fuel efficiency. The 2013 Framework for Implementation of Climate Change Policy spells out 44 mitigation actions with the following objectives:

- Minimize GHG emissions from transport sector.
- Minimize the adverse effects of aviation's

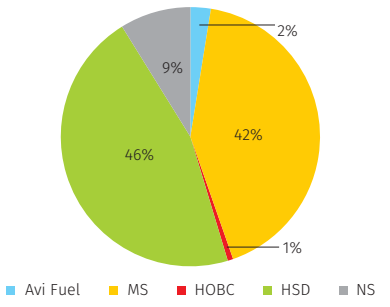

Figure 4.3: Energy Consumption in Transport

Source: Energy Year Book 2018

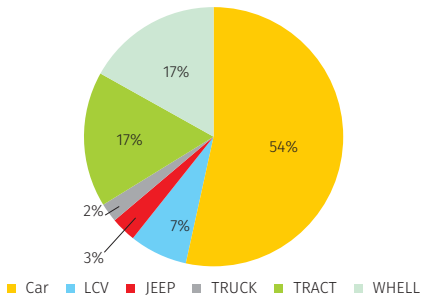

Figure 4.4: Number of Registered Vehicles (2018)

Source: Energy Year Book 2018

emission on the environment in the context of climate change.
- Upgrade, expand and modernize the railway network in the country.

6.2.1. Electric Vehicle Policy

The government has approved the National Electric Vehicle (EV) Policy 2019 to reduce oil import bill and pollution, targeting to convert 100,000 cars and 500,000 two and three wheelers into electric vehicles in the next four years (Ahmed, 2019). The average fuel consumption of motorbikes is around Rs. 6000 per month. That will be reduced to less than a thousand rupees. Similarly, the fuel cost of 650-800cc cars will come down to around Rs. 1200[11]. The EV Policy implementation is also likely to create around 40,000 new employment opportunities, mainly for young electric technicians. NEECA has been mandated to establish center of research and development for electric vehicles in Pakistan EV Policy. NEECA will be instrumental along with other stakeholders in the implementation of the recent EV Policy in Pakistan (National Energy Efficiency and Conservation Authority, 2020).

6.2.2. National Transport Policy 2018

A sustainable and integrated transport is best achieved when all subsector and related policies are aligned. This policy sets the overall objectives for the transport sector as a whole. Several specific policies exist, which are aligned and will be further harmonized with this Policy. This Policy is assumed to provide ongoing direction for the subsequent harmonization of other subsector policies and localized strategies as may be developed by Government. The role of transport is one of facilitating progressive change towards economic development, preserving the environment and achieving social equity. This includes driving the nation towards higher competitive productivity, following the priorities of the economic activity and associated employment and enhancing regional trade prospects; whilst at the same time addressing communities and individual's desires for inclusion, security and greater social equity. The Policy fully supports these priorities and the Master Plan is the means by which these benefits can become a reality.

- Automobile Development Policy (2016)
- National Aviation Policy (2015)
- National Trade and Transportation Facilitation Strategy (2016)

Highlights of National Transport Policy

- *The fuel economy standards such as Corporate Average Fuel Economy (CAFE) as practiced in developed world will be formulated and adopted for the transport sector of Pakistan.*
- *Following that, establishment of model Motor Vehicle Examination (MVE) Centers with the inclusion of Energy Efficiency parameters would also be focused.*
- *Various other interventions would be taken in cargo and mass transportation modes such as railways, buses, etc.*
- *NEECA has been mandated to establish center of research and development for electric vehicles in Pakistan by Electric Vehicle (EV) policy. NEECA will be instrumental along with other stakeholders in the implementation of the recent EV Policy in Pakistan.*

6.2.3. National Transport Research Centre (NTRC)

NTRC is a Research and Development organization mandated with collection of transport data and carry out research in Transport Planning and Engineering. The ongoing projects as of 2017-18 include:

- NTRC Operational Research Program (ORP)
- Projects Approved by Departmental Development Working Party (DDWP)
  a. NTRC Operational Research Program (ORP
  b. NTRC Axle Load Survey Program (ALSP)
  c. NTRC Permanent Traffic Count Program (PTCP)
- Launching of New PC-I Projects
  a. Accident data and cost study
  b. Origin-Destination Survey

11 Interview with Muhammad Sabir Shaikh, Chairman of the Pakistan Electric Vehicles Manufacturers Association (PEVMA) and Association of Pakistan Motorcycles Assemblers (APMA).

- Technical Support to the Ministry of Communications
- Collaboration / Liaison with Department / Institution (NHA, NH & MP etc.)
- Capacity Enhancement Measures.

7. Building Sector

7.1. Mitigation Potential

The residential sector in Pakistan consumes about 23.2% of the total energy mix (Ministry of Climate Change, 2018). The share of residential sector for electricity consumption stands at 49.2% (Ministry of Planning, Development & Reform, 2019). It is much higher than the global average of electricity consumed by this sector. At the same time, energy efficiency potential of this sector stands at 39%. According to estimates, the population in towns and urban centers in Pakistan is expected to reach 40 million by 2025, additionally (UNHABITAT, 2005).

The urban centers are facing serious challenges of resource availability. Apart from residential sector, Pakistan under the China–Pakistan Economic Corridor (CPEC) agreement is going to develop a number of commercial centers and industrial zones. These developments will also have consequences for residential sector. It is expected that construction in housing industry will occur at a very rapid rate in coming years (Ali and Al-Kodmany, 2012). Climate change and GHG emissions are also the concerns of the day to tackle the efforts to contribute in global climate change mitigation efforts to ensure restrict the global temperature rise to not more than 2°C by 2030 and residential consumers' energy in air-conditioning and heating (in extreme weather) (Ministry of Climate Change, 2018).

7.2. Mitigation Actions

7.2.1. Pakistan Building Codes

NEECA has been implementing building codes which covers the energy efficiency standards for building envelops, heating, ventilation and air-conditioning (HVAC) equipment & lighting and to ensure code compliance in the building sector. Building Code of Pakistan existed before but it does not address these energy efficiency issues in the building. NEECA in collaboration with PEC – the statutory body for the development and implementation of building codes, has prepared Energy Provisions-2011, as an addendum to the Building Codes. Currently, the NEECA and PEC are revising these codes which will be launched by the end of 2020 to achieve the 0.5 MTOE energy saving target. NEECA designated agency PEECA has also modified the Building code as per their province climatic conditions, which is also under review and will be implemented in Punjab. Its implementation is likely to reduce the energy consumption in Punjab by 30-40%.

7.2.2. Building Energy Audits

Energy audit of buildings is becoming very popular concept in Pakistan to save energy. NEECA being the apex institution is facilitating the public, private and domestic sector to conduct energy audits of the buildings. Recently, the energy audit of A-Block of Pak Secretariat was conduct. With the approval of Capital Development Authority (CDA) management, a sub metering program of each floor of A-Block building could be launched so that floor wise electricity consumption could be displayed on the digital board at the entrance of A-Block with an aim that every floor can restrict itself to certain limit of units' consumption. The Survey of A-Block Building was carried out with sub-metering perspective as well and was found viable. A survey was carried out to review current operational water usage in sanitary ware at A-Block and develop basis for a demo project as part of Energy Audit activity with a focus on Water Conservation using International Plumbing Code as green guideline.

7.2.3. Green Building Initiatives

The green building guidelines were launched at the Second Pakistan Green build Expo and Conference 2016 in Karachi. The green building council of Pakistan is the lead organization in this regards. NEECA has also set-forth strategies for the energy audits and construction of green buildings in Pakistan. The Punjab Province has formulated and approved the design of first ever public sector green building for the provincial energy department. Retrofitting of lights and fans in public buildings in Punjab is a World Bank funded project whose first phase has been completed. The project will save 30GWh of energy annually and result in reduction 22,320 MT of CO_2 once completed.

7.2.4. Labeling Schemes for Fans

The Energy Labeling Scheme was officially launched on 24th May, 2016 with the support of JICA experts. Subsequently, the fan manufacturers started submitting the applications on voluntary basis for issuance of Pakistan Energy Labels by NEECA, after improvement in their designs and complying with the criteria spelled out in the Scheme Outline for the fan manufacturers.

As per Pakistan Electric Fans Manufacturers Association, approx. 8-9 million fans penetrate the local market annually, out of which 50% are ceiling fans*. JICA analysis and ADB Report has shown that electric fans consume the largest amount of electricity in Pakistan, particularly in peak summer season.

There is an average saving potential of 40-60 Watts per ceiling fan and assuming production of 4.5 Million ceiling fans, as per 3 Star rating determined by NEECA, it could save up to 180-270 MW, per annum.

16 fan manufacturers have registered their 27 models and 348,500 security stickers for energy efficient Pakistan Energy Label Fans have so far been issued by NEECA. Installation/operation of all these labeled fans on maximum rpm results in suppressing electricity demand of 10-15 Megawatts at the user end and about 25-30 Megawatts at the generation side.

About 50% of the electricity in Pakistan is being consumed in the domestic sector and electric fans have the largest consumption being share. Therefore, keeping in view the availability of an accredited lab of electric fans in Pakistan located in PCSIR Complex Lahore and on the basis of the fan samples tested from open market, the MEPS for electric fans were adopted and notified by PSQCA.

NEECA has closely been working with various key stakeholders, like PCSIR, PSQCA and manufacturers of various energy appliances and development partners to form the basis for developing the Energy Labeling Scheme, in view of the best practices of regional countries.

The implementations of Energy Labeling programs have not only reduced thousands of MWs of electricity, but to a large extent has also addressed the issue related to climate change by reduction in greenhouse gases (GHG). Another significant benefit of Energy Labeling scheme is the consumer welfare, as the scheme provides awareness to the public for selection of most energy efficient products.

7.2.5. Energy Efficient Lighting

NEECA secured a grant from GEF and, together with, UN Environment is implementing the project titled "Delivering the Transition to Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors in Pakistan."

The project objective is to secure significant global climate mitigation and environmental benefits by instituting efficient lighting policies, because lighting alone consumes approximately 15% of the total electricity generated. This is a huge chunk of electricity consumption. Thus, the project is aimed to transform the lighting market in Pakistan into a market of energy-efficient and quality lighting, promoting innovative and high efficiency lighting products.

The project is being implemented through activities which have been segregated into four components. Through this project NEECA is developing a National Efficient Lighting Strategy, followed by focus on Strengthening, Monitoring, Verification and Enforcement capacities in Pakistan to ensure an effective transition to efficient lighting. This transition will be supported by creation of a RLF through financial institutions and with the help of an effective communication strategy, making use of gender mainstreaming, the use of high Efficiency Lighting and Controls will be encouraged and accelerated.

When fully implemented, the project is envisaged to have a huge impact on the environmental, social and economic aspects. This will bring about an estimated annual saving in energy of 2,300 Giga Watts and a cost saving of approximately USD 226 million, which is enough money to build a new 500 MW power plant.

7.2.6. Standards and Labeling for Air-Conditioning Units

NEECA is in consultation process with JICA to introduce energy performance standards for air-conditioners to ensure energy savings in domestic, commercial and

industrial sectors. NEECA's designated Agency PEECA is establishing the first public sector air conditioning testing lab to ensure that appropriate standards and labelling schemes are adhered to in locally manufactured air conditioners to help bring down carbon emissions and energy consumption. Policies and regulations shall be drafted to ban refrigerants that are hazardous to the environment. Only those whose Ozone Depletion Potential (ODP) is zero would be permitted to use.

7.2.7. On Bill Financing

NEECA in consultation with DISCOs is planning to launch on bill financing scheme for energy efficient home appliances. It will help to mitigate the emissions as well as energy bill of a household in the long-run. PEECA under the Energy Department, GoPu, has done a preliminary study to introduce an on-bill financing scheme for residential consumers with the help of relevant DISCOs. The households will be solarized on ESCO model, which will bear all the capital investment and maintain the solar PV system for at least 5 years. Similar scheme can be introduced to other provinces through agencies designated by NEECA.

