The Hashemite Kingdom of Jordan

Jordan's First Biennial Update Report to the United Nations Framework Convention on Climate Change

2017

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FOREWORD

On behalf of the Government of Jordan, I am pleased to announce the completion of Jordan's First Biennial Update Report (FBUR) to the United Nations Framework Convention on Climate Change (UNFCCC). The FBUR provides valuable insights to a wide range of interested parties in the field of climate change including policy makers, researchers, practitioners or the public at large.

Jordan continues to express a strong commitment to the goals developed by the international community to respond to the threats of climate change. Jordan signed and ratified lately the Paris agreement that was concluded in December, 2015. The agreement was a major accomplishment and an unprecedented display of political unity in the effort to tackle one of the most dangerous and complicated threats to our future welfare and prosperity.

This report is the result of a long, tedious and creative work by many Jordanian experts who together have delivered a comprehensive view of climate change in the Jordanian context and brought to light Jordan's efforts in climate action.

The FBUR is the outcome of a fruitful partnership between the Ministry of Environment, the Royal Scientific Society and the United Nations Development Programme (UNDP), that has utilized the full potential of national expertise and human resources with technical support from UNDP/UNEP Global Support Programme. The expertise gained during the preparation of this report will have a sustainable impact on the creation, dissemination and enhancement of knowledge about climate change in Jordan. It will also contribute significantly to the enhancement of knowledge-based decisions regarding our development and environmental management options. I wish to thank and congratulate all those who were involved in the preparation of this report and feel proud that such country-driven effort has culminated in a scientifically sound reference that will help us gain in-depth understanding of the complex dynamics of climate change in Jordan.

Jordan is now well positioned to contribute positively and effectively to the global effort in climate protection and continue its sincere commitment to meeting UNFCCC objectives. I would like to extend my appreciation to all the national experts who have participated in producing this report for their relentless effort and passionate attitude. This effort was greatly supported by both Global Environment Facility (GEF) and UNDP and enhances the strategic partnership between the Ministry of Environment and GEF-UNDP in the implementation of global environmental conventions.

Dr. YASEEN M. KHAYYAT

Minister of Environment

Jordan's First Biennial Update Report was coordinated by the Ministry of Environment and prepared in partnership with the United Nations Development Programme.

An agreement with the Royal Scientific Society was realized to execute the work. Preparation of the FBUR was a national effort with the participation of experts representing different national entities.

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Special thanks are in place for UNDP-Jordan who has facilitated the task of reviewing the National Greenhouse Gas (GHG) Inventory by the UNDP/UNEP Global Support Programme (GSP). The review has been essential in ensuring the high quality of GHG Inventory.

We would like to express our appreciation to the IPCC GHG Inventory Task Force for their continuous support with regard to the IPCC 2006 Guidelines and Software. We also extend our thanks to Mr. Taylor Binnington from Stockholm Environment Institute (SEI) for his support in using the Long-Range Energy Alternative Planning (LEAP) tool in the Mitigation Analysis.

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Royal Scientific Society

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ABBREVIATIONS

AF	Alternative Fuel
AFOLU	Agriculture, Forestry, and Other Land Use
ASE	Atomic Story Export
BAT	Best Available Technology
BEP	Best Environmental Practices
BOO	Build Own Operate
BRT	Bus Rabid Transit
BUR	Biennial Update Report
CBJ	Central Bank of Jordan
CCD	Climate Change Directorate
CDM	Clean Development Mechanism
CEM	Cement
CO_2eq	Carbon Dioxide Equivalent
COP or CP	Conference of the Parties
CSP	Concentrated Solar Power
DOS	Department of Statistics
EE	Energy Efficiency
EF	Emission Factor
EIA	Environmental Impact Assessment
EMRC	Energy and Mineral Regularity Commission
ENPEP	Energy and Power Evaluation Program
EPC	Engineering Procurement Construction
EU	European Union
FAO	Food and Agriculture Organization
GWP	Global Warming Potential
FBUR	First Biennial Update Report
FOD	First Order Decay
FSRU	Floating Storage and Regasification Unit
GAM	Greater Amman Municipality
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
giz	German Society for International Cooperation
GR	Growth Rate

ABBREVIATIONS

GSP	UNDP- UNEP Global Support Program
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HFO	Heavy Fuel Oil
HHV	Higher Heat Value
IFAD	International Fund for Agriculture Development
INDCs	Intended Nationally Determined Contributions
IPCC	Inter-governmental Panel on Climate Change
IPP	Independent Power Producer
IPPU	Industrial Processes and Product Use
JAEC	Jordan Atomic Energy Commission
JCC	Jordan Cooperative Corporation
JCI	Jordan Chamber of Industry
JD	Jordan Dinar (1.4 USD)
JEF	Jordan Environment Fund
JICA	Japan International Cooperation Agency
JOSCO	Jordan Oil Shale Company
JOSE	Jordan Oil Shale Energy Company
JPR	Jordan Petroleum Refinery
JREEEF	Jordan Renewable Energy and Energy Efficiency Fund
JSMO	Jordan Standards and Metrology Organization
KEMAPCO	Arab Fertilizers and Chemicals Industries LTD
KIO	Karak International Oil Co.
LEAP	Long-Range Energy Alternative Planning
LED	Low Emission Development
LHV	Lower Heat Value
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LULUCF	Land-Use, Land-Use Change, and Forestry
MEMR	Ministry of Energy and Mineral Resources
MoEnv	Ministry of Environment
MOMA	Ministry of Municipal Affairs
MRV	Monitoring, Reporting and Verification
MSW	Municipal Solid Waste

ABBREVIATIONS

MWI	Ministry of Water and Irrigation
NA	Not Applicable
NAMA	Nationally Appropriate Mitigation Action
NCCC	National Climate Change Committee
NCCP	National Climate Change Policy
NCs	National Communications
NE	Not Estimated
NEPCO	National Electric Power Company
NHV	Net Heat Value
NMVOC	Non-Methane Volatile Organic Compounds
NO	Not Occurring
NPC	National Petroleum Company
NPV	Net Present Value
NRA	Natural Resources Authority
O&M	Operation & Maintenance
ODS	Ozone Depleting Substances
PFCs	Perfluorocarbons
PM	Particulates Matter
PMR	Partnership for Market Readiness
PMU	Project Management Unit
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PV	Photovoltaic
RE	Renewable Energy
RSS	Royal Scientific Society
RWH	Rain Water Harvesting
SACOS	Saudi Arabian Corp for Oil Shale
SAR	Second Assessment Report
SME	Small Medium Enterprise
SWH	Solar Water Heater
SWM	Solid Waste Management
T&D	Transmission & Distribution
TAP	Technology Action Plan
TNA	Technology Needs Assessment

ABBREVIATIONS

TNC	Third National Communication
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nation Framework Convention on Climate Change
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan
WB	World Bank
WUAs	Water Users Associations
WWTP	Wastewater Treatment Plant

UNITS

Du	Dunum (1000m^2)
Gg	Gigagram (Kilo ton)
GJ	Giga Joule
GWh	Giga Watt Hour
ha	Hectare
Kg	Kilogram
Kgoe	Kilogram Oil Equivalent
km	kilometer
kt	Kilo ton
KW	Kilo Watt
Kwh	Kilo Watt Hour
m^3/s	Cubic Meter Per Second
MCM	Million Cubic Meter
MJ	Mega Joule
mm	Millimeter
MMcfd	Million Metric Cubic Feet
MMSCM/Y	Million Standard Cubic Meters Per Year
Mt	Million Ton
Mtoe	Million Tons of Oil Equivalents
MW	Mega Watt
ppm	Parts Per Million
TJ	Tera Joule
TWh	Tera Watt Hour
W	Watt

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EXECUTIVE SUMMARY

1. NATIONAL CIRCUMSTANCES

The Hashemite Kingdom of Jordan is a constitutional monarchy with a representative government. The reigning monarch is the head of state, the chief executive, and the commander-in-chief of the armed forces. The King exercises his executive authority through the Prime Minister and the Council of around 25 Ministers. The Council, meanwhile, is responsible before the elected House of Deputies which, together with the Senate, constitute the legislative branch of the government. The judicial branch is an independent branch of the government.

Jordan is a relatively small country situated at the heart of the Middle East. Jordan occupies an area of approximately 89,318 square kilometers. Despite the relatively small area, Jordan has diverse terrain and landscape demonstrating a variety usually found only in large countries.

Jordan is considered one of the 4 water-poorest countries in the world with an annual per capita water share of around 130 m^3/capita/year. Water resources in Jordan are directed towards three different sectors: agriculture at 51%, municipal supplies at 45%, and industry at 4%.

Jordanian agriculture is established along three major climatic regions: the highlands and marginal steppes where most rain-fed farming is practiced, the Badia (mostly livestock systems and some cultivation in watershed and from deep bore irrigation), and the lowlands (Jordan Valley) that thinly stretches from the North West to the South West.

According to the results of the General Census of Population and Housing in 2015, the total population of the Kingdom reached 9,531,712. The population of Jordan has doubled more than 10 times over the past 55 years due to forced migration. The largest increase has taken place during the last decade especially since 2011 following the Syrian Crisis. The Jordanian population of 6,613,587 makes up 69.4% of the Kingdom's total population, and non-Jordanians form 30% of the population, half of whom are Syrians.

At the regional level, the kingdom faces a combination of external and internal challenges that have affected the country's sustainable development. Throughout the period 2011-2014, the energy sector has experienced several setbacks. The rise in the price of crude oil and oil derivatives has affected the energy sector, as has the interruption of the Egyptian gas supply. As a result of a shift to more expensive fuel for electricity generation combined with a rising demand for electricity by 5.1% and 6.4% in 2011 and 2014, respectively, energy imports have reached 4.1 billion JD in 2013 and 4.5 billion JD in 2014, an increase of around 10%. However, in 2015 the fall in global crude oil prices to USD 30 per barrel reduced the cost of energy imports in 2015 to 2.5 billion JD.

Renewable energy has the potential to enhance energy security, improve access to affordable energy, create jobs, and mitigate climate change. The government of Jordan has recognized the importance of renewable energy and launched the 2007 Master Strategy of the Energy Sector with an ambitious target of meeting 7% of total primary energy supply from renewable energy by 2015 and 10% by 2020. This strategy has been updated for the period 2015-2025 and approved by the Ministerial Council in December 2015. The total capacity of renewable energy by the end of 2020 will be 1350 MW representing 25% of all installed generating capacity, contributing 20% of generated electricity.

Jordan has also developed a strategy for utilizing nuclear power to supply the country with 30% of its demand for electricity by 2030, with surplus destined for export. A nuclear power committee was set up in 2007 and a law was enacted to establish the Jordan Atomic Energy Commission (JAEC) and the Jordan Nuclear Regulatory Commission (JNRC). Current plans allow for the construction of two nuclear power plants by the Rosatom company, to be commissioned in 2023 and 2025.

Transportation infrastructure in Jordan is considered to be relatively well developed in a Middle Eastern context. Transportation demand is expected to see an average growth of 5-6%. The transportation sector accounts for more than 10% of GDP. The current public transportation system can be described as inefficient. Several projects have been proposed over the last decade to address the problems associated with the current transportation system. One of these mega projects is the Amman Bus Rapid Transit Project, a USD 160 million project currently under-construction in Amman that runs on 3 routes from Sweileh in West Amman to the Jordan Museum in Ras Al-Ain, passing by the sports city intersection where the route branches out to Al-Mahatta in East Amman.

The Ministry of Environment was established in 2003 to address the country's environmental problems. Since then, the country has witnessed a steady expansion of the legal and institutional framework for environmental protection. The Ministry has become the focal point for all international environmental conventions including the United Nations Framework Convention on Climate Change (UNFCCC).

Jordan is undergoing a rapid and effective process of enhancing its institutional and policy relevant framework for addressing climate change challenges. In August 2014, the Ministry of Environment has created the Directorate of Climate Change. The Directorate acts as the institutional hub for coordinating all climate change activities in Jordan in relation to the UNFCCC. A representative National Climate Change Committee (NCCC) was established in 2001 based on a decision by the Prime Minister. Members of the committee include many stakeholders directly associated with climate change sectors in Jordan.

2. NATIONAL GHG INVENTORY

Jordan's anthropogenic emissions by source and removals by sink of all greenhouse gases (GHGs) not controlled by the Montreal Protocol have been estimated for the years 2010 and 2012 using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. GHG emissions and removals were estimated for the following sectors: energy, industrial processes and product use (IPPU), agriculture, forestry and other land-use (AFOLU), and waste.

The national inventory included emission estimates for carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), in addition to perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and non-methane volatile organic compounds (NMVOC).

In 2010, Jordan contributed 23140.06 Gigagrams (Gg) of CO_2eq or 23.14 million tons (Mt) of CO_2eq of GHGs to the atmosphere. A sectoral breakdown is as follows:

- Energy (84% of the total) with 19410.88 Gg of CO_2eq
- IPPU (9% of the total) with 1982.04 Gg of CO_2eq
- AFOLU (1% of the total) with 180.50 Gg of CO_2eq
- Waste (7% of the total) with 1567.49 Gg of CO_2eq

In 2012, Jordan contributed 27997.73 Gg of CO_2eq or 27.99 million tons (Mt) of CO_2eq of GHGs to the atmosphere. A sectoral breakdown of Jordan's total emissions of GHGs is as follows:

- Energy (81% of the total) with 22756.83 Gg of CO_2eq
- IPPU (12% of the total) with 3368.47 Gg of CO_2eq
- AFOLU (1% of the total) with 237.29 Gg of CO_2eq
- Waste (6% of the total) with 1635.14 Gg of CO_2eq

The emissions resulting from the sectors in years 2010 and 2012 are described in the following paragraphs:

Energy sector

The total emissions from the energy sector resulting mainly from fuel combustion activities were 19,410.88 Gg of CO_2eq in 2010 and 22,756.83 Gg of CO_2eq in 2012. The emissions resulting from fugitive emissions were negligible for both years.

The energy industries and the transport subsectors accounted for 47% and 27%, respectively, of fuel combustion emissions in 2010. Emissions resulting from "Other sectors" (Residential, Commercial, and Agriculture) and from "Manufacturing Industries and Construction" accounted for 24% of the total.