8. Forestry Sector

8.1. Mitigation Potential

Pakistan being an arid and semi- arid zone has only 5.01% (Imaduddin, 2019) of land area (4.34 million hectors) as forest as assessed by Remote Sensing-based data (REDD Implementation in Pakistan, no date). The forest cover in different provinces is: Balochistan: 0.7%, Punjab: 2.8%, Sindh: 2.8%, Northern Areas: 9.5%, KPK: 16.6%, AJK: 20.7% (Final Report of the Task Force on Climate Change (TFCC), 2010). The state owned forests cover about 3.44 million ha of the total forest area while communal and private lands account for the remaining area (Ministry of Climate Change, 2018). This low forest cover qualifies Pakistan as Low Forestry Cover Counties (LFCC), where natural forest declining rate is 27,000 ha per year (REDD Implementation in Pakistan, no date) while on the other hand, human activities are putting immense pressure on forests and causing forest degradation. The contribution of land use change and forestry sector to GHG emissions is merely 2% (Ministry of Climate Change, 2016a), however, the decreasing forests are a critical issue that has to be addressed.

8.2. Mitigation Actions

The poor forest cover requires Pakistan to take immediate actions and some of the promising mitigation actions include:

- Community based forest management / social forestry particularly to conserve rare species and conifer forests;
- Agroforestry, particularly on irrigated farmlands by planting multi purpose and fast growing tree species;
- Commercial plantations; Afforestation of rangelands and degraded lands;
- Reforestation of degraded land;
- Preservation of forest land;
- Management of forest fires;
- Riverine plantations; and
- Provision of alternate fuels to reduce dependency on fuelwood.

Forest management by local communities is seen as a good option which will set limits on harvesting of trees for firewood; this can be achieved by providing training for sustainable management of forests and by introducing community based monitoring schemes. The tree plantation on farmland has many benefits such as safeguarding form soil erosion and strong winds, as well as being a source of fuel wood. It practice is also fruitful in maintaining the green cover of the country.

The northern areas of Pakistan, particularly, rely on forest resources to meet their energy demands. This deems it necessary to supply alternate fuels and space heating in these regions. Certain measures have been adopted to tackle the monopoly of publicly owned utilities over LPG supply, and private sector were given permission to import LPG and the prices of LPG were aligned with an international benchmark price. As a result, LPG supply increased to 756,414 TOE in 2014-15 from 277,809 TOE in 2000-01.

Pakistan is a member to a number of international conventions and treaties, and in order to achieve the goals set by each of them, Ministry of Climate Change has collaborated with a number of organizations. These include GEF, World Bank, UN agencies, multilateral donors and NGOs including World Wide Fund for Nature (WWF) and International Union for Conservation of Nature (IUCN), and PSDP.

The initiatives include:

- Mangrove for the Future (MFF) regional program in collaboration with IUCN-Pakistan;
- Preparation and implementation of National Biodiversity Strategy and Action Plan;
- Revival of forestry and wildlife resources in Pakistan (Green Pakistan Program);
- Up-scaling of Green Pakistan Programme (GPP) into Ten Billion Tree Tsunami (new initiative);
- Scaling-up of Glacial Lake Outburst Flood (GLOF) risk reduction in Northern Pakistan;
- Reversing Deforestation and degradation in high conservation value pine forests in Pakistan;
- Sustainable Land Management Program to combat desertification in Pakistan (SLMP II); and,
- Implementation of Federal Forest Policy 2015.

8.2.1. National Forest Policy 2015

Government of Pakistan has adopted ***National Forest Policy 2015*** which has wide objectives including increasing awareness, reducing deforestation and enhancing afforestation, managing protected areas, reducing carbon footprints and to help implement initiatives of the international conventions of which Pakistan is a member. Another important aspect of this policy is that Reducing Emissions from Deforestation and Forest Degradation (REDD+) will be adopted at the national level. The Forest Policy 2015, has stated different mechanisms to combat receding forest cover issue, but since the devolution of power to provinces, the policy is not fully implemented.

8.2.2. Green Pakistan Programme

Under the directives of Prime Minister ***Green Pakistan Programme (GPP)*** has been introduced to grow 100 million indigenous forest species on 50 percent cost sharing basis with the provinces/regions. This five-year plan has been launched by Office of Inspector General of Forests (OIGF) and initiated country wide in February 2017.

8.2.3. UN-REDD+ Programme

United Nations REDD+ programme was joined by Pakistan in 2011 as a partner under UNFCCC to operationalize REDD+ in its forest management policies. This climate change mitigation approach is committed towards forest conservation, sustainable forest management and the enhancement of carbon stocks to reduce the contribution of GHG emissions from Deforestation and forest Degradation. Pakistan has a great potential for REDD+ as only 4.34 million hectares of land area is forest which is very low. Rough estimates have revealed that Pakistan could earn between $94.74 million and $315.8 million, if it fulfills the REDD+ requirements (Khan and Nasir, 2011), however this estimate might be far more due to weak monitoring, reporting and verification capacity. In order to fulfill the thirteenth goal of SDGs, Pakistan has incorporated the REDD+ strategy into National Climate Change Policy and drafted a Forest Policy passed in 2015. The REDD+ preparedness phase for Pakistan was launched in 2013. International Centre for Integrated Mountain Development (ICIMOD) implemented the REDD+ project in Pakistan with collaboration of WWF-Pakistan. Inspector General of Forests is the main supervisor and this was be carried out with the financial help of One UN Joint Programme on Environment (JPE). The activity included a national REDD+ strategy road map and a national REDD+ project proposal. Pakistan secured a fund of USD 3.8 million after submitting its REDD+ Readiness Preparation Proposal to the Forest Carbon Partnership Facility (FCPF) and it has been in implementation phase since July 2015.

8.2.4. Forest Act 2019

The Government of Gilgit-Baltistan has passed the ***Forest Act 2019*** in order to protect the forests and preserve the environment (GB Forest Minister Attaches Great Expectations with Forest Act 2019, 2019). The new Act has been designed to meet the present-day challenges being faced and meet the requirements of the future generations as well. Under this Act, the cutting of trees will be met by a punishment by violators in the form of heavy fines.

8.2.5. Provincial Initiatives

Punjab has the highest irrigated tract i.e. 55% in Pakistan but it is very poor in terms of forest cover. The area under forest is only 1.66 million acres, and Punjab Forest Management controls about 6.60 million of rangelands (Initiatives, no date).

8.2.5.1. Billion Trees Tsunami Afforestation Project

The Provincial Government of KPK initiated Billion Trees Tsunami Afforestation Project (BTTAP) in 2014. This project has been completed in two phases from 2014-16 and 2016-7; covering 28 forest and watershed of the three (03) forest regions in the province. The second phase was the main period of the project where execution and implementation (GoPK, no date) were carried out in full swing. The overall project cost was PKR 11,738 million (Khan et al., 2017).

The physical targets of the project were as follows:

- Increasing natural regeneration;
- Plantation of multi-purpose fast growing tree species on communal and private lands;
- Rehabilitation of degraded watersheds; reclamation of saline and water-logged areas;
- Farm forestry & mass plantation;
- Promotion of non-timber forest products like medicinal plants, mushrooms and honey; and
- Establishment of model nurseries.

Overall, 593,232 ha of suitable grassland and barren land were planted with different species of trees. Out of the 593,232 ha; approximately 263,153 ha were allotted for afforestation, 306,983 ha were set aside for natural regeneration and 23,096 hectares were used for sowing and aerial seeding (Khan et al., 2019). Under the project, a total of 300 million trees of 42 different species were planted across the KPK province.

Mitigation Potential of BTTAP: Third party monitoring of the BTTAP was carried out by WWF in 2017 to assess the survival rate of planted seedlings and saplings. The survival rate accounted for 88.75% in the light of field work conducted by WWF team (Khan et al., 2017). SUPARCO has also carried out third part validation of BTTAP in KPK. It is estimated by World Economic Forum that after successful maturity, the BTTAP would sequester 0.04 giga-tonne of CO_2 by 2020 with an economic benefit of 120 million USD (Kamal, et al., 2019). It is also reported that about 0.5 million jobs have been created under the BTTAP (Khan, 2017); Nigahbaans (forest guards) were recruited, nurseries were financed, contractors were assigned, and laborers were employed for afforestation activities (Kharl and Xie, 2017).

A comprehensive research study needs to be conducted to better reflect the BTTAP's performance as a sink for GHG.

8.2.5.2. South Punjab Forest Company (SPFC)

The SPF Company has been introduced to promote sustainable forestry investments. The Government of Punjab through public private partnership has established this company under section 42 of the Companies Ordinance, 1984. SPFC having 123,000 ha land under its control leases land for a period of 15 years lease to establish forest or forest-based enterprises over the land on profit sharing basis. The land slots will be awarded to successful bidders after evaluation. The process of bidding has been opened on October 2, 2017.

8.2.5.3. Reclamation and Development of Forest Areas in Punjab

Realizing the need to improve Forestry sector in Punjab, Green Pakistan Programme is introduced in the province under Prime Minister's initiative. This program is focused on the afforestation of blank area in Punjab by planting 5.5 million trees in different forests types. The government has transferred PKR 1284.753 million to the forest department in Punjab for this purpose which is to be completed in 2016-2021.

8.2.5.4. Social Forestry to Increase Tree Cover on Farmlands (Kissan Package)

A great opportunity was realized to increase forest cover by increasing number of plants on farmlands in Punjab. There is a potential of increasing 30 trees per acre without any adverse effect on the agricultural crops already present. According to a survey conducted by Punjab Economic Research Institution (PERI) in 2000, the number of trees per acre on a farmland were 17 in number. The cost of this project with implementation period 2016-2021 is PKR 568.53 million. The aim is to increase per acre tree cover by afforestation of 11850 acres on cost sharing basis (70% Govt. share and 30% farmer share).

8.2.5.5. Kissan Package

This package aims to enhance rangelands production and plant fodder trees for the farming community.

Under the Project afforestation of 1700 acres' area with fodder tree species and reseeding of grasses over 27000 acres is being undertaken. The total cost of this project implemented during 2016-2019 is PKR 745.522 million.

8.2.5.6. Mangroves Restoration Project

The forest department of Sindh with the help of IUCN Pakistan carried out a mangrove plantation drive in April 2018. The mangrove saplings planted in Keti Bunder, Thatta District, along Sindh coast were 1,129,294 in number. Previously in year 2013, the Sindh government planted 847,275 saplings in Kharo Chaan region. Both these plantations led to setting Guinness World Record by Pakistan for most plantations in a day, whereby 2018 drive beating the record set by 2013 drive (IUCN, 2018).

9. Agriculture Sector

9.1. Mitigation Potential

The GHG emissions by agriculture sector in year 2018 were 223.45 MT CO2e (GCISC 2020a) and it is the second largest emitter after energy. The breakdown of these emissions 74.98 Mt CO_2 from agriculture soils, 109.12 from Livestock, 31.52 from Land and 7.83 from rice cultivation. (GCISC 2020) (Ijaz and Goheer, 2020).

The sector being the backbone of Pakistan economy, contributes about 18.9 percent to GDP, providing livelihood to 42.3 percent of the labor force. With the rapidly increasing population, at a rate of 2.4 percent per annum, the demand of agricultural products has increased which requires timely measures to be taken.

The agricultural sector showed productive performance during the year 2017-18 which is depicted by remarkable growth of 3.81 percent as compared to the expected growth of 3.5 percent, also it was better in comparison to the 2.07 percent growth observed in the last year. The underlying factors behind the success were higher yields, better output prices along with supportive government policies, use of pesticides and fertilizers, certified seeds and agricultural credit.

The two major types of crops in Pakistan include Kharif and Rabi crops. Kharif crops have sowing season in April-June and harvesting season in October-December. Examples include rice, cotton, sugarcane and maize. On the other hand, Rabi crops have sowing season in October-December and is harvested during April-May. Examples include barley, gram, wheat and lentils. The timely availability of water is very critical to the growth of each of these crops. The water available during 2017-18, in case of Kharif stood at 70.0 Million Acre Feet (MAF) corresponding to two percent decrease in comparison to Kharif (2016-17) and it was 4.3 percent over normal availability of 67.1 MAF. In case of Rabi crops, water availability in 2017-18 was 24.2 MAF showing 18.5 percent decrease over Rabi (2016-17) and it was 33.5 percent less than normal availability of 36.4 MAF.