Fuel combustion emissions in 2012 from the energy industries and the transport subsectors accounted for 50% and 32%, respectively, of the total. Emissions resulting from "Other sectors" (Residential, Commercial, and Agriculture) and from "Manufacturing Industries and Construction" accounted for 10% and 6%, respectively, of the total.

Subsectors	2010 (Gg of CO_2eq)	2012 (Gg of CO_2eq)
ENERGY SECTOR	**19410.88**	**22756.83**
Fuel Combustion Activities	19409.61	22755.78
Energy Industries	9112.78	11296.10
Manufacturing Industries and Construction	2306.36	1249.19
Transport	5296.81	7391.60
Other Sectors (Residential, Commercial, and Agriculture)	2275.97	2334.00
Non-Specified	417.70	484.92
Fugitive Emissions (Oil and Natural Gas)	1.26	1.02

Industrial processes sector

In 2010, emissions from industrial processes sector were 1982.04 Gg of CO_2eq accounting for 9% of Jordan's total GHG emissions. The emissions originated mainly from the mineral industry, product uses as substitutes for Ozone Depleting Substances (ODS) (mainly refrigeration, air conditioning, and fire protection), and chemical industry subsectors. The industrial processes sector was a source of NMVOC emissions and accounted for 288.77 Gg of CO_2eq. Emissions of HFCs were 377.33 Gg of CO_2eq.

In 2012, emissions from industrial processes sector were 3368.47 Gg of CO_2eq accounting for 12% of Jordan's total GHG emissions. The emissions originated mainly from the mineral industry, product uses as substitutes for Ozone Depleting Substances (ODS) (mainly refrigeration, air conditioning, and fire protection), and chemical industry subsectors. The industrial processes sector was a source of NMVOC and HFCs emissions accounting for 221.33 Gg and 1399.33 Gg of CO_2eq, respectively.

Categories	2010		2012	
	Gg of CO_2eq	Gg NMVOCs	Gg of CO_2eq	Gg NMVOCs
INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR	1982.04	288.77	3368.47	221.33
Mineral Industry	1214.31	NO	1531	NO
Chemical Industry	151.34	NO	157.05	NO
Metal Industry	16.94	NO	40.17	NO, NA
Non-Energy Products from Fuels and Solvent Use	208.80	288.77	226.88	215.66
Product Uses as Substitutes for ODS	377.33	NA	1399.33	NA
Other Product Manufacture and Use	13.32	NA, NO	14.07	NA, NO
Other (Food and Beverages)	NA	5.42	NA	5.67

Agriculture, forestry, and other land use change sector

The GHG emissions from the AFOLU activities accounted for 0.66% (180.5 Gg of CO_2eq) of Jordan's total GHG emissions in 2010, acting as a net emission source. These emissions were from various subcategories and were composed of methane and nitrous oxide.

The GHG emissions from the AFOLU activities accounted for 0.69% (237.29 Gg of CO_2eq) of Jordan's total GHG emissions in 2012, acting as a net emission source. As in 2010, these emissions were from various subcategories and were composed of methane and nitrous oxide.

Categories	2010	2012
	NET Gg of CO_2eq	NET Gg of CO_2eq
Agriculture, Forestry, and Other Land Use	180.50	237.29
Livestock	441.26	479.995
Land	-274.56	-254.172
Aggregate sources and non-CO_2 emissions sources on land	13.80	11.464

Waste sector

In 2010, GHG emissions from the waste sector totaled 1567.49 Gg of CO_2eq accounting for 7% of Jordan's total GHG emissions. Most of the emissions were generated from the disposal of domestic solid waste, which accounted for 89% (1391.77 Gg of CO_2eq) of total waste emissions, while wastewater handling accounted for 11% (171.67 Gg of CO_2eq) of total waste emissions.

In 2012, GHG emissions from the waste sector totaled 1635.14 Gg of CO_2eq accounting for 6% of Jordan's total GHG emissions. Most of the emissions were generated from the disposal of domestic solid waste, which accounted for 91% (1488.05 Gg of CO_2eq) of total waste emissions, while wastewater handling accounted for 9% (142.42 Gg of CO_2eq) of total waste emissions

Categories	2010	2012
	Gg of CO_2eq	Gg of CO_2eq
Waste	**1567.49**	**1635.14**
Solid Waste Disposal	1391.77	1488.05
Incineration and Open Burning of Waste	4.0457	4.68
Wastewater Treatment and Discharge	171.67	142.42

GHG Inventories by Gas

GHG (Gg of CO_2eq)	Total National Emissions and Removals	
	2010	2012
CO_2	20438.27	24112.427
CH_4	1929.76	2035.27
N_2O	394.69	450.71
HFCs	377.33	1399.33
NMVOCs	294.2 (No GWP)	221.33 (No GWP)
Net Emissions and Removals	23140.05	27997.731

In 2010, the majority of carbon dioxide emissions were contributed by the energy sector, accounting for 94% of the total, followed by 7% contributed by the IPPU sector. Methane emissions were highest from the waste sector, followed by the AFOLU sector with contributions of 75% and 23%, respectively. Nitrous oxide emissions were highest from the IPPU sector, followed by the waste and energy sectors, with contributions of 42%, 31%, and 26%, respectively. As expected, the IPPU sector contributed 100% of HFCs and NMVOCs emissions.

In 2012, the majority of carbon dioxide emissions were contributed by the energy sector, accounting for 94% of the total, followed by 7% contributed by the IPPU sector. Methane emissions were highest from the waste sector, followed by the AFOLU sector with contributions of 74% and 23%, respectively. Nitrous oxide emissions were highest from the IPPU sector, followed by the energy and waste sectors, with contributions of 38%, 32%, and 29%, respectively. As expected, the IPPU sector contributed 100% of HFCs and NMVOCs emissions.

3. GHG MITIGATION ANALYSIS

The mitigation analysis in this report provides updated baseline and mitigation scenarios. The Third National Communication (TNC) scenarios were reviewed and modified based on current policies, strategies, and trends in the different sectors. The overall baseline and mitigation scenarios have been constructed to cover the period of 2015-2040. The analytical mitigation methodology for the energy sector is based on the LEAP Model, which is being used for the first time in Jordan. Previous National Communications have utilized the ENPEP program.

The energy baseline scenario is defined by 2015 as the base year. Policies, programs and projects stated in the new energy strategy for 2015-2025 are considered committed and confirmed inputs for building up the baseline scenario up to 2040 using LEAP Model. For non-energy sectors (IPPU, AFOLU and Waste), linkages to demographic and macroeconomic and other sector specific factors were used to build up the scenario utilizing statistical and economic tools.

Baseline Scenarios for the Different Sectors

Baseline scenario for the energy sector

In light of the major changes in the Jordanian economy and the energy sector that took place in 2015, affecting the sector's strategies, policies, plans, activities, and projects, the baseline scenario for the period 2015-2040 was reviewed and rebuilt along with the new energy strategy of 2015-2025.

The field of oil and oil products

Securing the Kingdom's oil products needs will be achieved by the following:

- Jordan Petroleum Refinery (JPR) working on the same production of 14 thousand tons per day to meet 60% of the need of the domestic market of oil products. The remaining needs will be imported.
- The JPR expansion will be completed in 2022. In case the refinery will not be able to achieve the expansion, the government has two options; announce an investment opportunity to build new oil refinery in Jordan or stop the refining activities in the existing refinery and import oil products to meet Jordan's needs.
- Meeting Jordan's crude oil needs by importing Saudi Arabian oil via sea, then shipping the crude by trucks to the oil refinery up to 2022.
- Construction of a pipeline to ship 1 million barrels/day of Iraqi crude oil across Jordanian territory to the export terminal in Aqaba, with an arrangement to supply JPR with 150 thousand barrels/day of crude oil. The pipeline will be completed by 2022.
- Sustaining the policy of petroleum products price liberalization.

The field of natural gas

- Jordan has the ability to meet the country's needs of natural gas for electricity generation and for industrial uses following the construction of LNG terminal in Aqaba.
- In addition to the LNG terminal in Aqaba, other options to supply Jordan with natural gas include Egypt and Gaza. Developing the Risha gas field to increase LNG production to 50 MMcfd is another possibility.

The field of renewable energy

- The total capacity of RE by the end of 2020 will be 1350 MW accounting for 25% of all installed generating capacity and contributing 20% of generated electricity. The electricity grid expansion (green corridor project) will be implemented by the end of 2019 at a cost of 160 million JD. This will allow expansion in installed capacity in southern Jordan from 400 MW to 1000 MW.
- A 70 MW of net metering systems has been installed and these figures are expected to double by the end of 2018.
- Around 900 MW of renewable energy projects (solar and wind) are expected to be connected to the grid during the period 2021-2025, and thus are considered part of the updated baseline scenario.

The field of oil shale

- The new expected date for commissioning a 470 MW electricity power plant by oil shale direct burning was postponed to 2020.
- With regard to oil shale extraction, all companies were asked to postpone the development period for five to eight years, while other oil shale companies have totally stopped implementing projects.

The field of nuclear energy

Two nuclear power plants will be built with a capacity of 1000 MW each. The first and second reactors will enter service by 2023 and 2025, respectively, as stated in the new energy strategy 2015-2025.

Primary and final energy demand

- As a result of the baseline scenario analysis taking into account all committed projects as well as the economic variables which were mentioned earlier, the LEAP output shows that the primary energy required will be 10.3 Mtoe, 11.53 Mtoe, 16.33 Mtoe in 2020, 2025, and 2040, respectively, with an annual growth rate equal to 2.4% during the period 2015-2040.
- Primary energy mix in 2020 will consist of 50% oil products, 30% natural gas, 9% renewable energy, 6% oil shale, while in 2025 the primary energy mix will consist of 48% oil products, 7% natural gas, 9% renewable energy, 22% nuclear, and 5% oil shale. The decline in natural gas contribution in the energy mix is due to the introduction of nuclear power generation.
- With regard to final energy demand by sector, the share of transport sector is expected to decrease from 48% in 2015 to 46% and 42% in 2020 and 2025, respectively, due to the improvement measures that will be introduced to the transport sector including the Bus Rapid Transit, service upgrade in public transport, and increased penetration of hybrid and electric cars. The industrial sector's final energy consumption as a percentage of the total final energy will increase from 17% in 2015 to 27% in 2040. As for the share of the household final energy consumption, it will decrease from 22% in 2015 to 17% in 2040.
- Electricity generation requirements will grow during the period 2015-2040 at an average annual growth rate of 4.1%. Demand for electricity which reached 17980 GWh in 2015 is expected to reach 23150 GWh in 2020 and 28900 GWh in 2025, rising to 44500 GWh in 2040.

Baseline scenario for industrial processes and product use sector

- Jordan 2025 national vision addresses the industrial sector with a focus on assisting in financing and incentivizing the development and sustainability of Small and Medium Enterprises (SMEs).
- In 2014, a High-Level Committee and a Unit for Green Economy were established by a decree by the Prime Minister, on the basis of which a National Green Growth Plan for Jordan was developed by the Ministry of Environment to be followed by an action plan for transitioning towards a green economy.
- Enhancing the adaptation of Best Available Technology (BAT) and Best Environmental Practices (BEP) in the industrial processes.
- Improving regulations and policies that encourage industrial investment.
- Enhancing cooperation between the private and public sectors.

Baseline scenario for agriculture, forestry and other land use sector

The following considerations shaped the baseline scenario for the AFOLU sector:

- Field crops production: Increase productivity per unit area, promote water harvesting techniques to expand planted areas, and maintain productivity under predicted decrease in rainfall.
- Animal production: Promote high productive animal species under increase in prices of fodder, and other production inputs.

- Fodder production: Reclamation of rangelands, addressing overgrazing, introducing species with high productivity under drought conditions, and promoting wastewater reuse in fodder production.
- Forestry conservation: Maintain forests which are threatened by predicted drought cycles, urban and rural expansion, expected fire occurrences, and illegal deforestation.

Baseline scenario for waste sector

The waste sector was reviewed, and the baseline scenario was updated taking into account the following:

- In line with Jordan's water strategy, maximizing the amount of wastewater to be treated for agricultural purposes.
- All future needed WWTPs will be mechanical with activated sludge method of operation.
- Biogas utilization from sludge digestion is mainly practiced at the Samra plant. However other plants such as Shalalah started to utilize biogas and other plants are planning to do so in the future.
- Protein consumption per capita is fixed at 29.6 kg/capita/year.
- Solid waste generation will be directly linked to the country's population and the assumption that the collection will be improved with time.
- All factories within the industrial cities are connected to central aerobic wastewater treatment plants.

GHG Emissions in Baseline Scenario

Jordan's anthropogenic emissions by source, and removals by sink, of all GHGs in 2012 were estimated to be around 28 Mton of CO_2eq. These emissions are expected to grow according to the baseline scenario to around 38, 42, and 51 Mton of CO_2eq in the years 2020, 2030, and 2040, respectively. The contribution of the energy sector will continue to be the largest and it is expected to decrease in the future from 81% of total emissions in 2012 to 69% in 2040 due to the introduction of renewable and nuclear power sources into the energy mix. The contribution of the waste sector to total GHG emissions is expected to increase from 6% in 2012 to 11% in 2040.

The industrial sector is the second largest contributor to GHG emissions in Jordan according to the 2012 GHG inventory, with a 12% share. It is expected to increase modestly to 13% in 2040. The AFOLU sector contributed 1% to total GHG emissions in Jordan in 2012, and this contribution is expected to increase to 7% by 2040. The AFOLU sector was found to be a net emitter not a sink for GHGs. With a small forest area of less than 1% of the country's total area, it is important to direct our national efforts to forest protection and to better law enforcement at the national level.

Mitigation Scenario

Thirty-nine GHG mitigation projects were considered in several areas of primary energy, renewable energy, energy efficiency, waste, and agriculture. The cumulative GHG reductions in 2025 and 2040 were 7.85 and 9.32 Mton CO_2eq, respectively.

Based on the unit abatement cost and abatement marginal cost curve, the most feasible options are energy projects in general, and specifically, energy efficiency and renewable energy.

4. DOMESTIC MEASUREMENT, REPORTING, AND VERIFICATION

The MRV chapter within this report describes the current status in terms of GHG inventory estimation and reporting as well as GHG mitigation analysis.