9.2. Mitigation Actions

The major threats to the agriculture include extreme weather conditions and temperature changes, both of which negatively impact the soil. Some of the mitigation options with greenhouse gas abatement potential that have been / and are being adopted are:

- Improvement in management of irrigation / water systems
- Reduction of methane emissions from rice cultivation
- Promoting better manure storage and management
- Implement agroforestry practices
- Introduce genetically modified more carbon responsive crops
- Put limitations on crop burning practices
- Reducing the production of methane that is emitted during enteric fermentation is also a viable option. These emissions account for 60 percent of the agricultural emissions. This can be brought about by developing and adopting new breeds of cattle with lower methane production and which are more productive in terms of milk and meat
- Use appropriate chemical fertilizers in order to reduce nitrous oxide release from soils
- Promote no-till farming to improve soil carbon
- Nutrient management: mycorrhiza
- Energy efficiency improvement in tubewells
- Use agricultural and animal wastes to produce biogas and organic fertilizer

Emissions Mitigation Measure	GHG Emission Reductions in 2030 (Mt CO2e)	GHG Emission Reductions from Sector BAU in 2030 (%)	Marginal Abatement Cost ($/Tonne CO2e 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
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

Table 4.6: Emission Mitigation Measures and Impacts

Source: Greenhouse Gas Mitigation Options for Pakistan: Agriculture Sector

- Intensify use of organic pesticides and fertilizers
- Identify and implement ideal cropping patterns to manage soil nitrogen and reduce needs for chemical fertilizers.

Amongst the numerous options to offset GHG emissions, the five priority actions with higher abatement potential along with the associated costs and benefits are given in the Table 4.5.

9.2.1. Improved Irrigation/Water Management

Inefficient groundwater pumping is a very critical issue, since every year 50 billion cubic meters of water is pumped consuming six billion kWh of electricity and three to five billion liters of diesel. The 200,000 electric motors and diesel operated tube well used for pumping purposes account for 2.4 Mt CO2e emissions a year. Efficiency can be achieved by improving irrigation schedules which will reduce the amount of groundwater and fuel requirement.

9.2.2. Reduced Methane from Rice Cultivation

Different approaches have been adopted to minimize methane emissions in rice cultivation. Demos were conducted at 25 different locations and Controlled Irrigation (CI) or the rice management practice Alternate Wetting and Drying (AWD) was utilized. AWD is a controlled irrigation technique which uses alternate drying and re-flooding schedules without stressing the plant growth. After proper verification of these methods over three to four years, they are now being used in the rice cultivation regions of Sindh and Punjab. This technique is successfully being used in an area of 200,000 hectares currently. The AWD technology has also been successful in decreasing methane production in farming. Another approach that promises high methane reduction potential is to use low water dependent rice varieties.

9.2.3. Promoting Agroforestry Practices

The Government of Pakistan aims to increase its forest cover by 6%. Agroforestry promises great mitigation potential by planting multi-purpose tress. Agroforestry practices have already been in initiated in all the provinces of Pakistan, the commonly used plants for this purpose are eucalyptus, shishum (Dalbergia sissoo) and kikar (Acacia Arabica). Even though more than 80 percent of the farms in Pakistan are less than five hectares, but the studies show that plantation of 12 trees per hectare of agriculture land is feasible without impacting the crops.

9.2.4. Promoting Better Manure Storage and Management

There are two benefits associated with better storage and management of manure, firstly it will reduce emissions and secondly it can serve as fertilizer and/or can be utilized to produce biogas. This mitigation option was prioritized in Framework for Implementation of NCCP 2013. Manure is responsible for 16.95 Mt CO2e (95 per cent as Methane, 5 per cent as Nitrous oxide). This mitigation option has potential to reduce emissions by 25%.

9.2.5. Reduced Basmati Rice Crop Burning Practices

In Pakistan, crop rotation of rice and wheat is a common practice. It is a common practice to burn the residue of the previous crops before growing next crop in the fields. Burning of crop residues creates black

carbon which is ranked second after carbon dioxide as a contributor to global warming. In Punjab, 60 percent of farmers are burning crop residues after harvesting. Putting a ban on basmati rice will help to reduce 0.54 Mt CO2e emissions.

10. Solid Waste Management

10.1. Mitigation Potential

The solid waste generated in Pakistan is about 20 million tons a year (Ghauri, 2018) and only 60 percent of this waste is collected by the municipal authorities. The disposing methods deployed include landfill size reduction and screening. The common waste types in Pakistan are Municipal solid waste, Industrial waste, Agricultural waste and Hazardous waste. The solid waste generation ranges between 0.283 to 0.612 kg/capita/day, and growth rate of this generation is 2.4% per year. In terms of emission contribution, only 1.5 to less than 3% emissions are from waste sector. According to the 2012 GHG inventory, discharge from waste management disposal facilities is reported to be 8610 thousand tonne CO2e as Methane and of this, 7707 thousand tonne are generated from solid wastes and the remainder from the management of waste water (MoCC, 2016b). Projected emissions for the waste sector for the year 2030 are 89 Mt CO2e (MoCC, 2018).

According to the 2017-18 Greenhouse gas inventory, emissions from waste sector are reported to be 21.72 MT CO2e. Projected emissions for the waste sector for the year 2030 are 89 Mt CO2e (Ministry of Climate Change, 2018). CH_4 and N_2O form major proportion of the emissions (Table 4.6).

Activity	CH_4	N_2O	Total
Total	8.96	2.44	11.40
Domestic	7.34	2.44	9.78
Industrial	1.62	-	1.62

Table 4.7: GHG Emissions from Waste Water Sector in Thousand Mtof CO2e

Source: GCISC

10.2. Mitigation Actions

The waste sector has great opportunities for mitigation measures which include source reduction through waste prevention, recycling, composting, waste to energy incineration, waste segregation, reduction at source, anaerobic digestion for biogas, sanitary landfill sites with methane capture, healthcare waste management, proper statutory framework, public participation, private sector partnership, tax waiver for recycling enterprises, financial management, and CH_4 capture from landfills and wastewater. Waste minimization and GHG reduction policies include taxes on solid waste disposal (bag fees), market incentives (e.g. offsets) for improved waste management and recovery of Ch_4, and regulatory standards for waste disposal and wastewater management (e.g. mandatory capture of landfill gas).

10.2.1. Regulatory Actions

The regulatory actions to tackle waste include:

- National Policy on Control and Safe Management of Radioactive Waste;
- National Climate Change Strategy & Action Plan 2011- 2015;
- Guidelines for Handling, Storage, Inspection and Accident Investigation of Hazardous Substances and Hazardous Wastes;
- Pakistan Environmental Protection Act (PEPA) 1997, Section 11 of the Pakistan Environmental Protection Act prohibits discharge of waste in an amount or concentration that violates the National Environmental Quality Standards (NEQS);
- Hazardous Substances Rules of 1999;
- Guidelines for Hospital Waste Management since 1998;
- Hospital Waste Management Rules (2005);
- Hazardous Substances Rules (2003);
- National Environment Quality Standards Rules, Islamabad Capital Territory by Capital Development Authority Islamabad and Section 132 of the Cantonment Act (1924) deals with deposits and disposal of rubbish;
- Prime Minister's Committee on Climate Change ensures that the CDM requirements fulfilled under the Kyoto Protocol. This committee has a sub-divisional level technical committee on Waste Management; and,
- Section 12 of Pakistan Environmental Protection Act, 1997 directs that an Initial Environmental Examination (IEE), and wherever the project is

likely to cause an adverse environmental effect, an Environmental Impact Assessment (EIA) should be filed with the Environmental Protection Agency (EPA) for review and approval before the initiation of construction at site.

10.2.2. On-going Projects and Activities

Solid waste management in every province varies. In case of Punjab, Lahore is the only city that has the most properly managed solid waste disposal system. The system was outsourced to Albayrak and OzPak (Turkish companies). Similar systems are also planned for other big cities of Punjab. Currently, the World Bank is supporting the Urban Unit of Punjab responsible for reforming the solid waste management practices in the province. ADB has initiated a Sindh Cities Improvement Investment Program (SCIP), funding of US$400 million has been given by Infrastructure and Service Delivery Reform Program of ADB. The aim of this project is to provide wide range of improved waste management services in 20 secondary cities. The province of KPK, has planned to build a sanitary landfill under the Water and Sanitation Services Peshawar (WSSP). However, the largest province, Baluchistan still has no significant infrastructure for waste management system.

According to the United Nations Environment Program, there are six current activities and plans taking place towards an efficient Waste Management System. These current activities are as follows:

- Solid Waste Management Guidelines (draft) prepared with the support of Japan International Cooperation Agency (JICA), Japan.
- Converting waste agricultural biomass into energy/ material source – project by UNEP, IETC Japan.
- North Sindh Urban Services Corporation Limited (NSUSC) – Assisting the district government in design and treatment of water supply, sanitation and solid waste management.
- The URBAN UNIT, Urban Sector Policy & Management Unit P & D Department, Punjab. Conducting different seminars on awareness of waste water, sanitation & solid waste management etc.
- Lahore Compost (Pvt.) Ltd. only dealing with the organic waste with the cooperation of city district government Lahore, Pakistan. The company is registered as a CDM project with UNFCCC.
- Different NGOs are involved at small scale for solid waste collection, and recycling.

Additionally, a German company in November 2013 has agreed to invest for the installation of a 100-megawatt power plant that would generates energy from waste in Lahore. Lakhodair, almost 5km away from Mehmood Booti, is the first ever scientific disposal facility in Pakistan. It is expanded over 52 hectares of land and complies with all the international standards needed for a disposal site. This power plant according to the feasibility study shows potential to process 1035 tonne of municipal waste daily and generate 550 megawatts daily.

- Landhi Cattle Waste Management Project
- Composting of Organic Content of Municipal Solid Waste in Lahore, Version 01
- Compost from Municipal Solid Waste in Peshawar
- MSW Project in Quetta
- Composting of Organic Content of Municipal Solid Waste at Padri Landfill Site Lahore Canton

10.2.3. Pipeline Projects

Waste to energy is a promising technology, and it is hoped to replace the informal disposal practices in future. In this regard, Punjab Government has taken an initiative to use fluidized incineration technology for the conversion of waste to energy. The contract has been given to Eco Airs, US company to facilitate with their technical assistance. The project will have a capacity of 35 MW and will be managed by Lahore Waste Management Company (LWMC).

NEPRA has announced upfront tariff for municipal solid waste power plants. Such projects are very beneficial as they provide dual benefits; generation of electricity and disposal of garbage. The leveled tariff of US Cents 10/kWh based on 25 years operational period has been announced with overall capacity cap of 250 MW wherein share of each province and Federal Territory have been kept at 50 MW each. For protection from environmental hazards, the power producer shall

obtain necessary approvals from the relevant government agencies. The upfront tariff will be in field for one year.

Two compost making projects from waste have been registered under CDM while one project in Lahore is under implementation which has potential to save 548,407 tonnes of CO_2 in seven years. In order to overcome the shortage of energy, the industries have adopted the use of Refused Derived Fuel (RDF) and Tire Derived Fuel (TDF) as alternatives.

Mardan Solid Waste Management Power Project is another project in pipeline with 12 MW capacity. It has the technology to convert organic fraction in MSW into combustible gases. The conversion shall be conducted in two ways: Biological conversion for converting easily degradable wastes into energy rich gas (methane, CH_4). Gasification of other organics to become synthetic gases at a limited amount of oxygen. The objective of the project is to create a sustainable metropolitan municipal solid waste management system that supports GHG emission reduction.

11. Conclusion

Pakistan reiterates its commitment and obligations towards the UNFCCC and Paris Agreement, and the objective to limit the average global temperature increase to 1.5 to 2.0°C. In this reporting period, Pakistan has taken genuine steps in major sectors of the economy to curb the GHG emission. In this reporting period, the establishment of NEECA and its various programs, Industrial energy audits programs, National Transport Policy, National Electric Vehicle Policy, revision of energy building codes, 100 Million tree Project at National Level are the major initiatives. These measures and actions can be intensified in coming years with expected availability of international climate finance, technology development and transfer, and capacity building.

Chapter No. 5

Monitoring, Reporting and Verification (MRV)

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Monitoring, Reporting and Verification (MRV)

1. Overview

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992 and entered into force in 1994, laid the foundation for the current system of reporting of information related to its implementation. Information on Green House Gas (GHG) emissions by sources and removals by sinks, as well as on the actions that Parties are taking to mitigate and adapt to climate change to implement the Convention, is the key to determine the progress in the implementation of the Convention. Over the decade since the Convention was adopted the Framework was further elaborated to include development of a structured approach to measurement, reporting and, after COP 13 in Bali, also to verification. Parties adopted a number of decisions detailing guidance, including on the content and frequency of national communications, and established provisions for biennial update reports (BURs) and domestic frameworks for Measurement, Reporting and Verification (MRV).