Usually there are three types of MRV systems. The first is the MRV of GHG emissions, conducted at the national level, which seeks to understand the emissions profile and report it in the form of emissions inventory. The second is the MRV of mitigation actions (e.g., policies and projects) which seeks to assess GHG mitigation effects as well as monitor their implementation. The third is the MRV of support (e.g., climate finance, technology transfer, and capacity building) which seeks to track provision and receipt of climate support.

During 2016, Jordan has submitted its market readiness proposal (MRP) to the Partnership for Market Readiness (PMR) initiative. Jordan's MRP outlines a plan for implementing the market readiness components that will be necessary to support the development of appropriate market based instruments.

A multi-tiered integrated MRV system for Jordan is being developed based on the submitted proposal by the Government of Jordan and the World Bank. The MRV system design is being developed in consultation with different national stakeholders and it is anticipated to be completed soon.

5. GAPS, CONSTRAINTS AND NEEDS

According to decision 2/CP.17, non-Annex I Parties are to provide updated information on constraints and gaps, and related financial, technical, and capacity-building needs. Accordingly, the chapter of gaps, constraints and needs provides a description of the constraints and gaps (technical, institutional, methodological, financial, and capacity building) identified in previous national climate change reports as well as newly identified constraints. A set of recommendations and suggestions have been identified to address these gaps, constraints, and needs. In addition, the chapter provides a brief summary on the outcomes of a recent published national report on technology needs assessment. The summary identifies a priority list of adaptation and mitigation technologies along with a technology action plan for implementation.

NATIONAL CIRCUMSTANCES

1.1 Governance Structure

The Hashemite Kingdom of Jordan is a constitutional monarchy with a representative government. The reigning monarch is the head of state, the chief executive, and the commander-in-chief of the armed forces. The king exercises his executive authority through the Prime Minister and the Council of around 25 Ministers, or the "Cabinet". The Cabinet, meanwhile, is responsible before the elected House of Deputies which, together with the Senate, constitute the legislative branch of the government. The judicial branch is an independent branch of the government.

Jordan is divided into twelve administrative areas or Governorates (Amman, Irbid, Zarqa, Balqa, Karak, Mafraq, Ma'an, Tafiela, Jerash, Madaba, Ajloun, Aqaba). Each Governorate is managed by a Governor who is designated by the Cabinet based on the recommendation of the Minister of Interior. The Governorates are subdivided into districts, sub-districts, and chief towns, and these are managed by civil servants of the Ministry of Interior, whose task is to coordinate and supervise the decentralized services of other ministries under the authority of the Governor.

The Law of 1955 defines the Municipality as being "A financially independent national institution", having a "legal personality" and an administrative autonomy, which is managed by the town council that is composed of the Mayor and 6 to 11 councilors.

During the 90's, the environmental issues were managed by an environmental department at the Ministry of Municipal Affairs. After the Rio Earth Summit in 1992 the overall international environmental governance system was improved. Jordan created the "General Corporation for Environmental Protection, GCEP", which was operating under the auspices of the Ministry of Municipal Affairs from 1998 to 2002. Then in 2003, the Ministry of Environment was created to oversee all environmental affairs. Since then the country witnessed a steady expansion of the legal and institutional framework for environmental protection. The Ministry of Environment became the focal point for all international conventions including the United Nations Framework Convention on Climate Change (UNFCCC).

The environmental governance system in Jordan links multiple governmental organizations in developing and implementing environmental policies lead by the Ministry for Environment. The Ministry's mission is to maintain and improve the quality of Jordan's environment, conserve natural resources, and contribute to sustainable development by employing policies, legislation, strategies, and monitoring, and by mainstreaming environmental policies into all national development plans.

1.2 Location, Climate, and Geography

Jordan is a relatively small country situated at the heart of the Middle East. Jordan occupies an area of approximately 89,318 square kilometers. Despite the relatively small area, Jordan has diverse terrain and landscape demonstrating a variety usually found only in large countries.

Jordan's climate is characterized by long, hot, and dry summers and short, cool winters. The climate is influenced by the country's location between the aridity of the Arabian Desert and the humidity of the eastern Mediterranean area. January is the coldest month, with temperatures ranging from 5°C to 10°C, while August is the hottest month with temperatures ranging from 20°C to 35°C. Rainfall varies from season to season and from year to year. About 75% of the country can be described as having a desert climate with less than 200 millimeters of rain annually. About 70% of the average rainfall in the country falls between November and March while June through August are often rainless.

Jordan can be divided into three main geographic and climatic areas: the Jordan Valley, the Mountain Heights Plateau, and the eastern desert, or Badia region. The Jordan Valley is the country's most distinctive natural terrain. The northern segment of the Jordan Valley, known in Arabic as the Ghor, is the most fertile region. Several degrees warmer than the rest of the country, its year-

round agricultural climate, fertile soils, higher winter rainfall, and extensive summer irrigation have made the Ghor the food basket of Jordan. The Jordan Valley has the Jordan River; it extends from the northern border down to the Dead Sea. Over its upper course, the river drops rapidly in a 75-km run to the once large and swampy Lake Hula, which is slightly above sea level. Exiting the now much diminished lake, it goes through an even steeper drop over 25 km down to the Sea of Galilee, which it enters at its northern end. The Jordan River deposits much of the silt it carries within the lake, which it leaves again near its southern tip. At that point, the river is situated about 210 m below sea level. The last 120 km-long section follows what is commonly termed the "Jordan Valley", which has less gradient (the total drop is another 210 m) so that the river meanders before entering the Dead Sea, a terminal lake about 422 m below sea level with no outlet. Two major tributaries enter from the east during this last section: The Yarmouk River and Zarqa River.

The two major sources of the Jordan River, the Sea of Galilee and the Yarmouk River, were dammed during the 1960s to meet the water needs of the region's growing population. As a result flow volumes decreased dramatically, causing changes in the river's physical and ecological characteristics, as well as in its water quality. Current water sources are mainly diverted saline springs, agricultural return flows, partially treated wastewater, discharge from fish ponds, ground water, and storm water all of which contribute to varying salinity and pollution (Hillel, N. et al, 2015).

South of the Dead Sea, the Jordan Valley runs on through the hot, dry Wadi 'Araba. This spectacular valley is 155 km long and is known for the sheer, barren sides of its mountains. Its primary economic contribution is potash mining. Wadi 'Araba rises from 300 m below sea level at its northern end to 355 m above sea level at Jabal Risha, and then drops down again to sea level at Aqaba, Jordan's only seaside outlet.

The Mountain Heights Plateau is the highlands of Jordan extending through the entire length of the western part of the country and separate the Jordan Valley and its margins from the plains of the eastern desert. These areas receive Jordan's highest rainfall, and are the most richly vegetated in the country. This region hosts most of Jordan's population centers, including the cities of Amman, Madaba, Zarqa, Irbid, and Karak.

The region, which extends from Umm Qais in the north to Ras an-Naqab in the south, is intersected by a number of valleys and riverbeds known as wadis. All wadis eventually flow into the Jordan River, the Dead Sea, or the usually-dry Jordan Rift. Elevation in the highlands varies considerably, from 600 to about 1,500 meters above sea level, with temperature and rainfall patterns varying accordingly.

The northern part of the Mountain Heights Plateau, known as the northern highlands, extends southwards from Umm Qais to just north of Amman, and displays a typical Mediterranean climate and vegetation. This region is characterized by higher elevations and cooler temperatures. South and east of the northern highlands are the northern steppes, which serve as a buffer between the highlands and the eastern desert. The area, which extends from Irbid through Mafraq and Madaba all the way south to Karak, was formerly covered in steppe vegetation. Much of this has been lost to desertification, however. In the south, the Sharrah highlands extend from Shobak south to Ras an-Naqab. This high altitude plain receives little annual rainfall and is consequently lightly vegetated.

The Eastern Desert or Badia Region comprises around 75% of Jordan. This area of desert and desert steppe is part of what is known as the North Arab Desert. It stretches into Syria, Iraq, and Saudi Arabia, with elevations varying between 600 and 900 meters above sea level. Climate in the Badia varies widely between day and night, and between summer and winter. Daytime summer temperatures can exceed 40°C, while winter nights can be very cold, dry, and windy. Rainfall is minimal throughout the year, averaging less than

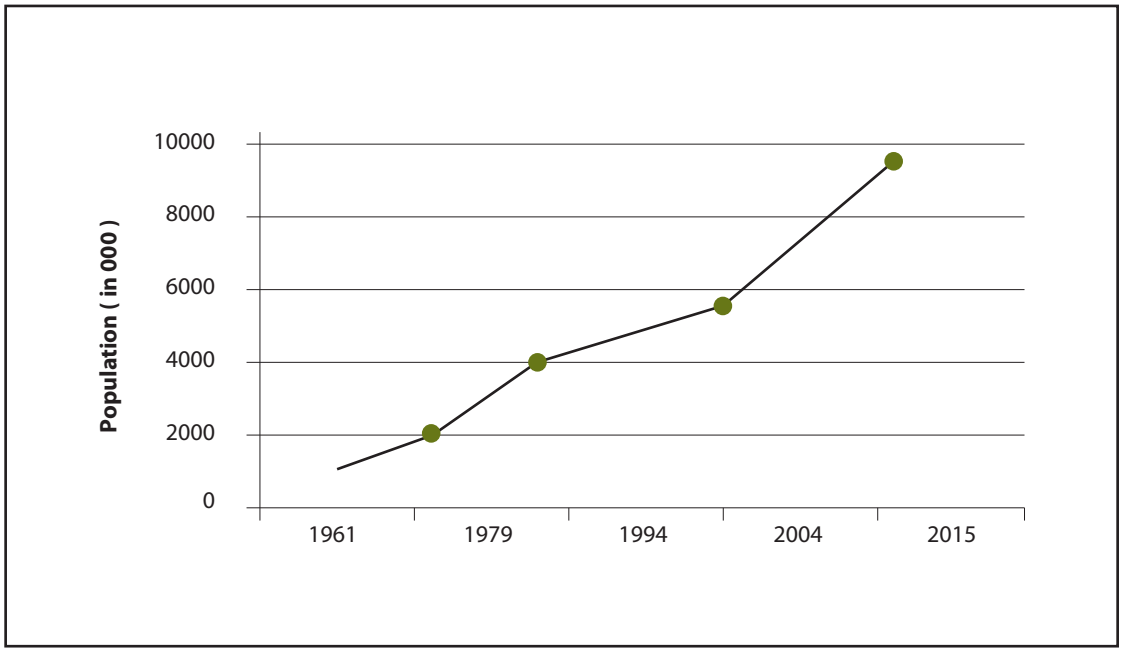
50 millimeters annually. Although the regions of the Badia (or desert) have common harsh desert climate, similar vegetation, and sparse population concentrations, those regions vary considerably according to their geology.

1.3 Demographic Profile

According to the results of the General Census of Population and Housing 2015, the total population of the kingdom reached 9,531,712. The population of Jordan has doubled more than 10 times over the past 55 years, as shown in Figure 1.1, due to forced migration. The largest increase has taken place during the last decade and especially since 2011 following the Syrian crisis. The annual population growth rate was 5.3% from 2004 to 2015. The Jordanian population of 6,613,587 makes up 69.4% of the Kingdom's total population (DOS, 2015), and non-Jordanians form 30% of the population, half of whom are Syrians .

Jordan provides asylum for a large number of refugees, including refugees from Syria and Iraq. It has granted Syrian refugees access to services, such as health and education, in host communities. The Syrian refugee camps of Azraq and Zaatari, which were built on land provided by the authorities, provide security.

Figure 1.1: Population in Jordan for the period of 1961-2015 (DOS, 2015)



The percentage of urban population in Jordan is 90.3% (DOS, 2015). This is due to rural-to-urban migration and to the fact that immigrants usually prefer to settle in cities rather than rural areas. Combined, the three largest cities (Amman, Zarqa, and Irbid) house 74.93% of the Jordanian population (DOS, 2015). However, rising rural-to-urban migration has contributed to increased pressures on housing, basic amenities, and demand for food (leading to inflation), and to rising inequality in living standards, both within the country, and within urban centers themselves.

Those under the age of 15 account for 34.3% of the population. About 62% of the population is between the age of 15 and 64, while 3.7% of the

population is above 65 years old (DOS, 2015). According to the Department of Statistics, the average household size in the kingdom has been declining since 1979. These figures mean that the average household size has declined by about two people per household in less than four decades from 1979 to 2015. This decline is attributed to changing cultural, economic, and social patterns as well as to the rising cost of living.

The average annual household income was about 9,258 JD in 2013 (DOS, 2013). Female labor market participation rates are one third those of men's on average. According to the latest household income and expenditure survey (DOS, 2010), the average annual income from employment of a female-headed household was 2,209.3 JD, while for a male-headed household it was 4,103.5 JD, which shows a gender pay gap of 46.16%.

Families headed by women tend to be among the poorest of the poor. They have fewer economic assets than households headed by men. For example, only 44% of households headed by women own agricultural land and 30% own livestock. In contrast, 68% of households headed by men own land and 36% of them own livestock. Similarly, only 21% of women who are heads of households receive loans for agricultural development and 9% receive loans for income-generating activities, compared to 43% and 14% for men who are heads of households (IFAD, 2015).

Jordanians are relatively well educated. The illiteracy rate is 6.7% for those above the age of 15 (9.8% for females and 3.7% for males). The government of Jordan spends more than 5% of Gross Domestic Product (GDP) on education. These investments are higher than those made by other lower-middle-income countries and have been instrumental in improving Jordan's literacy. Women have been equal beneficiaries of these policies. The main general educational services providers in Jordan are the Ministry of Education and the private sector, in addition to the Armed Forces.

The public health status in Jordan is amongst the best in the Middle East. This is largely attributed to the Kingdom's stability and to a range of active development plans and projects, which have included health as a major component. This is revealed in the Kingdom's basic health indicators, which are considered to be good and are improving steadily. The overall average life expectancy reached 74.4 years (72.4 for males and 76.7 for females) (MoH, 2013). The infant mortality rate per 1000 population declined from 23 in 2009 to 17 in 2013. The crude birth rate and the crude death rate per 1000 population were 28.1 and 7.0, respectively (MoH, 2013).

According to the Global Health Observatory (2013), Jordan's total annual expenditure on health care per capita is USD 761, representing 7.2% of Jordan's GDP. The public sector is the largest source of health funding (61.95%), followed by the private sector (35.13%) and donors (2.94%) (MoH, 2013).