The Bali Action Plan introduced language on "Measurable, Reportable and Verifiable" GHGs mitigation, actions and commitments, as well as support for GHG mitigation actions in developing countries. UNFCCC requests commitments or pledges, and to provide background information on the scope and ambitions of national climate change responses. Enhanced Transparency Framework (ETF) under the UNFCCC Paris Agreement, to which Pakistan is a signatory, has transformed the requirements for national MRV and GHG system for all developing countries.

This Chapter reviews the current MRV situation and MRV processes in Pakistan for different sectors including: energy; agriculture and livestock; industrial; land use change and forestry; and waste management. The Chapter proposes essential features of a national MRV system including: MRV components; Reporting requirements; and MRV pathways for GHG inventory, mitigation and adaptation, and support. The Chapter also identifies data providers for GHG inventory and Mitigation/ adaptation actions/ policies and support required and received. Key components of institutional arrangements, stakeholders' engagements and organizations' mandates are also included.

2. Current MRV Situation in Pakistan

Government of Pakistan has undertaken some initiatives to develop measuring and reporting system for various financial and physical parameters in the country, but the country does not conduct any MRV for GHG emissions directly. Ministry of Finance (MoF) monitors and publishes annual report of the economic condition of various sectors in Pakistan including energy, agriculture, climate change and many others in its reports titled as Pakistan Economic Survey. As a developing country, Pakistan does not have institutional arrangements for GHG Inventory preparation or broader climate MRV. However, Pakistan has conducted ad-hoc project-based inventory work, which has helped build somewhat sustainable institutional capacity for ongoing and continuously improving MRV outputs. The project under National Forest Monitoring System (NFMS) developed an MRV system for REDD+ in Pakistan to support continuous monitoring of forest and land/use change. Ministry of Climate Change (MoCC) has been working towards developing standards to make the climate change monitoring process efficient and effective. The Ministry is in the process of revision of NDCs to collaborate on MRV and GHG emission inventory strengthening components under the UNFCCC reporting.

2.1. National Initiative for Sustainable Development Goals (SDGs)

Ministry of Planning, Development & Special Initiatives (MoPD&SI), Government of Pakistan in collaboration with the provincial Planning & Development departments and support of UNDP-Pakistan has launched a five-years joint project of "National Initiative for Sustainable Development Goals" to institutionalize 2030 Agenda. The initiative brings together the planning, financing and statistical institutions to work collectively to lay foundation for SDGs implementation in the country. Table 5.1 is the summary of the initiative.

Periodic monitoring and evaluation of various strands of the SDGs framework remains an important priority. Baseline and targets for all SDG indicators have been determined since 2018. National data collection tools have been modified to improve data availability with a focus on equity and sustainability aspects of SDGs. Transparency would be a major hallmark of the monitoring and evaluation architecture–through the establishment of SDGs dashboard.

2.2. Sectoral MRV process in Pakistan

Pakistan currently lacks an appropriately detailed, comprehensive and unambiguous framework legal basis for national GHG MRV. The following section describes the current monitoring system in Pakistan for various parameters though some may not be related to GHG emissions.

2.2.1. Energy Sector

Pakistan Water & Power Development Authority (WAPDA) is operating 19 Hydel Power plants having total installed capacity of 6902 MW thus playing a vital role in providing cheap energy to National Grid. The Monitoring and Enforcement Department of National Electric Power Regulatory Authority (NEPRA) works to raise the competency and performance of the power sector by enforcing rules and regulations, statutory orders, and terms and conditions detailed in License Agreements, Standards and Code of Conduct etc. Reports are regularly prepared based on generation data of all power plants provided by the National Power Control Centre (NPCC).

Hydrocarbon Development Institute of Pakistan (HDIP) publishes annual reports as Energy Yearbooks. The data in this yearbook are presented as top down and are ideally suited for use in the IPCC GHG emission estimation methodology. Extensive data are taken from Energy Yearbook to estimate CO_2 emissions from energy sector. The emission factors of fossil fuels, such as coal, oil, and natural gas are the most important considerations in estimating the GHG emissions from the combustion of these fuels.

Pakistan Oil & Gas Regulatory Authority (OGRA) works to safeguard public interest through efficient and effective regulation in the mid and downstream petroleum industry. OGRA publishes annual reports of transparency and state of the regulated petroleum industry. In order to strengthen the monitoring and surveillance process, Economic Coordination Committee (ECC) of Cabinet approved the establishment of monitoring unit within both Ministry of Water and Power (MOWP), and Ministry of Petroleum and Natural Resources (MPNR) with the responsibilities to: monitor implementation of the Five Year Sector Reform Program; set up benchmarks and key performance indicators for distribution and generation companies and other related entities to the reform process; and make public disclosure of the monitoring reports.

Policies and Plans	Data Reporting	Financing	Innovation
Mainstreaming SDGs in local development plans and strategies clearly delineating the resource requirement.	Strengthening coordination, reporting and monitoring mechanism for SDGs.	Financing flows increasingly aligned with 2030 Agenda.	Supporting integrated and innovative approaches to accelerate progress on SDGs on priority.

Table 5.1: Summary of National Initiative for SDGs

2.2.2. Agriculture and Livestock Sector

The Agriculture and Livestock sector is highly vulnerable to climate change impacts. Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), in collaboration with erstwhile Ministry of Food and Agriculture, developed a satellite-based crop monitoring system which provides fast track and accurate information on crops and also reports any catastrophic situations. Agricultural map of Pakistan is developed based on high resolution data acquired during peak growth seasons of February for Rabi crops and September for Kharif crops. SUPARCO carries out wall to wall coverage of the agriculture area of the country using satellite data. These data are utilized to monitor various crops across seasons.

Planning and Research Monitoring Cell of National Agriculture Research Center (NARC) coordinates research related activities and monitors evaluation of research efforts. The objectives of this cell are to provide technical support to the NARC management and develop data base of research activities. Adaptation of technologies available from international research is also managed by NARC, in collaboration with the provincial research and extension institutions.

Distribution of livestock between provinces (first proxy for environment classification) is available from the livestock census, conducted every 10 years. Yet the last livestock census was completed in 2006. Pakistan Agricultural Research Council (PARC) is the apex national organization in Pakistan working in close collaboration with public and private sector institutions in the country to provide science-based solutions for the development of agriculture in Pakistan whereas Livestock and Dairy Development Board (LDDB) is mandated to promote and facilitate development of dairy, meat and allied commodities in the country to achieve the full potential of livestock in Pakistan. LDDB is also working for poverty reduction in rural areas to contribute to the economic growth of Pakistan. Under the project titled “Prime Minister's Initiative for Back Yard Poultry” monitoring of Avian Influenza and Newcastle Disease and improving productive performance of Backyard Poultry through propagation of superior hybrid poultry birds are also areas of cooperation between LDDB and PARC.

2.2.3. Industrial Sector

Government of Pakistan has taken various steps to control industrial pollution in the country. The most significant measure was the enactment of the Pakistan Environmental Protection Act, 1997 that makes it incumbent upon industrial facilities to restrict their air emissions and effluents.

Self-monitoring and reporting system of industries is the result of a consultative process extending over a few years, in which the Government, industries and other stakeholders participated to develop an environmental monitoring framework. The resultant system proposed by the Environmental Standards Committee, takes into account resources and interest of both the EPAs and industries. This system requires industrial units to get their effluents tested from laboratory, enter the results in electronic form using a “Self-Monitoring and Reporting Tool” software and then send data to respective Environmental Protection Agencies.

2.2.4. Land-Use-Change and Forestry (LUCF) Sector

WWF-Pakistan established Spatial Monitoring and Reporting Tool (SMART) based wildlife monitoring and conservation system in selected Protected Areas (PAs) of Pakistan. An operational National Forest Monitoring System (NFMS) is designed, developed and piloted for MRV system for REDD+ in Pakistan to support continuous monitoring of forest and land/use change. Integrated implementation of Satellite Land Monitoring System (SLMS) and National Forest Inventory (NFI) are component platform for operationalizing the Forest Land Assessment under MRV functions.

In order to improve tree cover in Pakistan, seasonal tree plantation campaigns are held each year. The government departments, private sectors organizations, defense organizations and NGOs are involved in these planting activities. The Billion Tree Tsunami Project (BTTAP) that started in 2015 in the country's northwestern province of KPK was followed by Ten Billion Trees Tsunami project (TBTTP). The 169 million USD program added a total of 350,000 hectares of forest through tree planting and regeneration. Under the projects, Forest departments offer subsidies

to landowners to plant trees on their land. The landowners receive free seedlings with the choice of which species they wanted to plant. Most chose Eucalyptus, because of its quick growth characteristics.

2.2.5. Waste Management Sector

Pakistan Nuclear Regulatory Authority (PNRA) regulates all radioactive waste generated during operation and decommissioning of nuclear installations, radiation facilities and associated activities in the country. Radioactive waste management is a critical area of PNRA's regulatory regime as exposure to radioactive waste can pose serious hazards to human health and safety. While PNRA strives to ensure the protection of human health and the existing environment, equally hard efforts are made to ensure that any undue burden is not imposed on future generations.

Local Government & Community Development Department (LGCDD), Government of Punjab established six solid waste management companies on the pattern of Lahore Waste Management Company (LWMC). These companies developed an IT based monitoring system. Vehicle Trip Counting System (VTCS) is automatically operated without any human involvement. The volume of waste collected from the city and transferred to dumping areas is recorded using VTCS. This web-based system is accessible through internet. The amount of waste delivered by each vehicle can be seen in real time with a picture of the vehicle.

The Clean Green Pakistan Index (CGPI) is a city / tehsil neighborhood-level index which aims to rank cities/tehsil and neighborhood according to their cleanliness and greenery. The CGPI is the core pillar of CGPM officially launched by the Prime Minister of Pakistan in November, 2019. CGPI is used for cities' ranking against the performance indicators set for each component including safe drinking water, solid waste management, liquid waste management/ hygiene, plantation, and total sanitation. The purpose of CGPI is to rank the cities based on greenery and cleanliness.

Pakistan has estimated GHG emissions from dumpsites but not from waste incineration. However, waste burning activities are known to be occurring at some dump sites. In Pakistan, municipal corporations systematically collect urban waste and dispose it of at waste disposal landfill sites. Its anaerobic decomposition results in CH_4 emissions. The emissions estimate is partial due to lack of solid waste activity data. In rural areas, waste is neither collected nor dumped, but is thrown in the fields for decomposition.

3. Proposed National MRV System for Pakistan

3.1. Current Situation

Pakistan has no formal MRV system in the country. Greenhouse Gas inventories are being prepared on need basis. The first effort on preparing the GHG inventory was undertaken by Asian Development Bank (ADB) during 1995-98 under its project “Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS)”. The second GHG inventory for the country was prepared by M/s Hagler Bailly during 1990-2003, with the support of GEF through UNEP) under the project GF/2200-97-57, for preparing Initial National Communication for submission to UNFCCC. The third GHG inventory of Pakistan was prepared indigenously by the Applied System Analysis Division (ASAD), Pakistan Atomic Energy Commission (PAEC) in 2009 using 2006 IPCC guidelines; this GHG inventory, however, was not submitted to UNFCCC. Fourth GHG inventory was prepared by GCISC in 2015 using UNFCCC Non-Annex 1 Greenhouse Gas Inventory Software, Version 1.3.2 in accordance with Revised 1996 IPCC Guidelines and was submitted to UNFCCC.

Pakistan currently has no formally established institutional arrangement for the preparation of GHG Inventory and broader climate MRV system. However, a little institutional capacity has been built as a result of GHG Inventory work in projects. The MoCC and other related institutes viz. Pakistan Climate Change Council (established under Act, 2017) and GCISC, have the mandate for conducting climate MRV in Pakistan. Pakistan Climate Change Council has the responsibility to “monitor” implementation of UNFCCC and “consider” reports prepared by Pakistan Climate

Change Authority. Reporting system is already established in the country for many physical and financial parameters but this system does not conduct any MRV for GHG Inventory directly.

In Pakistan, responsibilities for the climate change issues have largely remained at the federal level but some of the input data necessary for a National GHG Inventory are collected by provincial departments. After the 18th amendment to the constitution of Pakistan in 2010 resulting in altered relationship between the federal and provincial governments, the MoCC provides vertical coordination between federal and provincial governments and supports preparation of reports including National Communication (NC) and Biennial Update Report (BUR). The major contributor to such efforts is GCSIC, a research arm of MoCC.