1.4 Regional Political Context

At the regional level, the kingdom faces a combination of external and internal challenges that have affected the country's sustainable development. Throughout the period 2011-2014, the energy sector has experienced several setbacks. The rise in the price of crude oil has affected the energy sector, as has the interruption of the Egyptian gas supply. As a result of a shift to more expensive fuel for electricity generation combined with a rising demand for electricity by 5.1% and 6.4% in 2011 and 2014, respectively, energy imports have reached 4.1 billion JD in 2013 and 4.5 billion JD in 2014, an increase of around 10%. However, in 2015 the fall in global crude oil prices to USD 30 per barrel reduced the cost of energy imports in 2015 to 2.5 billion JD.

In addition, the country has had to deal with the impacts of Syria's civil war, where over the past years the Kingdom has had to absorb one million and three hundred thousand Syrian refugees (DOS, 2015). Approximately 80% of the Syrian refugees in Jordan live in urban areas in the north of Jordan, while the remaining 20% live in

the Za'atari, Mrajeeb al-Fahood, Cyber City, and Al-Azraq camps. This has placed a huge burden on the country's infrastructure, public services, and natural resources. The additional pressures on energy contributed to high growth rate in energy and electricity demand. A high number of Syrian refugee children, 140,000 in all, have been enrolled in Jordan's already crowded public schools. Housing costs in the north have risen by a staggering 300%, according to government data. The annual cost of providing for the refugees is roughly USD 2.9 billion (8% of Jordan's GDP), according to government data, of which only 5.5% has been covered by the international community. The arrival of more than 200,000 Syrian laborers (around 10% of Jordan's workforce), who are willing to work at below market wages, has placed downward pressure on local wages.

Agricultural product exports are a significant contributor to Jordan's overall export profile, having accounted for about 20% of merchandise exports in 2013, according to World Trade Organization data. Exporting agricultural produce has been affected by the conflict in Syria, causing a severe decline by around 25% as well as disrupting overland exports to other markets (Oxford Business Group, 2015).

1.5 Economic Structure and Activities

Jordan is classified as a country of "high human development" with an "upper middle income" economy. The Jordanian economy, one of the smallest in the region, is attractive to foreign investors. Nonetheless, a lack of natural resources, a high population growth rate, the ongoing regional conflicts, the rising cost of health care, and the growing expectations of people have posed challenges to the country's sustainable social and economic development.

According to the International Monetary Fund (IMF), Jordan has done well despite the effects of regional instability. This is largely due to a recovery in industry and mining, with phosphate production reaching as high as 746,200 Tons. The national accounts statistics published by the Department of Statistics (DOS) showed that there was an improvement in the growth rate and in GDP per capita at existing prices in 2014, as shown in Table 1.1.

Table 1.1: Indicators of national accounts, 2009-2014

Indictors	2009	2010	2011	2012	2013	2014
Gross Domestic Product at Current Prices (million JD)	16,912.2	18,762	20,476.6	21,965.5	23,851.6	25,437.1
Gross Domestic Product at Constant Prices (million JD) (1994=100)	9,759.9	9,985.5	10,243.8	10,515.3	10,812.8	11,147.6
GDP Growth Rate at Constant Prices (%)	5.5	2.3	2.6	2.7	2.8	3,1
GDP Per Capita (JD)	2,82.1	3,069.2	3,276.8	3,438.6	3,652.6	3,810.8

Source: DOS, 2015

Table 1.2 shows that Jordan's top five contributing sectors to GDP are government services, finance, manufacturing, transport, as well as tourism and hospitality.

The percentage contribution to GDP by economic activity at existing market prices during the period, 2008 to 2015 sectors

Economic Activity	2008	2009	2010	2011	2012	2013	2014	2015
Manufacturing	17.6	17.0	16.9	17.2	17.1	17.0	16.7	16.5
Wholesale and Retail Trade, Restaurants, and Hotels	10.0	9.9	9.5	9.6	10.0	10.0	10.1	9.9
Transport, Storage, and Communications	14.3	13.8	14.2	14.3	14.5	14.7	14.4	14.5
Finance, Insurance, and Business Services	8.7	8.2	8.8	8.9	9.4	9.7	9.7	9.9
Producers of Government Services	11.6	11.2	11.4	11.5	11.5	11.5	11.4	11.4

Source: DOS, 2015

The government identified poverty and unemployment as two of the most important challenges facing the country. Jordan is one of the Arab countries with the lowest employment rates for both men and women, among those above the age of 15, the percentage of economically active was 36.4% in 2015. Of those economically active, the percentage of males was 59.5% of the total labor force in Jordan, compared with 13% for females. For women, the employment rate rises with educational level. Only 16.7% of women with less than secondary education were employed in 2015 (DOS, 2015), as shown in Table 1.3.

Table 1.3: Jordanian employed persons age 15+ years by sex and educational level, 2015

Educational Level	Male	Female	Total
Illiterate	3.4	9.5	6.4
Less than Secondary	58.9	49.9	54.4
Secondary	16.3	16.7	16.5
Intermediate Diploma	6	9.1	7.5
Bachelor and Above	15.4	14.8	15.1

Source: DOS, 2015

All categories of the 2015 budget, including domestic revenues, foreign grants, current expenditure, and capital expenditure, showed a decline compared with the year before. The sharp drop in foreign grants, by 28.3%, came as a shock, as Jordan depends heavily on foreign grants to finance its capital expenditure. The actual financial performance of 2015 showed a rise in the deficit by 59.1% in comparison to the previous year and a rise of 98.2% over the national budget.

Outstanding external public debt (government and government guaranteed) increased by 275.8 million JD to reach 10574.8 million JD at the end of the first third of the year 2017 equivalent to 37.9% of projected 2017 GDP by the end of first third 2017 compared to 10299 million JD or 37.5% of GDP at the end of 2016 (MOF, 2016). Net outstanding domestic debt (budgetary and own-budget agencies) increase at the end of first third of the year 2017 to reach 13908.5 million JD or 49.9% of projected 2017 GDP by the end of first third of the year 2017 compared to 13780.4 million JD or 50.2% of GDP at the end of 2016, reflecting an increase of 128 million JD (MOF, 2016).

The net outstanding public debt (domestic and external) increased at the end of first third of the year 2017 above its level at the end of 2016 by 403.8 million JD or 1.7% to reach 24483.2 million JD or 87.8% of projected 2017 GDP by the end of first third of the year 2017 compared to 24079.4 million JD or 87.7% of GDP in 2016.

1.6 Ecosystem and Biodiversity

Jordan captures four bio-geographic regions: the Mediterranean, Irano-Turanian, Saharo-Arabian, and Sudanian, each with its unique ecosystems and flora and fauna. There are thirteen vegetation types in the country reflecting the various climatic and geographic variations (IUCN-ROWA, 2014). The total number of wild species recorded in Jordan is approximately 4,000 from terrestrial and marine flora and fauna. Around 2,622 species of vascular plants have been recorded, representing about 1% of world flora; one hundred species are endemic.

Jordan has 644 animal species, of which 83 are mammals, 436 species of birds, 348 species of fish, and many more others. Avifauna composition is especially rich in Jordan because of the country's geographical location associated with the Great Rift Valley and lying on major migratory birds' routes.

Threats to national biodiversity continue to endanger long-term ecosystems sustainability. Key current threats include land degradation, tourism, and climate change, among others. Various government, nongovernment, and academic organizations and institutions are exerting significant efforts to adapt to the impact of the different threats and mitigate their root causes. National initiatives and programs have been undertaken to assess, valuate, and promote the economic value of ecosystems' provisional, regulatory, and cultural services. This includes several strategic studies on medicinal plants, rangelands, and protected areas. Despite the progress made, much more is needed to systematically capture the economic value of ecosystems services and mainstream results into national decision-making frameworks and processes.

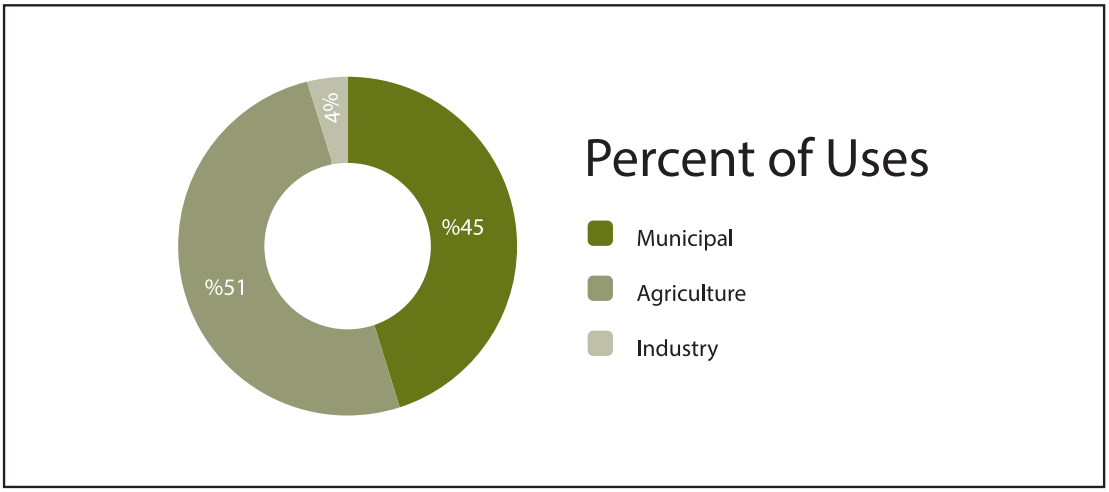
1.7 Water Resources

Jordan is known to be one of the Four water-poorest countries of the world with an annual per capita water share of around 130 m^3/capita/year (MoEnv, 2016).

While Jordan's population is expected to increase as a result of natural population growth, the country has also experienced population growth due to the influx of multiple waves of refugees seeking a safe haven within its borders. Refugee flows have put additional strain on Jordan's already severely limited water resources and have come without warning.

Water use in Jordan targets three different sectors: agriculture, municipal supplies, and industry. Agriculture is by far the largest user of the country's water resources, accounting for roughly 51% of the total water supply, while 45% goes to municipal uses, and 4% goes to industry, as indicated by Figure 1.2.

Figure 1.2: Water use by sector, 2015



About 45% of agricultural demand is met by groundwater resources, as shown in Table 1.4 (MWI, 2014). The majority of irrigated land in Jordan is located in the highlands and desert areas (about 52,700 hectares), and in the Jordan Valley (about 31,600 hectares).

About 75.5% of the water supply for domestic uses is met by groundwater sources with the exception of the water that is pumped from the Yarmouk River to meet Amman's water demand. The portable water infrastructure in Jordan is not very efficient. Only 45% of the daily domestic consumption is accounted for and about 55% of the daily domestic consumption is lost.

About 82.2% of the industrial demand is met by groundwater resources. It is worth noting that industrial water demand is projected to increase due to anticipated expansion in industrial enterprises as a result of Jordan's inclusion in the World Trade Organization (WTO), the free trade agreements signed between Jordan and the United States, and the establishment of free zones in different regions of Jordan. These agreements make Jordan a desirable destination for regional investors and manufacturers.

Table 1.4: Water sources for different sectors

Water Source	Sector			Total (MCM)
	Municipal	Industrial	Agriculture	
Groundwater	325	32.2	231.3	589
Surface water	103.8	4.8	150	259
Treated wastewater	0	1.7	123.3	125
Total	429	39	505	972
Percentage of total	44.1%	4%	51.9%	100%
Rain-fed agriculture consumes around 100 MCM per year				

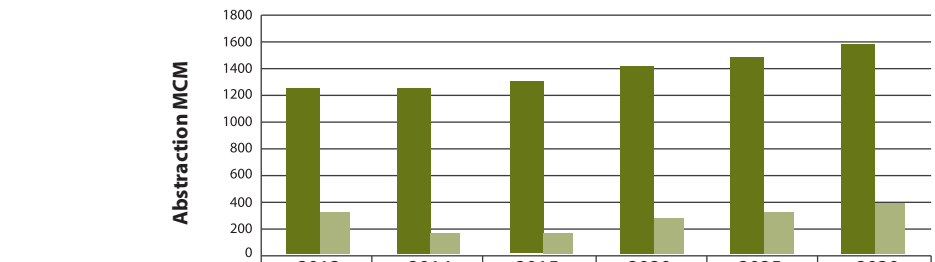
Source: MWI, 2014

Groundwater contributes about 61% to the total water supply. Of the 12 major groundwater basins, six are over-extracted, four are at capacity, and two are underexploited. Increasing overall water extraction to meet national needs carries a high cost. Jordan is now accessing nonrenewable water resources from fossilized deep-water aquifers. Underground water from the non-renewable Disi aquifer (about 100 MCM) is being used to meet Jordan's water supply for domestic use, while treated wastewater (125 MCM) is being used to meet the country's agricultural needs. Surface water supplies account for 27% of Jordan's total water supply. Developed surface water supplies were 259 MCM in 2014.

Jordan's population of 9.5 million (2015) is expected to almost double by 2050. The proportion of water used for domestic purposes may increase by 50-60% in the same time period. By 2025, water demand will exceed available water resources by more than 26%, but this deficit is projected to decline to 6% when the Red Sea-Dead Sea project goes online (MWI, 2014).

A comparison of the water demand in 2013 (used as a reference for the comparison) with water demand in 2014, 2015, 2020, 2025, and 2030 is shown in Figure 1.3, which reveals major water deficits in all years.

Figure 1.3: Projected water demand and deficit, 2013-2030



	2013	2014	2015	2020	2025	2030
Water Demand Deficit	1213	1243	1266	1384	1454	1532
Deficit	312	145	156	254	309	364

Source: MWI, 2014

It is clearly demonstrated that water shortages in Jordan is a chronic problem and will continue to be so for years to come. If current domestic, agricultural, and industrial water use practices are not improved, the water supply in Jordan will deplete in quantity and quality with time. Overdraft of groundwater and surface water is creating a tremendous stress on the water supply in Jordan. The reduced flow of surface water to the Dead Sea is also a source of concern.