3.2. Proposed Components for National MRV

Pakistan was using the revised 1996 IPCC Guidelines and National GHG Inventory software version 1.3.2 for the preparation of past GHG inventories. However, since 2018, after the Katowice Decision, the IPCC 2006 Guidelines are being used for the preparation of GHG inventories. The following components are proposed for the national MRV implementation so that the collected data are evolved into a comprehensive national MRV system.

Measurement of: Financial and technical support needed and received, capacity building for the implementation of mitigation and adaptation policies and actions, and activity data of national emissions (and removals by sinks) of all the sectors (Energy, transport, industrial processes and product use, AFOLU, transport, and waste).

Reporting of: GHG Inventory, adaptation and mitigation policies, and actions with associated data on cost-benefit.

Verification of: GHG reductions by implementation of mitigation and adaptation actions and reported GHG Inventory.

3.3. Reporting Requirements

Pakistan is focusing on developing institutional arrangements on the basis of current UNFCCC reporting requirements, as well as the new MPGs under the Paris Agreement. Specifically, current UNFCCC requirements are:

- 2/CP.17, Annex III, Para 2(a) (UNFCCC BUR guidelines for non-Annex I Parties): The scope of biennial update reports is to provide an update to the most recently submitted national communication in the areas of: Information on national circumstances and institutional arrangements relevant to the preparation of the national communications on a continuous basis.
- 17/CP.8, Annex, Para 5: Non-Annex I Parties may provide a description of existing institutional arrangements relevant to the preparation of their national communications on a continuous basis.
- 17/CP.8, Annex, Para 13: Non-Annex I Parties are encouraged to describe procedures and arrangements undertaken to collect and archive data for the preparation of national GHG inventories, as well as efforts to make this a continuous process, including information on the role of institutions involved.

3.4. MRV Structure

The MRV setup is proposed to consist of a single national entity to act as supervisory body. MoCC is currently the coordinating entity and the national and international focal point for the climate related activities with the Prime Minister's Committee on Climate Change, headed by Prime Minister of Pakistan, functions as the Apex Body for key decisions and actions on climate change. Further Pakistan Climate Change Act was passed in 2017 under which a Climate Change Council headed by Prime Minister, with representation from all the federating units, professionals from research and academia, and representation from civil society organizations, has been formed. The Climate Change Authority, the implementing arm, under the Climate Change Act is yet to be established. There is a need to establish MRV system in the country as it would allow tracking progress towards climate change-related targets and

steer mitigation actions to achieve targets. MRV provides information about emission sources and trends, helps companies to increase their energy efficiency and take decisions on where to reduce their emissions. With the Paris Agreement, MRV system is gaining further importance as it is the key element to guarantee transparency, precision and comparability on climate change information.

MRV pathways consist of the following three tracks:

- MRV of GHG Inventory
- MRV of Mitigation and Adaptation Policies
- MRV of Support

The existing infrastructure for GHG MRV is shown in Figure 5.1.

3.4.1. MRV of GHG Inventory

The first track is concerned with GHG inventory, which is based on aggregate national level data. This track is primarily concerned with gathering GHG data from the respective units holding activity data under each relevant ministry. Currently GGCISC, on behalf of MoCC, collects and arranges data from respective Ministries and departments in required forms and prepares the inventories using IPCC Guidelines.

This arrangement is likely to continue. GCISC with the support of GIZ and CITEPA is in the process of development and implementation of a MRV web platform (Monitoring, Reporting, Verification) for monitoring GHG inventories. This platform will support the compilation of the national GHG inventory according to Modalities, Procedures and Guidelines (MPGs) as adopted in Decision 18/CMA.1 at COP-24 in Katowice. CITEPA carries out the overall management of the project, the diagnosis of the existing situation, the consultation of stakeholders through sectoral workshops, the definition of the characteristics of the MRV platform, the training of future users. The IT development of the platform is managed by Office International de l'Eau (OIEau) and funded by Gesellschaft für Internationale Zusammenarbeit (GIZ).

The Centre is also in the process of formation of Technical Working Group and signing the Letter of Agreement with the data providers for planning and Institutionalization of data provision process by

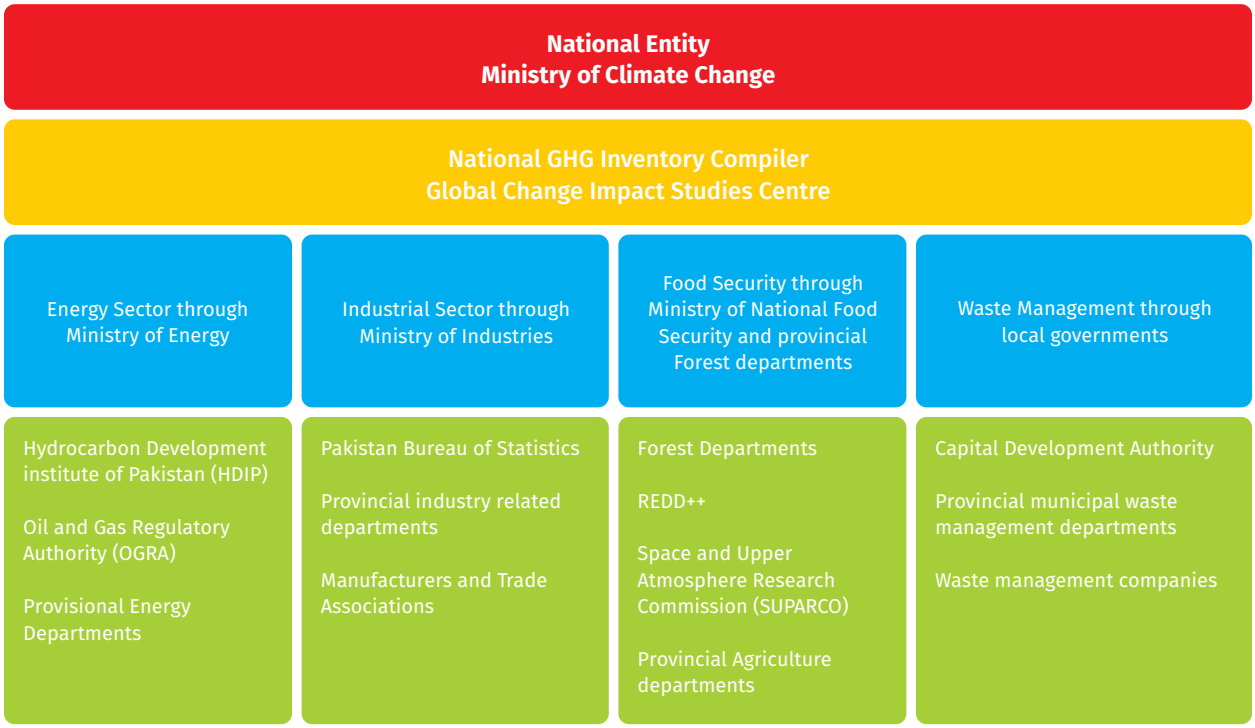

Figure 5.1: Existing Institutional Structure for GHG MRV in Pakistan

developing a software. The Technical Support Working Group for MRV (TS-WG) is to be established from a group of data providing agencies and national experts to provide technical assistance and guidance to the coordinating entity, Climate Change Reporting Unit, and the relevant ministries. The main role of this group is to provide support to the coordinating entity regarding the design of data collection templates for GHG inventory, mitigation actions, and support and review the prepared reports prior to submission to the QA-WG and UNFCCC.

A roadmap and a communication strategy for the awareness-raising of climate-relevant data amongst data providers in Pakistan is also being prepared for establishing a robust data management system and preparation of GHG inventories on regular basis.

3.4.2. MRV of Mitigation and Adaptation

The second track is the MRV of Mitigation and Adaptation. MoCC and the Technical Working Group will be involved in this track to provide country's vision and strategies. Each organization related to GHG emissions would have an MRV unit reporting for quantifying the actual GHG reduction after implementation of mitigation actions. This track also includes the adaptation policies and actions which would be implemented across all the relevant organizations. Each organization will submit an Annual Report directly to the coordinating entity viz. MoCC providing information about the status of implementation mitigation and adaptation actions. Technical support working group will provide technical support to the implementing key progress indicators, MRV plans and GHG estimation methodologies.

Pakistan is the eighth most vulnerability country to climatic risks as per German Watch and is in great need of adaptation support from international community. However, limited capacity in showcasing effectiveness of adaptation actions and future adaptation needs hinders Pakistan in accessing bilateral and international funding on climate change adaptation. Therefore, developing an adaptation inventory and building a robust M&E system for adaptation actions is very important and also in line with the recommendations of UNFCCC's Least Developed Countries Expert Group's Technical Guidelines that emphasize on Parties to monitor progress and effectiveness towards the goals and objectives of their National Adaptation Plans process. Such a system can eventually contribute to reporting Pakistan's contributions to the UNFCCC, including towards the

global goal on adaptation defined under the Paris Agreement. It can also help Pakistan report on achievement of SDGs, in particular SDG 13 on Climate Action, and the Sendai Framework's targets and indicators. At the same time, this system will also support the Country in demonstrating the effectiveness and efficiency of the resources allocated to climate change adaptation to donors and will allow to fetch more climate funding and financial support to build resilience to climate change.

In addition to GHG inventory and MRV system, tracking adaptation actions is another requirement of MPG chapter IV to submit the progress on adaptation actions under Article 7 of the Paris Agreement on climate change. Pakistan has very limited capacity and resources to monitor and evaluate adaptation actions at the national level. Further, it does not have any concrete mechanism and IT platform for M&E of adaptation actions. Against this background the GCISC, the representative organization from MoCC on NDCs with the support of GIZ and CITEPA is working on the development of an adaptation tracking framework and strengthening its capacities in assessing/improving the measurement of adaptation progress and getting funding for adaptation and resilience.

3.4.3. MRV of Support

The third track is the MRV of support. MoCC in collaboration with the Planning Commission and MoF is determining the domestic and international sources for financing different climate change related activities. All the organizations that receive climate support are required to determine the sources of finance for their climate related activities and report them to the national coordinating entity viz. MoCC.

3.5. Data Providers

3.5.1. GHG Inventory (Track 1)

GCISC is proposed as the data hub to which the GHG inventory information flows from the relevant ministries. It will be obligatory on all ministries/departments to submit annual data to GCISC through a quality control system. All GHG Inventory data will be properly validated.

3.5.2. Mitigation and Adaptation Actions / Policies (Track 2)

The relevant ministries and other entities implementing mitigation and adaptation programs will act as data providers and be responsible to monitor the progress of such actions. Universities and

research centers have an important role to play in supporting the ministries in relevant data collection and monitoring actions. The templates and methodologies to be used by these entities are proposed to be prepared by Technical Support Working Group. Each ministerial MRV unit will generate reports on their respective mitigation programs in line with the national strategies issued by the Planning Commission and will communicate directly to MoCC as the National Coordinating Body.

3.5.3. Support Received (Track 3)

Ministry of Finance and Ministry of Industries are proposed as data providers to MoCC on the support received. This entails categorizing climate change projects receiving climate finance and indicating the type of funding received in the system by the concerned entity.

3.6. Key components of Institutional Arrangements

Institutional arrangements can be organized around following five components:

1. Stakeholder engagements
2. Organizational mandates
3. Expertise
4. Data flows
5. Coordination System and Tools

3.6.1. Stakeholder Engagements

Strong stakeholder engagement ensures that the transparency system reaches a broad range of stakeholders, including those from national government, local government, the private sector, academia, NGOs, the media and the public, so that data can be gathered from the most reliable and relevant sources and the outputs can inform their decision-making processes. Engagement should include stakeholders involved in the implementation of action, as well as stakeholders who provide data and advice on data interpretation.

3.6.2. Organizational Mandates:

Suitable, clear organizational mandates guarantee the availability of experts, flow of data, efficient systems and tools, and sufficient stakeholder engagement to deliver useful insights to decision makers and fulfill regular national reporting obligations under the Convention and the Paris Agreement.

3.6.3. Expertise

Having a strong team of national professionals ensures that expert resources are available to regularly generate technical outputs that inform decision makers and wider audiences of upcoming challenges, and the country's progress and ambitions. The team will be responsible for knowledge retention and transfer between expert roles and training of junior level of professionals.

3.6.4. Data Flows

Well-functioning data flows ensure that data needed would help understand the challenges faced in reducing GHG emissions, climate-related risks, and vulnerabilities.