Despite Jordan's severe water scarcity, more than 94% of Jordanians have access to safe drinking water and 93% have access to improved sanitation. These are some of the highest rates in the Middle East and North Africa region. However, water supply is intermittent and the rooftop tanks have become an integral part of the supply water storage system. Water is delivered once a week on average in big cities while some areas receive water every other week or once every two weeks.

Since the Disi-Amman Conveyor project became operational in the summer of 2013, the continuity of water supply to Amman has improved. However, population centers in the northern Governorates have not benefitted fully because of increased demand driven by the concentration of Syrian refugees in the north. Aqaba has continuous water supply from the Disi aquifer. It is planned to bridge the remaining gap between demand and supply through increased use of non-conventional water including reclaimed water and desalinated seawater to be provided by the Red Sea-Dead Sea project in the near future. Water tariffs are subsidized. The National Water Strategy emphasizes desalination as well as treated wastewater reuse to meet shortfalls in freshwater availability (MWI, 2014).

1.8 Agriculture and Forestry

Jordanian agriculture is established along three major climatic regions: the highlands and marginal steppes where most of the rain-fed farming is practiced, the Badia (mostly livestock systems and some cultivation in watershed and from deep bore irrigation), and the lowlands (Jordan Valley) that thinly stretches from the North West to the South West.

The contribution of agriculture to GDP in relative terms declined sharply from 20% in 1974 to 3.8% in 2011 (DOS, 2014), while its contribution in absolute terms has increased from 57 million JD in 1974 to 713 million JD (MoA and Central Bank of Jordan Periodic Reports, 2013).

The importance of the agricultural sector stems from the fact that it is not only a major source of food, in particular fruits and vegetables, but it is also a source of hard currency from exports. In addition, the agro-industrial sector is characterized by a large number of small enterprises. The vast majority of irrigated agricultural production targets fruit trees and vegetables. More than 90% of irrigated areas in Jordan are dedicated to the cultivation of fruit trees and vegetables.

According to 2012 statistics, 2% of employees in Jordan were active in the agricultural sector, 17.5% in the industrial sector, and 80.5 % in the service sector (Jordan Statistical Portal, 2013). The number of net created jobs in agriculture, forestry, and fishing in 2011 was 769 persons. The total number of non-Jordanian workers holding work permits in the agricultural sector in 2012 was 85880 (84924 males and 956 females).

Agriculture is mostly influenced by water availability and the ability to use advanced practices, technologies, and interventions to adapt to the impacts of climate change. Over the past two decades, Jordan has witnessed a drastic drop in rainfall and prolonged drought periods. Precipitation is projected to decrease by 15-60% and, a rise of 1-4°C in temperatures is predicted by 2020. These climatic changes will have serious negative consequences on natural ecosystems, river basins, watersheds, and biodiversity, according to the National Climate Change Policy of Jordan 2013-2020.

Jordan has limited forest resources with forests covering less than 1.5% of the country. Of this forest land, only 26% has forest cover with a canopy density of 10% or more and the rest is mostly composed of land sparsely covered with vegetation.

The forest vegetation in Jordan can be divided into natural forests that are composed of evergreen shrubs, pine and juniper forest as well as broadleaf forests and private forests are registered in the name of their private owners and are found mostly in the northern part of Jordan where higher rainfall is prevailing. They include natural forest vegetation and tree plantations on farms, in the form of windbreaks and shelter-belts. Private forests account for less than 4% of the total declared forestland.

1.9 Coastal Zone and Coral Reefs

The Gulf of Aqaba is a semi-enclosed ocean basin connected via a narrow, relatively shallow, energetic tidal strait to the rest of the Red Sea. The annual rainfall in Aqaba is less than 30 mm and the surface runoff is practically zero. The best estimate for the annual mean evaporation from the surface is 1.6-1.8 m (Ben-Sasson et al., 2009).

The Gulf exchanges water with the northern Red Sea through the Strait of Tiran. The Gulf of Aqaba measures a length of 180 km and expands to a width of 25 km, which decreases to about 5 km at the northern tip. The mean depth of the Gulf is about 800 m, with a maximum of about 1850 m, which is close to that of the Red Sea. Coastal ecosystems have proven to be highly vulnerable to a variety of human impacts. One of the most important human stressors that may harm marine ecosystems is industry. Industrial activities affect marine habitats mainly by mechanical damage such as discharges, spills, ship groundings, and degraded near shore water quality. The lack of regular fresh water input and the high evaporation rate contribute heavily to the particularly saline conditions within the gulf. The salinity is relatively high and ranges between 40 and 45 g/l compared to an ocean's average salinity of 35 g/l. Vertical salinity differences are very small, ranging between 50 and 150 m. In general, the eastern side of the Gulf is less saline, most likely due to the influx of Red Sea (ICRI, 1995).

The calm and clear waters provide a suitable environment for the growth of corals, and favorable salinity levels provide a suitable environment for countless varieties of marine-life forms. Different species of corals occur at various depths and are of special attraction to tourists. Many species of coral fishes are encountered among the corals. More than 50% of the Gulf's shoreline is covered by an ancient coral reef where more than 151 scleractinian (stony-reef-building coral species) and 120 species of soft coral were recorded. Some of them, such as the red and black corals, are globally endangered. In addition, the Jordanian coastline is distinguished by extensive fringing reefs, which are considered one of the most dynamic and diverse of all-natural ecosystems.

The northern parts of Aqaba city are the most vulnerable regions for flashflood hazards. These parts have been set aside for town residential expansion, the Aqaba International Industrial Estate, King Hussein International Airport, light industries, and logistics.

Authorities in Aqaba have been taking measures to mitigate damage which rainy season flash floods may cause. Projects to improve the sewage system, increase drainage, and elevate street levels were recently finished and are now in operation.

Rainwater that gathers in the mountains surrounding Aqaba can also be a recurring source of flooding. The Aqaba Special Economic Zone Authority (ASEZA) has recently announced tenders for the construction of 10 dams for water collection, to be followed by tenders for 20 more dams.

1.10 Energy Sector Profile

Jordan imports 97% of its energy needs. Energy imports were 18% of GDP in 2014, but declined to 13% of GDP in 2015 due to the drop-in oil prices.

Local sources of oil and natural gas remain very limited in Jordan, despite efforts to develop existing fields and to explore for new resources. Jordan contains large amounts of oil shale, with a surface reserve of 70 billion tons containing more than 7 billion tons of oil shale. Oil shale can be utilized to generate electricity via combustion. Alternatively, shale oil and gas can be extracted using distillation or thermal injection.

The interruption of the Egyptian gas supply forced the Jordanian government to identify new, secure ways of procuring natural gas to the country. The construction of a Liquefied Natural Gas (LNG) jetty project at Aqaba port, the connection to the Arab gas pipeline, and the leasing of a Floating Storage and Regasification Unit (FSRU) were successfully implemented and put in commercial operation in September 2015. Eventually, Jordan will develop the ability to meet all its needs of natural gas for

electricity generation and for industrial use. In 2016, 90% of electricity generation in the Kingdom was based on imported natural gas via terminals.

Renewable energy has the potential to enhance energy security, improve access to affordable energy, create jobs, and mitigate climate change. The government of Jordan has recognized the importance of renewable and launched the 2007 Master Strategy of the Energy Sector with an ambitious target of generating 7% of total primary energy supply from renewable sources by 2015 and 10% by 2020. This strategy has been updated for the period 2015-2025 and approved by the Ministerial Council in December 2015. The total renewable capacity by end of 2020 will be 1350 MW accounting for 25% of all installed generating capacity and contributing 20% to generated electricity.

A legislative and regulatory framework for renewable energy has been set up by enacting a special renewable energy law and preparing the needed bylaws and instructions, which offer financial incentives. As a result, many renewable energy power purchase agreements were signed to supply the grid with electricity generated from solar and wind. Many of these projects have become operational in 2015.

Jordan has also developed a strategy for utilizing nuclear power to supply the country with 30% of its demand for electricity by 2030, with surplus destined for export. A nuclear power committee was set up in 2007 and a law was enacted to establish the Jordan Atomic Energy Commission (JAEC) and the Jordan Nuclear Regulatory Commission (JNRC). In December 2016, JAEC in cooperation with a consortium headed by the Korean Atomic Energy Research Institute, inaugurated the 5 MW Jordan Research and Training Reactor. The facility is the first nuclear reactor in the county. It will provide radioactive isotopes for medical applications in Jordan, and will provide training for students at the Jordan University of Science and Technology to prepare skilled workforce for the country's planned commercial nuclear power reactors. Current plans allow for the construction of two nuclear power plants by the Rosatom company, to be commissioned in 2023 and 2025.

1.11 Transport Sector

Transportation infrastructure in Jordan is considered to be relatively well developed in a Middle Eastern context. Transportation demand is expected to see an average growth of 5-6%. The transportation sector accounts for more than 10% of GDP (Public Transportation in Jordan, FES- 2017).

Land and air transportation infrastructure is well developed, with plans to improve maritime and railway infrastructure. The Government of Jordan has developed a national transport strategy to upgrade the country's infrastructure and enable the Kingdom to capitalize on its strategic geographical advantages.

Today, there is an extensive 80,000 square kilometers road network which spans across the Kingdom, connecting it with neighboring countries. The Port of Aqaba and the newly expanded Queen Alia International Airport (QAIA) are Jordan's two major gateways to the rest of the world and both are undergoing significant upgrades in capacity and quality of service. Jordan's transport network is crucial to the flow of trade through the region, and it is set for significant expansion. The Kingdom serves as an important regional transport hub between Gulf Cooperation Council (GCC) countries and Turkey and Europe, and also between Iraq and the Red Sea and the Mediterranean.

The current public transportation system can be described as inefficient. This is the result of practices governing public transportation - particularly related to the layout of routes and the granting of licenses for running them - that date back over a period of more than four decades. Several projects have been proposed over the last decade to address the problems associated with the current transportation system. One of these mega projects is the Amman Bus Rapid Transit Project, a USD 160 million project currently under-construction in Amman that runs on 3 routes from Sweileh in West Amman to the Jordan Museum in Ras Al-Ain, passing by the sports city intersection where the route branches out to Al-Mahatta in East Amman.

1.12 Industrial Sector

Jordan is attractive for foreign investments in the Middle East primarily due to its political stability and its central location in the region. Industry in Jordan is principally dominated by manufacturing and mining.

Qualified Industrial Zones (QIZ) are business parks that are recognized as free trade zones set up in collaboration with the United States. Jordan is one of two countries to have this arrangement, the other being Egypt.

In Jordan, the Qualified Industrial Zones are:

- Al-Hassan Industrial Estate
- Al-Hussein Ibn Abdullah II Industrial Estate
- Jordan Industrial Estate Corporation
- Jordan Cyber City
- Al-Tajamouat Industrial Estate
- Gateway QIZ
- Aqaba Industrial Estate
- Ad-Dulayl Industrial Park
- El-Zai Ready-wear Manufacturing Company

The manufacturing sector includes leather and footwear manufacturing, chemicals, plastics, IT, furniture, food, packaging, and manufacturing of engineering technology. The contribution of manufacturing to GDP decreased to 506.90 million JD in the fourth quarter of 2016 from 517.39 million JD in the third quarter of 2016 (DOS, 2016).

The mining industry sector is one of the most important strategic industries. Mining contributes to the employment of local labor and caters to the needs of the market for raw materials, while being a source of hard currency.

The contribution of mining to GDP increased to 50.20 million JD in the fourth quarter of 2016 from 39.67 million JD in the third quarter of 2016 (DOS, 2016).

The mining sector consists of the following sub-sectors:

- Phosphate and potash.
- Cement and chalk mining.
- Mining and extraction of limestone to produce calcium carbonate.
- Mining and manufacturing kaolin, gypsum, feldspar, and silica.
- Extracting and crushing stone tablets, slabs, marble, and granite stones and sand.

Phosphate and potash are the most significant natural resources in Jordan. The sector relies primarily on large investments, driving several firms to invest in such a promising field. The mining sector is the third largest industrial sector in terms of invested capital and the fourth largest sector in terms of exports in 2014. It also ranked first in terms of foreign investments in Jordan. Moreover, products from mining are used as raw material inputs for other industries such as fertilizers. Positive outlooks loom large as domestic value-added activities are increasingly combined with investing in other areas, such as shale oil and uranium. This requires activating the exploitation of untapped raw materials in the Kingdom to create products that meet the global demand forenergy.

1.13 Waste Sector

Jordan has experienced a large increase in population over the past decade as a result of a high population growth rate and forced migration. Economic and cultural development has improved the standard of living and changed consumer habits, resulting in an increase in the volume of municipal solid waste (MSW) over time. However, no official statistics have been disclosed regarding the increase in solid waste generation after the influx of Syrian refugees. Yet, preliminary official estimates refer to more than 20-35% increase in solid waste generation in Jordan following the Syrian crisis, putting substantial burden on municipalities as well as on the surrounding ecosystems.

In Jordan, solid waste is collected from 94 municipalities in containers without segregation. There are 18 recorded landfills in the country, most of which are not properly designed or operated, demonstrated by their lack of proper lining, leachate collection system, and landfill gas management (LFG) system. The only sanitary landfill is Al-Ghabawi landfill, which receives 50% of the waste produced in Amman and Zarqa. Al-Ghabawi landfill is located 23 km to the East of Amman over an area of 2000 Dunums, enough area to dispose of waste until 2025, using safe burying techniques. The Great Amman Municipality purchased 1000 Dunums from surrounding lands to rent out to the private sector to encourage investment in waste segregation and recycling.

The Jordanian government has identified in 1989 the Swaqa landfill, 125 km to the South-East of Amman, as a facility to process hazardous waste. The landfill is overseen and operated by the Ministry of Environment. The Ministry of Environment has also founded a center in Swaqa landfill to oversee the disposal of electronic waste in a safe manner to discourage improper storage and illegal re-selling. In general, the sector is in need of studies to investigate the potential of waste recycling.

The Jordan national water strategy 2016-2025 has identified treated wastewater, when mixed with surface water, as a source of irrigation water. In 2013, the amount of treated wastewater exceeded 120 MCM. There are 33 public working wastewater treatment plants in Jordan, most of which use activated sludge. They are either operated by the Water Authority of Jordan (WAJ) or managed by the Project Management Unit (PMU) at the Ministry of Water and Irrigation (MWI) through contracts with the private sector. The Samra Wastewater Treatment Plant (WWTP) receives more than 70% of the country's total generated wastewater.

According to MWI figures, the ratio of industrial to total water use in 2013 was very small (4.3%). Industrial wastewater discharged to Wadis and other surface water bodies was first regulated by Martial Law issued in 1981 to force all industries to treat their wastewater before discharge to receiving water bodies. A number of industrial entities divert their wastewater to the public sewer system according to WAJ regulation No. 18/1998.

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NATIONAL GREENHOUSE GAS INVENTORY

2.1 Introduction

The GHG Inventory (emissions and removals) was prepared following Decision 17/CP.8, which states that:

- Each non-Annex I Party shall, as appropriate and to the extent possible, provide in its national inventory, on a gas-by-gas basis and in units of mass, estimates of anthropogenic emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) by sources and removals by sinks.
- Non-Annex I Parties are encouraged, as appropriate, to provide information on anthropogenic emissions by sources of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).
- Non-Annex I Parties are also encouraged, as appropriate, to report on anthropogenic emission by sources of other greenhouse gases such as carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOC). Other gases not controlled by the Montreal Protocol, such as sulphur oxides (SOx), included in the IPCC Guidelines may be included at the discretion of the Parties.

The national GHG emissions were estimated for the years 2010 and 2012 using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines and Software for Parties not included in Annex I of the UNFCCC.

All sector and subsector national experts used Tier 1, since the current version of the software supports only Tier 1. The sectors and subsectors that were considered are the following:

1. Energy:

- Stationary Combustion
- Mobile Combustion
- Fugitive Emissions

2. Industrial Processes and Product Use (IPPU):

- Mineral Industry Emissions
- Chemical Industry Emissions
- Metal Industry Emissions
- Non-Energy Products from Fuels and Solvent Use
- Emissions of Fluorinated Substitutes for Ozone Depleting Substances and Other Product Manufacture and Use

3. Agriculture, Forestry, and Other Land Use (AFOLU):

- Cropland and Forest Land
- Emissions from Livestock and Manure Management
- N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application

4. Waste Generation, Composition, and Management Data

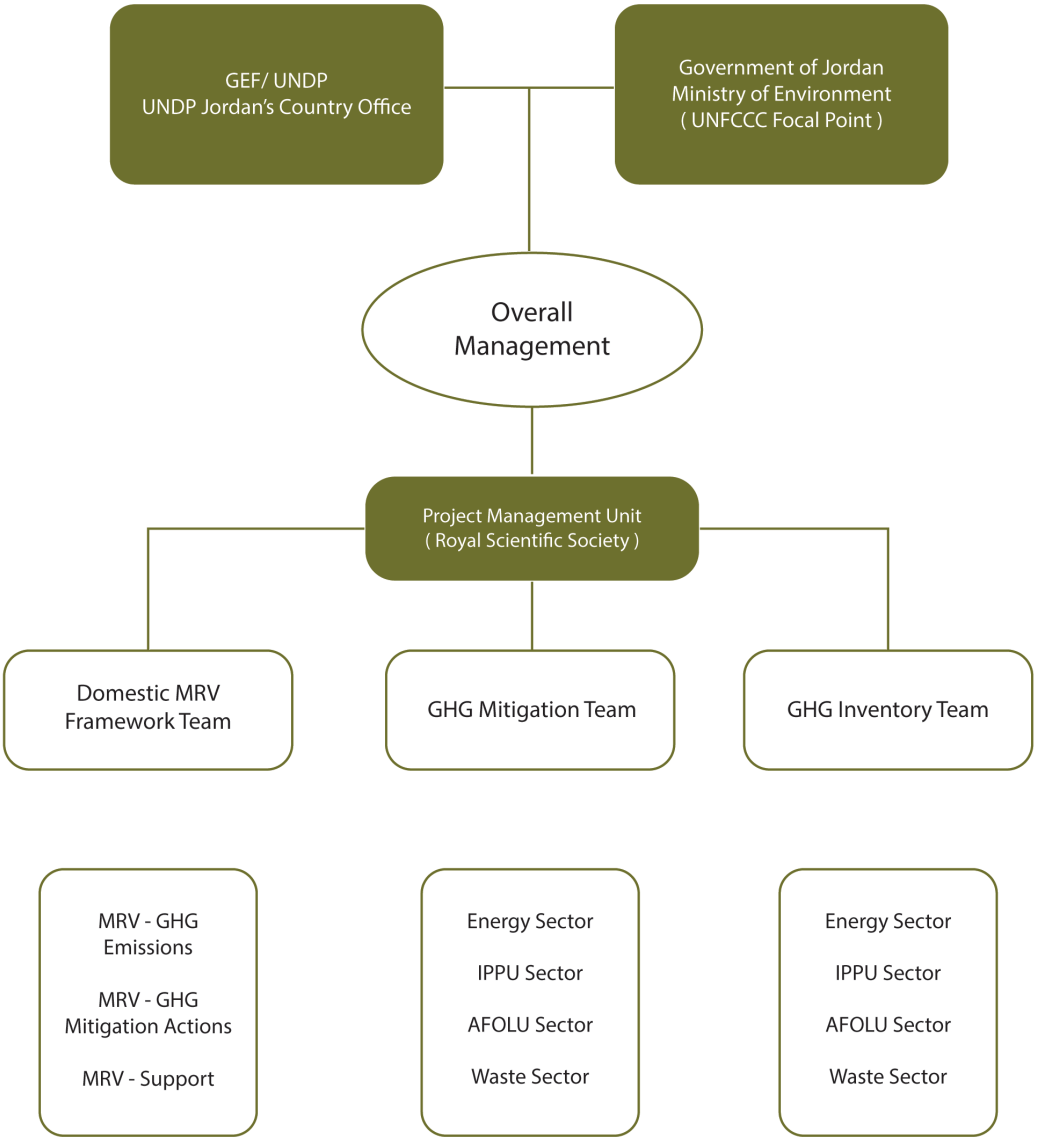
- Solid Waste Disposal
- Biological Treatment of Solid Waste
- Incineration and Open Burning of Waste
- Wastewater Treatment and Discharge

This chapter addresses emissions of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Those gases are supported by the software and the IPCC 2006 Guidelines. Non-methane volatile organic compounds (NMVOCs) emissions resulting from the solvents subsector were estimated using EMEP/EEA air pollutant emission inventory guidebook 2013.

2.2 Institutional Arrangements

The Ministry of Environment is the focal point for issues relevant to the UNFCCC and is responsible for seeing that Jordan's commitments are met. Preparation of Jordan's FBUR was coordinated by the Ministry of Environment in partnership with UNDP. An agreement with the Royal Scientific Society (a national non-governmental, non-for-profit organization for applied research) was realized to achieve the work. The GHG inventory development was accomplished with the participation of a pool of national experts representing different national entities, as demonstrated by the organizational chart in Figure 2.1.

Figure 2.1: Organizational chart for national GHG inventory development

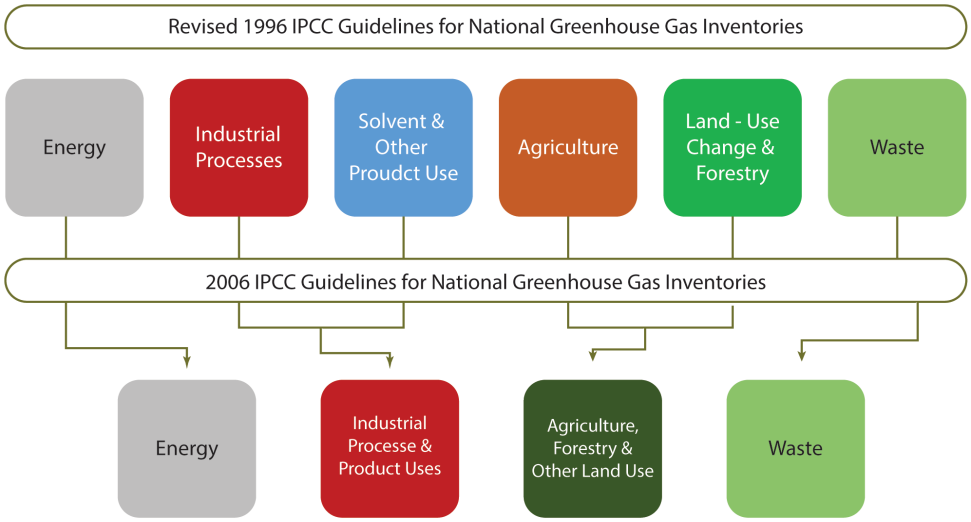


2.3 Methodology and Inventory Estimation

The IPCC Greenhouse Gas Guidelines provide detailed methods for estimating GHG emissions by sources and removals by sinks. The 2006 IPCC Guidelines is an update of and was synthesized from the Revised 1996 Guidelines, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Good Practice Guidance for Land Use, Land-Use Change, and Forestry.

There are some structural changes in the 2006 Guidelines, such as combining the previously separate Agriculture and Land-Use, Land-Use and Forestry (LULUCF) sectors into one sector, as shown in Figure 2.2. It is worth noting that the inventory methods in the 2006 Guidelines are just an update of the previous editions with additional sources and some new default emission factors.

Figure 2.2: Structural differences between Revised 1996 and 2006 IPCC Guidelines



In addition to guidance on appropriate estimation methods, the 2006 Guidelines include cross-sectoral good practice guidance for inventory preparation. This includes collection of activity data, key category analysis, quality assurance and control, and inventory planning and documentation.

Since the IPCC Guidelines are intended to be used by all countries with different capacities, they provide different tiers of methods for each category of emission source or removal category. The higher tier methods (Tier 3 being the highest) are typically more detailed, data intensive, and rely on country-specific parameters to estimate emissions. In contrast, Tier 1 methods utilize more aggregated data and default emission factors. The 2006 IPCC Guidelines provide methodologies for estimating national GHG inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol. The 2006 Guidelines are of five volumes. Volume 1 describes the basic steps in inventory development and offers general guidance in estimating greenhouse gas emissions and removals. Volumes 2 through 5 offer guidance in making estimates for different sectors of an economy.

In preparing Jordan's FBUR inventories, the 2006 IPCC Guidelines and the IPCC Software (versions 2.16 and 2.17) were used.

National inventories for years 2010 and 2012 were estimated. And as per the guidelines, four sectors were considered, namely, Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and other Land Use (AFOLU), and Waste.

Inventories were prepared on a gas-by-gas basis and in units of mass. Estimates of anthropogenic emissions of the direct GHGs of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were assessed by sources and removals by sinks.

Not all indirect GHGs were estimated. To improve completeness of emission estimates, it is recommended to estimate them in the future by using the EEA Guidelines and methodology.

For reporting purposes, the notation keys NO (not occurring) or NE (not estimated) and NA (not applicable) were used as necessary in the inventory reporting tables.

Emissions were estimated in Gigagrams (Gg) for all direct and indirect gases, as well as in Gg of CO_2-equivalent (CO_2eq) for all direct gases. For the conversion from Gg of different GHGs to Gg of CO_2eq, the Global Warming Potential (GWP) values provided in the IPCC SAR (temporal horizon 100 years) were used (as per Decision 17/CP.8).

The following sections report Jordan's GHG inventories by sector and on a gas by gas basis.

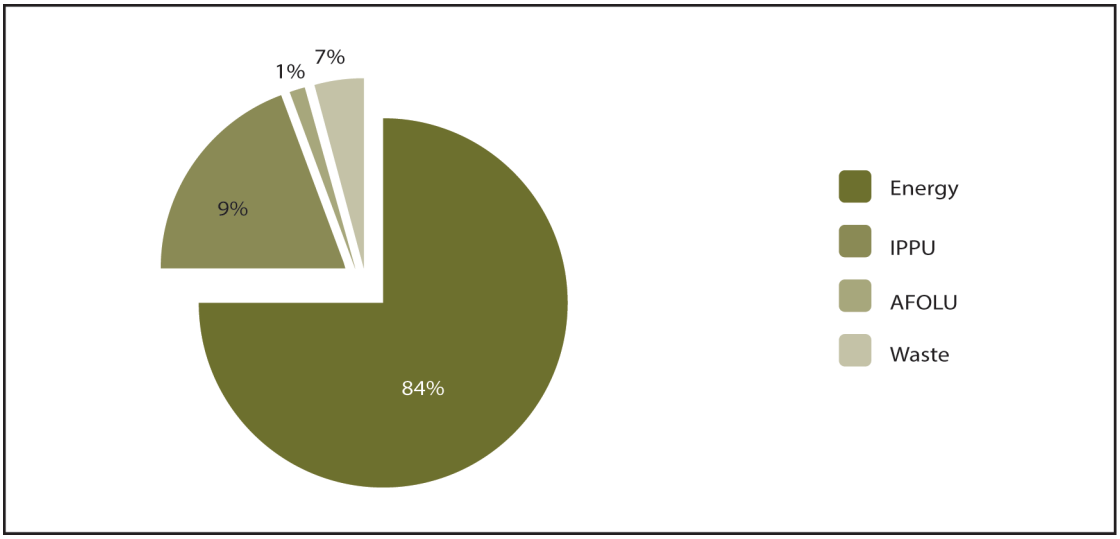
2.4 GHG Inventories by Sector

According to the overall GHG Inventory estimates, Jordan contributed 23140.06 Gg of CO_2-equivalent (CO_2eq) in 2010. A breakdown of Jordan's total emissions of GHGs by sector indicated that the Energy Sector is the major emitter accounting for 84% of total national emissions followed by the Industrial Sector with a contribution of 9%. GHG emissions by sector in 2010 are shown in Table 2.1 and Figure 2.3.