3.6.5. Coordination System and Tools

Effective coordination system and tools ensure that the team of national experts are able to access data, manage data flow, perform quality assurance and control and produce timely quality outputs that would improve over time. They will also facilitate the engagement of a wide range of stakeholders responsible for providing data and making use of the outputs.

Key components of institutional arrangements are given in Figure 5.2.

Figure 5.2: Key Components of Institutional Arrangements

Photo @ Glacial Lake Outburst Flood (GLOF) Risk Reduction Project

Chapter No. 6

Constraints, Gaps & Solutions and Need for Financial/Technical/ Capacity Building Support

Chapter No. 6

Constraints, Gaps & Solutions and Need for Financial/Technical/Capacity Building Support

1. Overview

This Chapter gives details of updated information required from non-Annex I countries in accordance with decision 2/CP.17, Annex III and includes a description of constraints and gaps with related solutions, and the financial, technical and capacity needs of Pakistan, including the level of support received to enable the preparation and submission of biennial update report. The contents of this chapter are updated information from year 2015 till 2021.

The Chapter identifies constraints and gaps in GHG inventory preparation, assesses the vulnerabilities, mitigation and adaptation actions taken. Identification of constraints and gaps are based on literature review (MoCC 2016, MoCC 2017, and MoCC 2018) and a detailed survey to collect primary information in order to help identify barriers & gaps and help draft recommendations and solutions. Information on mitigation gaps and adaptation actions are presented sectors wise; however, some general constraints that are common among all sectors are described separately. These constraints and gaps are identified in terms of economic, social, technical and political aspects.

The information presented in this Chapter is collected after a thorough review of existing literature as well as a consultative process involving concerned federal and provincial government departments and civil society organizations.

Photo: @ ansabalipk

2. Constraints, Gaps and Solutions

2.1. GHG Inventory Preparation

Preparation of GHG Inventory is an important component of climate change mitigation strategies. However, Pakistan does not have a formal arrangement for preparation of such inventory. The lack of sector specific emissions data makes it difficult to estimate exact GHG emissions. Hence, a unified approach at the national level is needed where each concerned government organization could play its part under the supervision of an umbrella organization.

Detailed constraints and gaps encountered in inventory preparation and proposed solutions are presented in Table 6.1.

Sr. No.	Constraints & Gaps	Proposed Solutions
1	Lack of credible data. For example, data on the use of fossil fuels for manufacturing solid fuel are not available; estimation figures of methane emissions at national level are uncertain due to lack of time series data on municipal solid waste (MSW) generation; and, fraction of carbon oxidized may vary due to inefficient combustion processes.	▪ Give clear mandate to organizations working under each sector to record, maintain and submit emission data at regular intervals to the governing organization. ▪ Develop a mechanism for direct coordination among UNFCCC, EPAs, Power companies, Transport etc. to help estimate emissions. ▪ Conduct detailed surveys in various sectors for estimating GHG emissions. For example, detailed survey for measurement of GHG emission can be carried out in rice fields where crop residue burning is practiced.
2	Lack of country specific GHG emission factors (Tier 2 and 3) which results in poor estimation of GHG emissions.	Enhance efforts to provide accessibility to technical tools/facilities for preparing GHG inventories.
3	Inadequate human resources for GHG inventory preparation. Presently, only a few professionals in Global Climate Impact Studies Center (GCISC) are capable of preparing GHG inventory following IPCC Guidelines	Increase Capacity Building programs specifically designed for GHG Inventory preparations for institutions at federal & provincial level.
4	Negligible involvement in capacity building activities and lack of financial resources for climate change related field activities organized by relevant organizations.	Build human resource capacity in related fields of climate change by introducing relevant educational programs in higher education institution.
5	Inter-provincial, intra-provincial and provincial-federal linkage gaps.	Make it mandatory, through amended rules of business, upon provincial and federal organizations to practice improved coordination and collaboration among themselves.

Table 6.1: Inventory Preparation Constraints, Gaps and Proposed Solutions

2.2. Vulnerability Assessment

Vulnerability assessment of different sectors for adaptation to climate change effects is necessary as an initial step in the climate assessment adaptation planning process. Typically, vulnerability assessment focuses on species, habitats, or systems of interest, and helps in identifying the greatest risks to them from climate change impacts. Being a relatively new concept, one of the major issues faced in Pakistan in carrying out vulnerability assessment is the limited technical expertise for climate change related modeling and forecasting.

Detailed constraints and gaps with appropriate solutions to help assess vulnerability on scientific lines are given in Table 6.2.

Sr. No.	Constraints & Gaps	Proposed Solutions
1	Green Productivity (GP) Assessments are not mandatory and are not considered in any plan to cope with climate change.	Working groups, responsible for planning, implementation and monitoring of climate change activities should take GP assessments into consideration, which has been developed by NPO since 2005 with the support of APO, Tokyo, Japan.
2	Lack of measuring tools and equipment. For instance, non-availability of real-time climate data and rivers flow observational is hard to obtain.	Provide adequate technical resources that will aid in vulnerability assessment in all the sectors specifically water and energy efficiency sectors.
3	Under-utilization of workforce of organizations due to lack of financial resources.	▪ Introduce financial incentives at national level to overcome this issue. ▪ Organizations should tap international funding opportunities available for vulnerability assessmcleaent related projects.
4	Limited inter-organizational collaboration at federal and provincial level such as meteorology, disaster management, agriculture, irrigation and water management authorities.	Develop regular communication system between federal and provincial government organizations.
5	Limited focus on climate change related R&D and analytical studies causing hindrance in disaster risk reduction in the country.	▪ Establish sector specific research centers at provincial levels for mitigating climate change effects. ▪ Undertake improvement in early warning communication and dissemination system through promotion of R&D activities in this field. ▪ Capacity building of relevant stakeholders, i-e, PAEC/ GENCOs/ thermal IPPs to study long-term impacts of climate change on their respective technologies.
6	Lack of technical expertise to develop and run advanced numerical forecasting models. interpret satellite high-resolution imagery and forecast model output at local level.	Offer technical educational programs on climate change and vulnerability assessment at higher education level.

Table 6.2: Vulnerability Assessment – Constraints, Gaps and Proposed Solutions

2.3. Adaptation Actions

Adaptation actions are necessary for the most vulnerable sectors such as water and agriculture. Water scarcity is a major issue that results from global warming and affects agricultural production. Major constraints in taking adaptation actions are both technical and financial. Lack of timely drafted policies also hinders progress in adaptation action. A detailed adaptation plan has been presented by MoCC in need assessment project (MoCC 2016a) which can help overcome these barriers.

Detailed constraints and gaps identified with proposed solutions are presented in Table 6.3.

Sector	Sr. No.	Constraints & Gaps	Proposed Solutions
Common	1	Lack of awareness about the existence and usefulness of adaptation technologies.	Raise awareness in public and private sector organizations on importance of adaptation actions.
	2	Underdeveloped market, weak supply chain and distribution mechanisms for adaptation technologies.	Setup local manufacturing units to indigenize latest technologies to help reduce import bills and strengthen local markets.
	3	Lack of legal regulations and policies for technology adoption and replication especially in water and agriculture sectors.	Develop sector specific policies to help promote adoption of adaptation technologies at national level.
	4	Lack of state-of-art equipment in research laboratories.	Strengthen infrastructure of related research organizations to enable undertaking R&D work.
	5	Lack of coordination and cooperation between public and private sector.	Enhance collaboration between private and public sectors for designing and developing cost effective technologies.
	6	Lack of incentives for developers and consumers of green infrastructure.	Provide subsidies, loans and financial assistance to developers and consumers of green infrastructure.
Agriculture	1	Delayed release of varieties and limited seed suppliers for drought tolerant crops leads to uncertainty in demand side of the chain.	Enhance the scope of R&D in agriculture sector to timely release of new crop varieties.
	2	In case of leasing a land, authorization of owner is required to construct, install and maintain any technology. Moreover, water and property rights hinder the construction of water storage tanks.	Develop and implement legal framework for property and water rights to solve conflicting issues between owners of lands and farmers.
	3	High capital cost for development of adaptation technologies such as sprinkle and drip irrigation system as well as drought tolerant crops.	Create pilot scale production facilities for cheaper availability of various components of efficient irrigation systems like drip and sprinkle irrigation.
	4	Lack of farmer community cooperative societies.	Undertake national awareness raising program on advantages of cooperative societies at the national level to promote agriculture.

Sector	Sr. No.	Constraints & Gaps	Proposed Solutions
Agriculture	5	Lack of on farm water management and cropping patterns causing water shortage.	Promote use of water management techniques at farm level and cropping patterns that require less water for maturity like 'Direct Seeded Rice'
Water	1	Lack of policy to promote balanced use of ground and surface water.	Promote balanced and conjunctive use of ground and surface water through dedicated policies.
	2	Absence of institutional structure with an overseeing body at national level for water resource management, irrigation and flood management.	Formulate proper organizational structures with synergized objectives for all concerned organizations to manage water resources and convey timely information to MoCC.
	3	Insufficient legal and regulatory framework for promoting rainwater harvesting systems.	Formulate legal framework and standard procedures for developing and managing rainwater harvesting and groundwater recharge systems.
	4	Cost of feasibility studies for groundwater recharge and rainwater harvesting system is higher as compared to cost of projects.	Conduct feasibility studies for foreign aided projects and assigning priorities to help collect data on groundwater quality and quantity.
	5	High cost of constructing and maintaining dams to increase water storage capacity.	Increase water storage capacity to ensure sustainability in water resources availability.
	6	Poor understanding of existing water rights and rules for using ground water and harvesting rain water.	Develop and implement legal framework for groundwater rights to solve conflicts among water users.
	7	Lack of hydrological information at regional level.	Redefine mandate of organizations working in water sector for proper data collection.
	8	Huge cost of construction or repair urban storm water drainage.	Allocate dedicated budget for improving water drainage infrastructure in areas highly vulnerable to floods and heavy rains.
Forestry & Land Use	1	Scarcity of interest in local communities to undertake social forestry and forest management due to lack of awareness, fiscal incentives and regulations at the provincial level.	▪ Give incentives to local communities to promote sustainable forest management. ▪ Enact legislation and develop rules and regulation at the provincial level to discourage and reduce deforestation. ▪ Ensure implementation of above legislation, rules and regulations ▪ Introduce and give monetary punishments to violators of rules and regulations.
	2	Lack of coordination among the federal agencies and provincial line departments like Forest and Wild life departments.	Develop a unified organizational structure to strengthen forest friendly culture in the country.

Table 6.3: Adaptation Actions – Constraints, Gaps and Proposed Solutions

2.4. Mitigation Actions

Mitigation actions are necessary for reduction of GHG emissions in transport and energy sectors. Renewable energy sources, especially solar and micro hydropower, are recognized as most important mitigation technologies in TNA report published by MoCC (MoCC 2016b). Similarly, BRT system can greatly help to reduce GHG emissions from transport sector.

The gaps and constraints in mitigation actions and proposed solutions in different sectors are presented in detail in Table 6.4.

Sector	Sr. No.	Constraints & Gaps	Proposed Solutions
Common	1	Lack of awareness in organizations regarding mitigation techniques of climate change.	Encouraging replacement of old and obsolete technologies with efficient and environment friendly technologies within organizations for promotion of mitigation techniques.
	2	Lack of Sector Specific technical Staff to address emission issues.	Build the technical capacity in government organizations to enhance their skills in dealing with issues.
	3	Non availability of user manuals of imported equipment in local language to enable easy comprehension.	Translation of user manuals in native language for a better understanding of general public and technical staff.
	4	Lack of coordination on mitigation efforts between relevant ministries/departments at federal and provincial levels.	Undertake more harmonized/coordinated efforts between concerned departments at federal and provincial level.
	5	Lack of financial sources to carry out sector specific R&D for mitigation efforts.	Allocate sufficient and dedicated budget to concerned organizations to enable them carry out R&D in climate mitigation technologies in various sectors. All mitigation measures have to be promoted in the long-term basis.
Energy	1	Lack of local manufacturing units for RE products, such as Solar panels and turbines for MHP equipment, due to which Initial capital costs for RE based systems are high.	Indigenous production of solar panels will make the technology cost effective.
	2	Lack of testing facilities at national level for solar products leading to sub-standard products in market.	Establish testing facilities for RE products at national level. KOICA is collaborating with PCRET for establishing testing facility for solar panels.
	3	Difficulty in installation and maintenance of MHP systems in remote areas.	Conduct trainings on MHP technology for local governments to enable them to handle MHP projects on their own.
	4	MHP plants require localized guidelines for design and development of systems making its diffusion difficult.	Promote local adoption of international standards of MHP at national level.