Table 2.1: GHG net emissions by sector, 2010

Categories	Emissions CO_2 Equivalents (Gg)	Percentage of the overall
Total National Emissions and Removals	**23140.06**	**100%**
Energy	19410.88	84%
Industrial Processes and Product Use	1982.04	9%
Agriculture, Forestry, and Other Land Use	180.50	1%
Waste	1567.49	7%

Figure 2.3: GHG net emissions (%) by sector, 2010

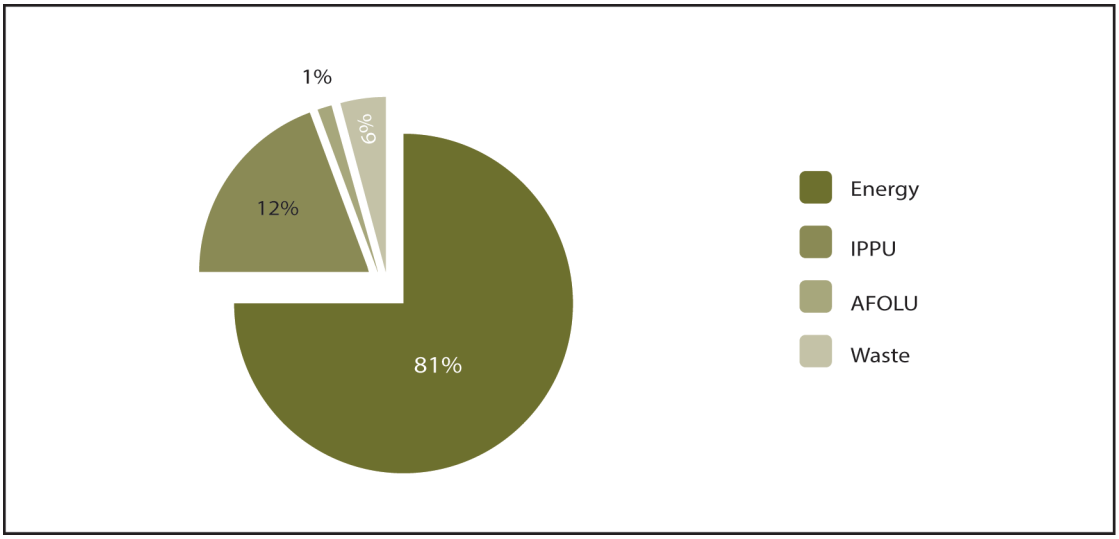


In 2012, Jordan contributed 27997.73 Gigagrams (Gg) of CO_2 equivalent (CO_2eq). A breakdown of Jordan's total emissions of GHGs by sector indicated that the energy sector was the major emitter capturing 81% of total national emissions followed by the industrial sector with a contribution of 12%. The 2012 GHG emissions by sector are shown in Table 2.2 and Figure 2.4.

Table 2.2: GHG net emissions by sector, 2012

Categories	Emissions CO_2 Equivalents (Gg)	Percentage of the overall
Total National Emissions and Removals	**27997.73**	**100%**
Energy	22756.83	81%
Industrial Processes and Product Use	3368.47	12%
Agriculture, Forestry, and Other Land Use	237.29	1%
Waste	1635.14	6%

Figure 2.4: GHG net emissions (%) by sector, 2012



In the below sections, a detailed description is given for the emissions resulting from the sectors in years 2010 and 2012.

2.4.1 Energy sector

Jordan has limited indigenous energy resources, leaving the country heavily dependent on energy imports to meet a growing demand, expected to double to a forecasted 15.08 million tons of oil equivalent (Mtoe) by 2020 from 7.357 Mtoe in 2010 and 8.205 Mtoe in 2012. Moreover, rapid economic growth, population growth, and the successive influx of refugees over the last decade have all imposed additional demands on energy resources. The costs of energy imports have increased as has the risk of interruptions in energy supplies. This has spurred governmental action to improve energy efficiency and search for additional energy resources.

Jordan imports 97% of its oil and gas, accounting for almost 18% of the 2014 gross domestic product (GDP). This has made the country completely vulnerable to fluctuations in the global energy market. The current energy strategy is to transform the energy mix from one heavily reliant on oil and natural gas to one more balanced with a higher proportion of energy supplied by renewable sources.

Energy-related activities have a dominant share of GHG emissions in Jordan. Emissions from this sector are classified into two main categories:

- Emissions from fuel combustion, and
- Non-combustion (fugitive) emissions.

2.4.1.1 GHG emissions in 2010

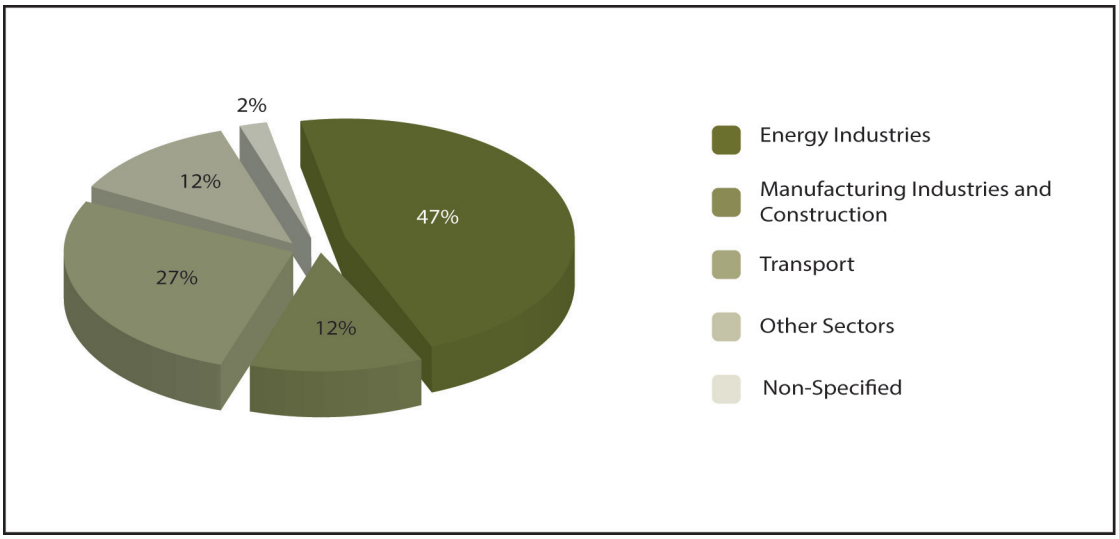
Total emissions from the energy sector were 19410.88 Gg of CO_2eq in 2010, resulting primarily from fuel combustion activities, as shown in Table 2.3. Fugitive emissions (from oil and natural gas) were negligible.

Within the fuel combustion activities, major emissions resulted from the Energy Industries and Transport subsectors with a share of 47% and 27% respectively. Emissions resulting from "Other sectors" (Residential, Commercial, and Agriculture) as well as "Manufacturing Industries and Construction" accounted for 24% of the total, as indicated in Figure 2.5.

Table 2.3: Energy sector net emissions, 2010

Categories	Net CO_2	CH_4	N_2O	Net Gg of CO_2eq
		(Gg of CO_2eq)		
ENERGY SECTOR	**19260.38**	**48.48**	**102.02**	**19410.88**
Fuel Combustion Activities	**19259.93**	**47.67**	**102.01**	**19409.61**
Energy Industries	9096.06	5.00	11.72	9112.78
Manufacturing Industries and Construction	2298.74	1.93	5.69	2306.36
Transport	5182.71	34.26	79.83	5296.81
Other Sectors (Residential, Commercial, and Agriculture)	2266.68	5.39	3.90	2275.97
Non-Specified	415.74	1.08	0.88	417.70
Fugitive Emissions (Oil and Natural Gas)	0.45	0.82	0.0009	1.26

Figure 2.5: Shares of emission (%) per subsector within the energy sector, 2010



International Bunkers, 2010

As per Decision 17/CP, to the extent possible, and if disaggregated data are available, non-Annex I Parties should report emissions from international aviation and international water-borne navigation separately in their inventories. Emission estimates from these sources should not be included in the national totals and should be reported only as information items. Estimated emissions (Gg) are shown in Table 2.4.

Table 2.4: Emissions reported as item information under memo 5, 2010

Emissions	Net CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
International Bunkers	**985.9870**	**0.0113**	**0.0275**
International Aviation (International Bunkers)	933.6305	0.0065	0.0261
International Water-borne Navigation (International bunkers)	52.3565	0.0048	0.0014

2.4.1.2 GHG emissions in 2012

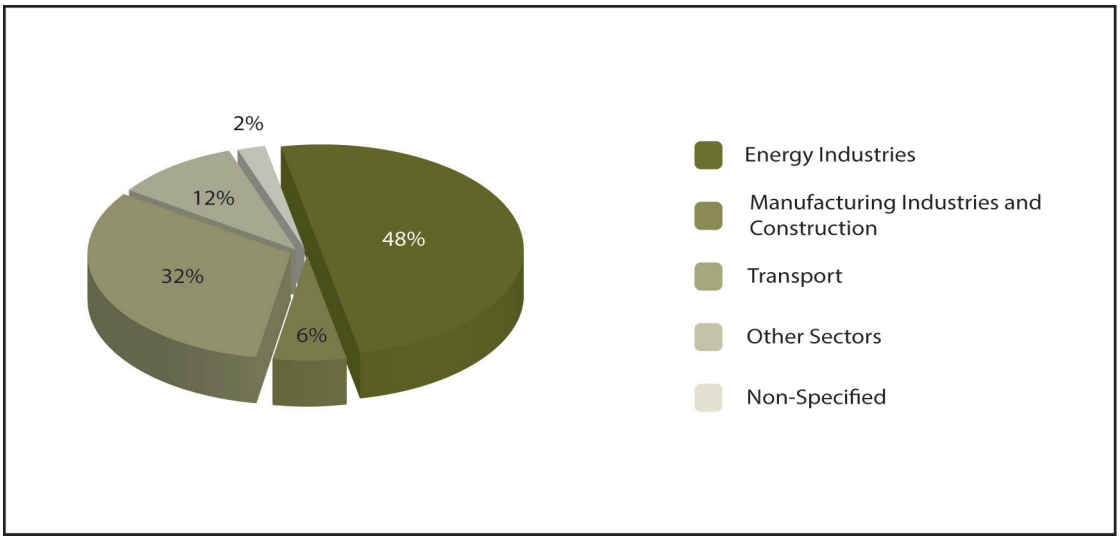
Total emissions from the energy sector were 22756.83 Gg of CO_2eq in 2012, resulting mainly from fuel combustion activities, as shown in Table 2.5. Fugitive emissions (from oil and natural gas) were negligible.

Within the fuel combustion activities, major emissions were the Energy Industries and the Transport subsectors with shares of 50% and 32%, respectively. Emissions resulting from "Other sectors" (Residential, Commercial, and Agriculture) as well as Manufacturing Industries and Construction accounted for 10% and 6%, respectively, of the total, as indicated in Figure 2.6.

Table 2.5: Energy sector net emissions, 2012

Categories	Net CO_2 (Gg)	CH_4	N_2O	Net Gg of CO_2eq
		(Gg of CO_2eq)		
ENERGY SECTOR	**22558.35**	**53.40**	**145.08**	**22756.83**
Fuel Combustion Activities	22557.98	52.75	145.05	22755.78
Energy Industries	11263.32	8.54	24.24	11296.10
Manufacturing Industries and Construction	1245.16	1.03	3.01	1249.19
Transport	7242.10	36.50	113.00	7391.60
Other Sectors (Residential, Commercial and Agriculture)	2324.62	5.48	3.91	2334.00
Non-Specified	482.79	1.20	0.93	484.92
Fugitive Emissions (Oil and Natural Gas)	0.37	0.65	NA	1.02

Figure 2.6: Shares of emission (%) per subsector within the energy sector, 2012



International Bunkers, 2012

Emissions from international aviation and international water-born navigation were estimated for the year 2012, as shown in Table 2.6.

Table 2.6: Emissions reported as item information under memo 5, 2012

Emissions	Net CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
International Bunkers	**1015.3249**	**0.0119**	**0.028**
International Aviation (International Bunkers)	959.1958	0.0067	0.027
International Water-borne Navigation (International bunkers)	56.1290	0.0051	0.0015

2.4.2 Industrial processes sector

the industrial sector in Jordan is considered one of the main pillars for the Jordanian economy. The industrial sector contributed directly to about 25% to the national GDP in 2014 to become the second-largest economic sector after the services sector. The sector has also contributed directly and indirectly for 40% of GDP through linkages with other key sectors such as transport, insurance, and trade.

The industrial sector consists of two subsectors, manufacturing and mining. The manufacturing (converting) subsector includes chemicals, electrical, engineering and construction, food and beverages, glass and ceramic, tobacco and cigarettes, paper and cartoon, pharmaceuticals and medical, printing and packaging, and textile and leathers. The mining subsector includes phosphate, potash, salt, carbonate, lime and limestone, fertilizers, cement and construction materials. Mineral extraction from mines and quarries is also included.

2.4.2.1 GHG emissions in 2010

In 2010, emissions from industrial processes sector were 1982.04 Gg of CO_2eq accounting for 9% of Jordan's total GHG emissions. The emissions were generated mainly from minerals industry, product uses as substitutes for Ozon Depleting Substances (ODS) (mainly Refrigeration, Air Conditioning, and Fire Protection), and the Chemicals Industry Subsectors.

The industrial processes sector was a source of NMVOCs emissions and accounted for 288.77 Gg of CO_2eq. In addition to CO_2 and NMVOCs, the sector generated emissions of HFCs with 377.33 Gg of CO_2eq. Estimated emissions (Gg of CO_2eq) are shown in Table 2.7 and Figure 2.7. While Table 2.8 and Figure 2.8 show the emissions from the minerals industry subsectors of the IPPU.