Sector	Sr. No.	Constraints & Gaps	Proposed Solutions
Energy	5	Current demand supply scenario indicates a surplus power generation capacity leaving a limited space for procuring renewable electricity.	▪ Replace thermal power plants that have already retired, or are on the verge of retiring with renewable power projects. ▪ Replace highly expensive RFO/DIESEL based power plants with renewable power generation
	6	Areas with optimal resource of renewable energy are far flung, with limited power evacuation capacity and weak grid system. Evacuation capacity at currently developed RE corridor is also exhausted/committed.	▪ Identify interconnection ready zone (IRZ) for bringing more renewable power. ▪ Give serious consideration to setting up renewable power projects preferably connected at 132/220 KV level instead of setting up concentrated large sized (GW scale) at one location.
	7	The limited capacity of power management system in the country does not support the large scale integration of variable renewable energy and impact systems and operations.	▪ Upgrade and digitalize the power management system for system operator to manage large share of variable RE. ▪ Establish centralized RE forecasting system to improve power management
Agriculture	1	Lack of focus on mitigation actions in Agriculture sector.	Strengthen functional Climate Change Research Centers in Agriculture departments for applied research on climate related issues under changing climate scenario.
	2	In-sufficient funding for R&D that leads to increase in capital costs of certified seeds.	Develop public private partnership to produce crop varieties at pilot scale will reduce the capital cost of seeds.
	3	Lack of technical expertise, equipment, physical infrastructure for genetic manipulation of crops.	Upgrade R&D labs with state-of-the-art equipment with adequately trained staff in agriculture sector.
	4	Lack of balanced fertilizer which ultimately decreases the produced quality and yield and increases GHG emissions.	▪ Introduce use of balanced fertilizer and micronutrients to enhance productivity. ▪ Promotion of integrated plant nutrition management system.
Transport	1	High capital cost for local manufacturing and maintenance of hybrid vehicles and fuel efficient buses.	Develop long-term plans for indigenization of hybrid vehicles as envisaged in national electric vehicle
	2	Lack of suitable action plan Lack of suitable policy for operating and maintaining BRT systems and non-availability of financial assistance.	Formulate detailed action plan for realization of formulate detailed BRT based transport policy with loan plans to help promote the technology.
	3	High capital cost and lack of training for computerized tune-up systems.	Widen the scope to include cost effectiveness of NEECA project helping the private sector build computerized tune-up centers throughout the country.
Waste	1	The water and sanitation related services primarily falls under the jurisdiction and authority of local government authorities, which typically face funding and capacity issues in order to design and implement such high-cost projects.	Tap foreign funding to help local governments and promote collaboration between federal and provincial government institutes to resolve sanitation issues.

Table 6.4: Mitigation Actions – Constraints& Gaps and Proposed Solutions

3. Support Needed and Received

This section describes the technical and financial support that was initially required, support that was actually received/provided and some additional support required for the following categories:

1. GHG inventory preparation;
2. Vulnerability assessment;
3. Mitigation Actions; and
4. Adaptation Actions.

3.1. Technical Support

Table 6.5 provides details of technical support needed and, so far received to address climate change issues. The information presented is based on literature review (MoF, 2017, MoF, 2018, MoF, 2019; MoCC 2016, MoCC, 2017, MoCC, 2018] and consultation with the relevant experts in the field.

Sector	Support Required	Support Received	Additional Support Required
GHG Inventory Preparation	1. Technical expertise for hands on training to local staff 2. Demonstration programs on certification of facilities and Individuals 3. Technical equipment to prepare GHG inventory	An on-line training and certification program of Greenhouse Gas Management Institute (GHG-MI) on the 2006 IPCC Guidelines for national GHG inventories which the UNFCCC secretariat supported financially was arranged in 2019-2020. Experts from Pakistan also participated in the course.	1. Conduct more such trainings and coordinating all EPAs and providing technical tools to prepare reliable GHG Inventory. 2. Develop a comprehensive and authentic methodology for compiling the inventory, data sources, institutional structures, and quality assurance &control procedures.
Vulnerability Assessment	1. Development of Chapter on Vulnerability Assessment for Industrial Policy. 2. Measuring/assessment tools/ Instruments. 3. Development of Resource Management/Monitoring System for different sectors. 4. Setting up agricultural production surveillance system in various arid, semi-arid and other vulnerable areas to categorize them according to their vulnerability to extreme climate events. 5. Installation of automatic weather stations and similar monitoring systems to reduce data gaps in delineation of areas vulnerable to floods and droughts.	1. Basic training of staff on GP on its own. 2. Installing automatic weather stations in various ecological zones. 3. Delineating flood prone areas in Chaj Doab[12] and drought prone areas in Bahawalpur, Rahim Yar Khan, Khushab, and Layyah districts.	1. Allocate financial resources for conducting GP assessment. 2. Purchase equipment/ instruments to enable assessment of all aspects of climate change. 3. Create certification facilities and undertake training programs. 4. Conduct collaborative surveys of vulnerable areas by federal and provincial institutes.

12 Chaj Doab Is the land between the rivers Chenab and Jhelum.

Sector	Support Required	Support Received	Additional Support Required
Mitigation Actions	1. Conducting technical Surveys to help identify gaps in improvement programs in different potential sectors, leading to factual mitigation actions. 2. Technical Expert Services on planning and development of projects regarding mitigation actions. 3. Promotion of solar groundwater pumping solution. 4. Provision of climate smart agriculture projects for Green Climate. 5. Customizing clean climate smart technologies in agriculture to offset GHGs. 6. Providing forecasting tools, software (SCADA), digitalizing power system, and hardware (advance metering systems). 7. Providing stabilizers, capacitors, and grid system optimizers to ensure grid stability. 8. Providing innovative technologies and solutions for large share of VREs. 9. Conducting field activities for checking fuel quality and vehicular emissions.	1. Installation of a mobile solar pumping system for farming communities in Potohar region. 2. Promoting crop diversification at two field sites in Potohar region. 3. Solarization of public buildings, schools and mosques. 4. Minimum Energy Performance Standards (MEPS) for Electric.	1. Conduct technical trainings in the fields of air and water quality management, solid waste management, and hazardous/ infectious waste disposal.
Adaptation Actions	1. Provision of Technical Expert Services on: a. Planning and Development of projects on Adaptation Actions b. Project Risk Assessments c. Monitoring and Evaluation 2. Provision of solar drying units for preserving fruits and vegetables. 3. Introduction of dry/Aerobic Rice Production technology for adoption by farmers. 4. Optimization of cropping calendar for different agro-ecological zones. 5. Promoting adoption of permanent raised beds for the various farming systems in Pakistan.	1. Solar unit for drying of dates at PARC site in Sindh. 2. Drought tolerant and heat resistant varieties of wheat crop. 3. Initiation of 10BTTP for promotion of forestry.	1. Support sustainable, climate-smart and resilient projects. 2. Hire experts in agriculture or related field for proper training of farmers on use of balanced fertilizers, crop residue management and direct seeded rice.

Sector	Support Required	Support Received	Additional Support Required
Adaptation Actions	6. Introduction of drought tolerant and heat resistant varieties of wheat, barley, moong, maize in different arid areas of Pakistan. 7. Promotion of community-based range improvement interventions in Potohar and Umerkot for better vegetative cover, forage production and soil improvement. 8. Ensuring availability of mobile livestock health units. 9. Re-structuring, reviewing and formulating new rules/guidelines for adaptation actions needed to be taken in water and agriculture sector. 10. Conducting farmers' trainings on use of balanced fertilizers, crop residue management and direct seeded rice.		

Table 6.5: Technical Support Needed and Actually Received

3.2. Financial Support

Table 6.6 provides details of financial support needed and, so far received to address climate change issues.

Sector	Support Required	Support Received	Additional Support Required
GHG Inventory Preparation	1. Financial assistance to build capacity of team on GHG Inventory Preparation. 2. Establishment of fully equipped facilities for GHG Inventory preparation center.	UNFCCC financially supported a training on the 2006 IPCC Guidelines for national GHG inventories conducted by GHG-MI for international participants.	Conduct more such trainings for technical staff working on GHG Inventory preparation.
Vulnerability Assessment	1. Field activities (Assessments and Trainings of Clients) 2. Support for measuring equipment 3. 200 million PKR cost for projects on: a. Setting up agricultural production surveillance system in various arid, semi-arid and other vulnerable areas; b. Installing automatic weather stations and similar monitoring systems to reduce data gaps in this area; and, c. Delineating areas vulnerable to floods and droughts.	Utilized in house resources	1. Arrange adequate operational funds to fully utilize the existing capacity of the organizations 2. Allocate funds for procurement of measurement equipment.
Mitigation Actions	1. Grants to improve grid infrastructure to enable managing large share of VREs. 2. Grants to enhance capacity of distribution network of all the DISCOs to manage large share of VREs. 3. Grant to ensure provision of electricity to remote areas of the country to ensure compliance to SDG7 through various application including RE-fed micro grids. 4. Funding facility of finance renewable power projects all over the country. 5. Surveys identification of best practices in different sectors and for development of best practices manuals.	International funding from sources like GCF, GEF and KOICA for mitigation projects. The details of these projects are given in Table 6.8.	Allocate and tap funding for feasibility studies and mitigation related projects.

Sector	Support Required	Support Received	Additional Support Required
Mitigation Actions	6. 350 million PKR cost for projects on: a. Promotion of solar water pumping solution. b. Provision of climate smart agriculture projects to offset GHGs emissions.		
Adaptation Actions	1. Support for capacity development on adaptation actions. 2. Funding for projects such as projects on: a. Adoption of dry/Aerobic rice production technology. b. Setting up satellite-based crop monitoring and yield estimation system. c. Promoting permanent raised beds for various farming systems. d. Introducing drought tolerant and heat resistant varieties of wheat, barley, moong, maize in different arid ecologies. e. Promoting community-based range improvement interventions for better vegetative cover, forage production and soil improvement. f. Improving livestock health units. 3. Funding for farmer trainings.	International funding from sources like GCF, GEF and UNDP for adaptation projects. The details of these projects are given in Table 6.8.	Support required for building resilient infrastructure/ mechanism that avoids costly maintenance/ repairs and minimizes the wide-ranging consequences of natural disasters for the livelihoods and well-being of people.

Table 6.6: Financial Support Needed and Received

3.3. Capacity Building Support

Table 6.7 outlines the capacity building support needed and received and additional support that is required to fill the gaps.

Sector	Support Required	Support Received	Additional Support Required
GHG Inventory Preparation	Development & implementation of a robust capacity building program on GHG Inventory Preparation.	Training on the 2006 IPCC Guidelines for national GHG inventories organized by GHG-MI.	Enhancement of the scope of GHG inventory preparation and data collection trainings to provincial level as well.
Vulnerability Assessment	1. Advance Training and Certification of Staff. 2. Development of Management System. 3. Development & implementation of projects on: a. Adoption of dry/Aerobic Rice Production technology, b. Setting up satellite-based crop monitoring and yield estimation system in Pakistan. c. Promotion of permanent raised beds for the various farming systems in Pakistan. d. Introduction of drought tolerant and heat resistant varieties of wheat, barley, mung, maize in different arid ecologies of Pakistan. e. Promotion of community-based range improvement interventions for better vegetative cover, forage production and soil improvement. f. Improvement of livestock health units.	Basic trainings on GP assessment through local resources.	Conducting trainings on different Climate Change related topics for development of practical skills of the team that may lead to sustainability of the efforts and investment done.
Mitigation Actions	1. Advance Training and Certification (Local/ Abroad) of existing team. 2. Capacity building in solar water pumping solution for enhancing agriculture productivity. 3. Training in climate smart agriculture interventions for Green Climate and customizing clean climate smart technologies in agriculture to	1. Local trainings for promotion and awareness regarding RE sources has been carried out.	1. Developing Local Demonstration Companies on mitigation actions. 2. Conducting trainings for plant breeders to develop varieties.

Sector	Support Required	Support Received	Additional Support Required
Mitigation Actions	offset GHGs. 4. Capacity building of the stakeholder to manage higher share of VREs. 5. Capacity building of the stakeholder for preparing renewable power procurement plans, development of sites for auctioning VRE capacity, developing standard concession packages undertaking competitive bidding and ensure of the transactions. 6. Capacity building of the financing sector for innovative financing models for renewable power sector for consumers, SMEs, industries, agriculture and IPPs. 7. Capacity building of the manufacturing sector for localizing the technology. 8. Capacity building of the provincial and municipal department and development authorities for low carbon development and undertaking mitigation projects to help improving environment. 9. Improving curriculum of the universities particularly engineering.		
Adaptation Actions	1. Advance Training and Certification (Local /Abroad) of existing team. 2. Capacity building in adoption of dry/Aerobic Rice Production technology. 3. Capacity building in satellite-based crop monitoring and yield estimation. 4. Capacity building in developing permanent raised beds for the various farming systems in Pakistan. 5. Training in developing drought tolerant and heat resistant varieties of wheat, barley, moong, maize in different arid ecological regions of Pakistan. 6. Training in promoting community-based range improvement interventions. 7. Farmer training on use of balanced fertilization and farmer training on crop residue management.	KOICA has established Pak-Korea capacity building center for agriculture and livestock technology in PMAS Arid Agriculture for R&D purposes.	1. Developing Local Demonstration Companies on adaptation actions. 2. Conducting trainings for agronomists for DSR technology and Integrated Plant Nutrition Management System.

Table 6.7: Capacity Building Support Needed and Received

4. Internationally Funded Projects

This section presents information regarding ongoing projects mentioned in the second national communication as well as new initiatives. All of these projects are supported by international funding agencies including GCF, GEF, UNDP, IUCN, KOICA, IFAD, and UNIDO.

Sr. No.	Projects	Duration / Project Approved	Total Cost (million USD)	Funding Agency
1.	Transforming the Indus Basin with Climate Resilient Agriculture and Water Management.	2018 - 2026	47.70	GCF
2.	Project scaling-up of glacial lake outburst flood GLOF risk deduction in northern Pakistan.	2017 - 2021	20.80	GCF
3.	Project-Building a zero-emissions bus rapid transit BRT system that is safe and accessible to all.	2018 - 2024	583.50	GCF
4.	Delivering the Transition to Energy Efficient Lighting in Residential Commercial, Industrial, and Outdoor Sectors.	Approved in 2016	7.40	GEF
5.	Sustainable Forest Management to Secure Multiple Benefits in High Conservation Value Forests.	Approved in 2015	57.90	GEF
6.	Snow leopard and ecosystem protection program.	2016 - 2018	0.24	GEF
7.	Reversing Deforestation and Degradation in High Conservation Value Chilgoza Pine Forests in Pakistan.	Approved in 2018	28.10	GEF
8.	Generating Global Environmental Benefits from Improved Decision-Making Systems and Local Planning in Pakistan.	2016 - 2021	1.40	GEF
9.	Sixth Operational Phase of the GEF Small Grants Programme in Pakistan.	Approved in 2017	5.80	GEF
10.	Irrigation: economic transformation initiative.	2015 - 2022	120.15	IFAD
11.	National poverty graduation program.	2017 - 2023	149.80	IFAD
12.	Pak-Korea Capacity Building Institute for Water Quality Management at PCRWR, Islamabad.	2011 - 2018	2.58	KOICA
13.	Pak-Korea Capacity Building Center for Agriculture & Livestock Technology, Rawalpindi.	2012 - 2016	3.27	KOICA
14.	Establishment of Pak-Korea Testing Laboratory for PV Modules & Allied Equipment.	2019 - 2023	9.50	KOICA

Sr. No.	Projects	Duration / Project Approved	Total Cost (million USD)	Funding Agency
15.	Strengthening of National Level Water & Sanitation and Hygiene (WASH) Cell.	2019 - 2024	7.42	KOICA
16.	Policy support for mainstreaming the sustainable development goals in Pakistan.	2016 - 2022	10.40	UNDP
17.	Community stewardship and water replenishment for drinking and hygiene.	2013 - 2022	9,07	UNDP
18.	Eco-tourism & camping villages project.	2017 - 2020	2.16	UNDP
19.	Institutional Strengthening Project for the Implementation of Montreal Protocol - Phase IX.	2009 - 2021	7.13	UNDP
20.	Generating global environmental benefits from improved decision-making system and local planning systems.	2016 - 2021	1.42	UNDP
21.	UNIDO Country Programme 2018-2022 to promote inclusive and sustainable industrial development in Pakistan.	2017 - 2022	0.12	UNIDO
22.	Sustainable Energy Initiative for Industries.	2-14 - 2020	3.55	UNIDO
23.	The Project for Agri food and Agro-industry Development Assistance in Pakistan.	2019 - 2023	4.68	UNIDO
24.	Transforming the leather and sugar processing industries towards low emissions and climate resilient development paths in Pakistan.	2016 - 2022	2.04	UNIDO
25.	Promoting Sustainable Energy Production and Use from Biomass in Pakistan.	2012 - 2019	1.86	UNIDO
26.	Mainstreaming Climate Change Adaptation via WRM in Leather Industrial Zone Development.	2015 - 2023	3.30	UNIDO

Table 6.8: Internationally Funded Projects

5. Support Needed & Received for BUR-1

Pakistan is carrying out the preparation of Biennial update report as an enabling activity with financial support from Global Environmental Facility (GEF) to prepare this report. The implementing agency for this project is MoCC, which has further distributed the task among thematic working groups. The following Government organizations are assigned as team lead for thematic working groups to complete this activity.

i. Global Change Impact Studies Center
ii. National Energy Efficiency and Conservation Authority
iii. Pakistan Council for Renewable Energy Technologies

This activity is carried out in consultation with federal as well as provincial level organizations in-order to present a unified authentic report. Details of project are given in Table 6.9.

6. Conclusion

Pakistan is one of the most adversely climate change affected countries. In order to combat the negative impacts of climate change, an effective strategy focusing on all four of GHG features including inventory preparation, vulnerability assessment, adaptation, and mitigation actions is required. This is only possible by identifying and overcoming the constraints and gaps mentioned in earlier sections. Moreover, support at the international and national level is needed to strengthen the efforts being undertaken to address the issue of climate change. The support includes both financial, technical, and capacity building to develop local expertise and necessary infrastructure. Need is also felt to include climate change subject at advanced level in the Country's educational system to promote awareness and develop indigenous expertise at the national level.

Project	Donor Agency	Funding (USD)	Duration	Type of Support	Support Received
Biennial Update Report	GEF Trust Fund	342,000	Aug 2018 to Nov 2020	Capacity Building	Institutional strengthening & training at organizational level
	Government of Pakistan	50,000		Financial	Consultancy at national level and other services

Table 6.9: Support Received for BUR-1

Annexure

NAMAs Submitted to UNFCCC Registry

NAMA stands for Nationally Appropriate Mitigation Action that are to be undertaken by developing nations, given that adequate financial and technological support is provided. Recognizing the importance of developing nations to help achieve the greenhouse gas emission reduction goals, in 2007, Bali Action Plan introduced the term NAMA. Devising policies and programs to tackle the emissions, however, Pakistan has a very clear stance on the matter that NAMA should not constraint the economic and social development of the country.

Currently, there are eight NAMA's that have been submitted by Pakistan in NAMA Registry of which six are still seeking support so that they can be implemented. These NAMAs deal with energy sector directly by working towards renewable energy and indirectly through energy efficiency practices. The Figure Annexure I displays the sectoral distribution of the NAMAs and Table Annexure I gives title of the NAMAs and their respective sectors. The details on these NAMAs are given in the paragraphs below.

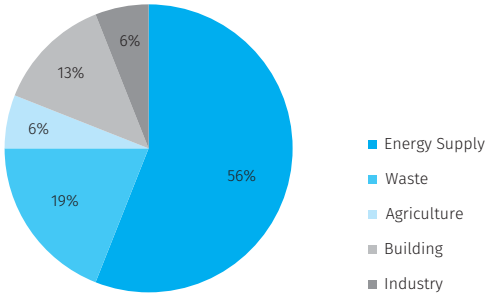

Figure Annexure I: Energy Consumption in Transport

Source: Nama-database.org/index.php/Pakistan

Title	Sector	Sub-Sector
Harnessing Municipal Waste of big Cities of Pakistan to Generate Electricity	Waste Management	Renewable Energy
Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors of Pakistan	Residential and Commercial Buildings	Energy Efficiency
Development and Installation of Carbon Dioxide Sequestration Technologies in Pakistan	Minerals and Mines	Refining and Energy Production
Supporting Mechanisms for Promoting Distributed Generation (Net Metering, Wheeling, Banking etc.) in Pakistan to put 3 GW Alternative and Renewable Energy (ARE) Projects in next 7 years.	Energy Supply	Renewable Energy
Bio-energy generation and greenhouse-gases mitigation though organic-waste utilization	Agriculture, Waste Management	Renewable Energy
Accelerating the Market Transformation to Energy Efficient Lighting	Residential and Commercial Buildings	Energy Efficiency

Title	Sector	Sub-Sector
Strategizing for Grid Strengthening / Improvement for evacuation of power from Solar Power Projects	Energy Supply	Renewable Energy
Strategizing for Grid Strengthening / Improvement for evacuation of power from Wind Power Projects	Energy Supply	Renewable Energy

Table Annexure I: NAMA and their Sectors

Source: Nama-database.org/index.php/Pakistan

Following paragraphs describe the objectives of each of the above projects

1. **Harnessing Municipal Waste of big Cities of Pakistan to Generate Electricity**

   Objective: The aim is to utilize municipal waste collected for energy generation. This NAMA is therefore seeking for regulatory, legislative and financial support to achieve this goal.

2. **Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors of Pakistan**

   Objective: By introducing efficient lighting in Residential, Commercial, Industrial, and Outdoor sectors, this NAMA aims to contribute towards energy security and greenhouse gas emission reduction. This is the only NAMA that has been able to get funding. This project, now called Delivering the transition to Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors of Pakistan is being funded by Global Environmental facility (GEF) under the guidance of UNEP and NEECA. Currently the project is under implementation phase.

3. **Development and Installation of Carbon Dioxide Sequestration Technologies in Pakistan**

   Objective: In order to keep the energy supplies in Pakistan intact, this NAMA promotes development and installation of CO_2 sequestration or scavenging technologies. The aim is to make safe use of the carbon deposits with minimum risk of un-capture carbon and carbon dioxide by installing these technologies near Thar coal, Kandra gas fields and other power generating stations.

4. **Supporting Mechanisms for Promoting Distributed Generation (Net Metering, Wheeling, Banking etc.) in Pakistan to put 3 GW Alternative and Renewable Energy (ARE) Projects in next 7 years.**

   Objective: This NAMA aims that a regulatory regime is established that opens doors for development of Alternative and Renewable Energy (ARE) Distributed Generation in the country. This support document will provide a conductive environment for development of such a mechanism in the country.

5. **Bio-energy generation and greenhouse-gases mitigation though organic-waste utilization**

   Objective: This NAMA project has an aim to introduce technologies and management practices for bio-energy generation that are environment friendly and cost effective. This bio-energy will be generated using organic waste for sustainable development in agriculture and water sectors, in order to promote cost effective farming practices and to reduce GHGs.

6. Accelerating the Market Transformation to Energy Efficient Lighting

Objective: This NAMA is also the part of the project developed by United Nations Environment and NEECA under the name "Delivering Transition to Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors of Pakistan". The activities included in this NAMA include: Developing a National Energy Efficient Lighting Strategy leading to development of minimum energy performance standards (MEPS); Strengthening Monitoring, Verification, and Enforcement (MVE); Environmentally sound management (ESM); and, Promoting the benefits of high efficiency LEDs through communication and distribution campaigns. A Revolving Loan Fund (RLF) will also be established to accelerate the transition to efficient lighting products.

7. Strategizing for Grid Strengthening / Improvement for evacuation of power from Solar Power Projects

Objective: The aim of this support project is development of solar power through a Master Plan and to prepare a strategy therein facilitating the national grid to evacuate the power. This NAMA, additionally, seeks support to address the issues related to lack of finances and capacity.

8. Strategizing for Grid Strengthening / Improvement for evacuation of power from Wind Power Projects

Objective: The aim of this support project is development of wind power through a Master Plan and to prepare a strategy therein facilitating the national grid to evacuate the power. This NAMA, additionally, seeks support to address the issues related to lack of finances and capacity.

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