Table 2.7: Emissions of industrial subsectors, 2010

Categories	CO_2eq (Gg)	NMVOCs (Gg)
INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR	**1982.04**	**288.77**
Mineral Industry	1214.31	NO
Chemical Industry	151.34	NO
Metal Industry (Iron and Steel Production)	16.94	NO
Non-Energy Products from Fuels and Solvent Use	208.80	288.77
Product Uses as Substitutes for ODS (Refrigeration and Air Conditioning and Fire Protection)	377.33	NA
Other Product Manufacture and Use	13.32	NA, NO
Other (Food and Beverages Industry)	0.00	5.42

Figure 2.7: Shares of emission (%) per subsector within the IPPU sector, 2010

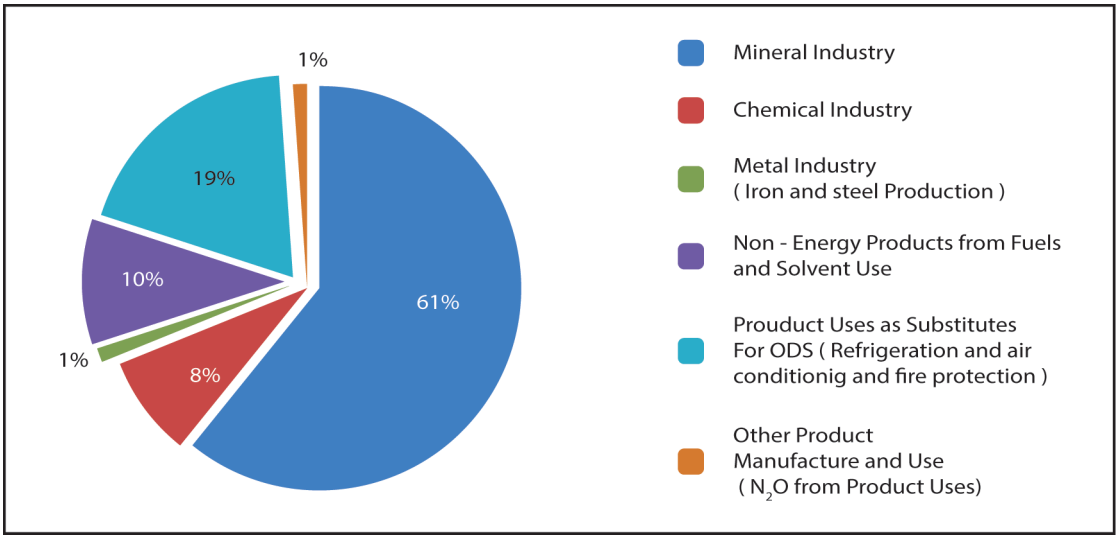
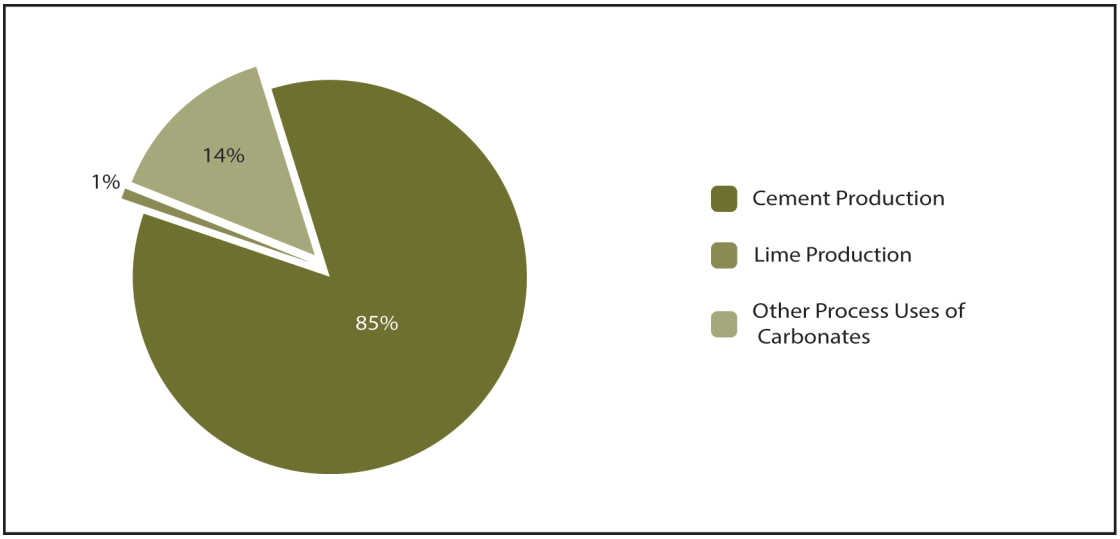


Table 2.8: Emissions of mineral industry, 2010

Categories	CO_2eq (Gg)
MINERAL INDUSTRY	**1214.31**
Cement Production	1038
Lime Production	10.71
Other Process Uses of Carbonates	165.60

Figure 2.8: Shares of emission (%) per subsector within the mineral industry subsector, 2010



2.4.2.2 GHG emissions in 2012

In 2012, emissions from industrial processes sector were 3368.47 Gg CO_2eq accounting for 12% of Jordan's total GHG emissions. The emissions were generated primarily by the minerals industry, product uses as substitutes for ODS (Refrigeration, Air Conditioning, and Fire Protection), and the chemicals industries subsectors.

The industrial processes sector was also a source of NMVOCs emissions and accounted for 221.33 Gg of CO_2eq. In addition to CO_2 and NMVOCs, the sector generated emissions of HFCs with 1399.33 Gg of CO_2eq. Estimated emissions (Gg of CO_2eq) are shown in Table 2.9 and Figure 2.9, while Table 2.10 and Figure 2.10 show the emissions from the mineral industry subsectors of the IPPU.

Table 2.9: Emissions of industrial subsectors, 2012

Categories	CO_2	N_2O	HFCs	Net	NMVOCs
	CO_2eq (Gg)				
Industrial Processes and Product Use	**1798.36**	**171.12**	**1399.33**	**3368.47**	**221.33**
Mineral Industry	1531.31	No	NA	1531	NO
Chemical Industry	NO	157.05	NO	157.05	NO
Metal Industry (Iron and Steel Production)	40.17	NO	NO	40.17	NO, NA
Non-Energy Products from Fuels and Solvent Use	226.88	NA	NA	226.88	215.66
Product Uses as Substitutes for ODS (Refrigeration and Air Conditioning and Fire Protection)	NA	NA	1399.33	1399.33	NA
Other Product Manufacture and Use (N_2O from Product Uses)	NO	14.07	NO	14.07	NA, NO
Other (Food and beverage Industry)	NA	NA	NA	NA	5.6731

Figure 2.9: Shares of emission (%) per subsector within the IPPU sector, 2012

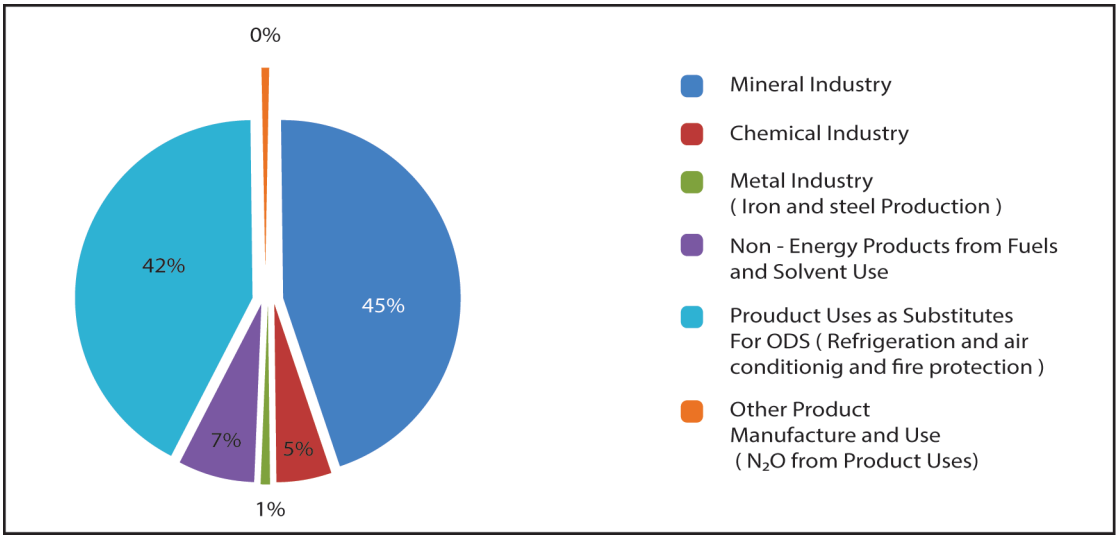
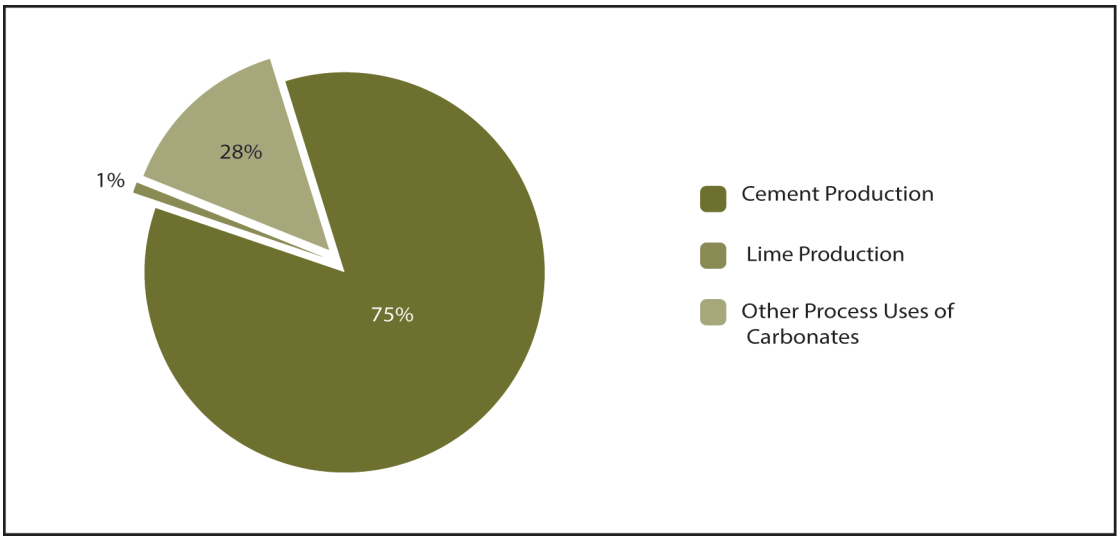


Table 2.10: Emissions of the mineral industry, 2012

Categories	CO_2eq (Gg)
MINERAL INDUSTRY	**1531.31**
Cement production	1162.50
Lime production	8.47
Other Process Uses of Carbonates	360.33

Figure 2.10: Shares of emission (%) per subsector within the mineral industry subsector, 2012



2.4.3 Agriculture, forestry and other land use change sector

Jordan is located about 100 km from the south-eastern coast of the Mediterranean Sea. It has a land area of about 89 200 km^2 and is rated among the world's most water poor countries.

Natural ecosystems in Jordan support human activities in agriculture, forestry, animal husbandry, tourism, traditional and pharmaceutical health products, and traditional medicine, among others. According to the Ministry of Agriculture 2007 survey, less than 5% of the country's total area is arable land while grazing land makes up 90% with 100–200 mm of annual rainfall. Natural and human-made forests cover around 1% of the country's total area. The number of farm holdings is 80,000, at an average area of 40 dunum per holding (56,000 are plant production holdings and 14,000 are animal production holdings). Plant production holdings are mostly field crops, olives, fruit trees, and vegetables.

The contribution of agriculture to GDP in relative terms declined sharply from 40% in the 1950s to 4% in 2016. Irrespective of how humble the contribution of agriculture is to national GDP and economic performance, farming remains important. The importance of agriculture stems from the fact that it is not only a major source of food, in particular dairy products, fruits, and vegetables, but it is also a source of livelihood for 25% of the total poor population (livestock keepers, smallholder farm households, and landless former agriculturalists) living in rural areas.

2.4.3.1 GHG emissions in 2010

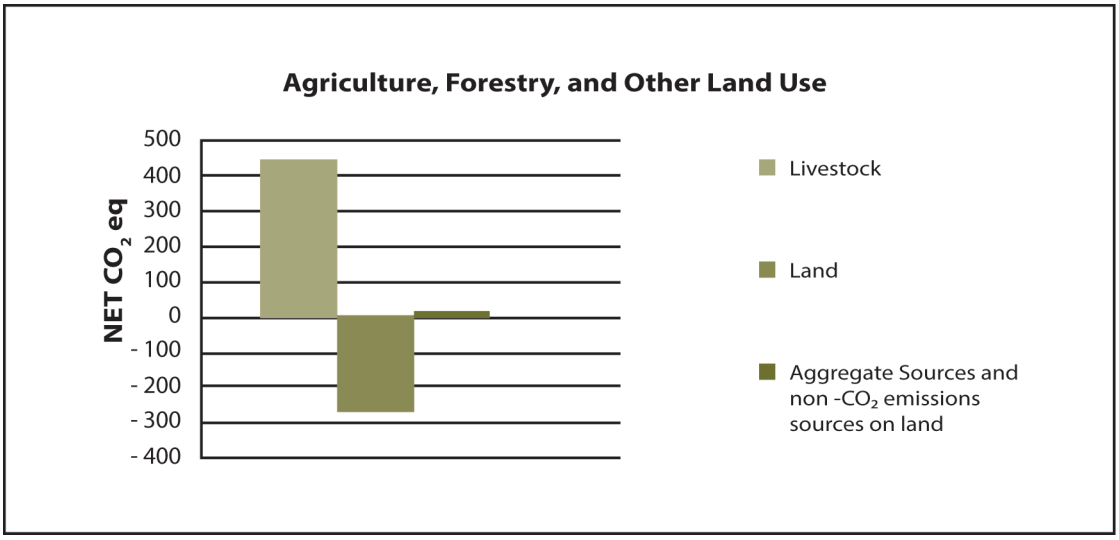
the most significant change made in the 2006 IPCC Guidelines compared with the Revised 1996 IPCC and GPG 2000 was in this sector. The 2006 Guidelines have consolidated the approach to Land-Use, Land-Use Change, and Forestry (LULUCF) in GPG LULUCF and the Agriculture sector in GPG 2000 into a single Agriculture, Forestry, and Other Land-Use (AFOLU).

The GHG emissions of AFOLU activities accounted for 0.66% (180.5 Gg of CO_2eq) of Jordan's total GHG emissions in 2010, acting as a net emission source. The emissions were composed of methane and nitrous oxide and were generated by various subcategories. AFOLU emissions and removals are shown in Table 2.11 and Figure 2.11.

Table 2.11: Emissions of the AFOLU sector, 2010

Categories	Net CO_2 (Gg)	CH_4-CO_2eq (Gg)	N_2O-CO_2eq (Gg)	Net CO_2eq (Gg)
Agriculture, Forestry, and Other Land Use	**-263.89**	**439.41**	**4.97**	**180.50**
Livestock	NA	439.11	2.15	441.26
Land	-274.56	NA	NA	-274.56
Aggregate sources and non-CO_2 emissions sources on land	10.67	0.298	2.82	13.80

Figure 2.11: Emissions of the AFOLU sector, 2010



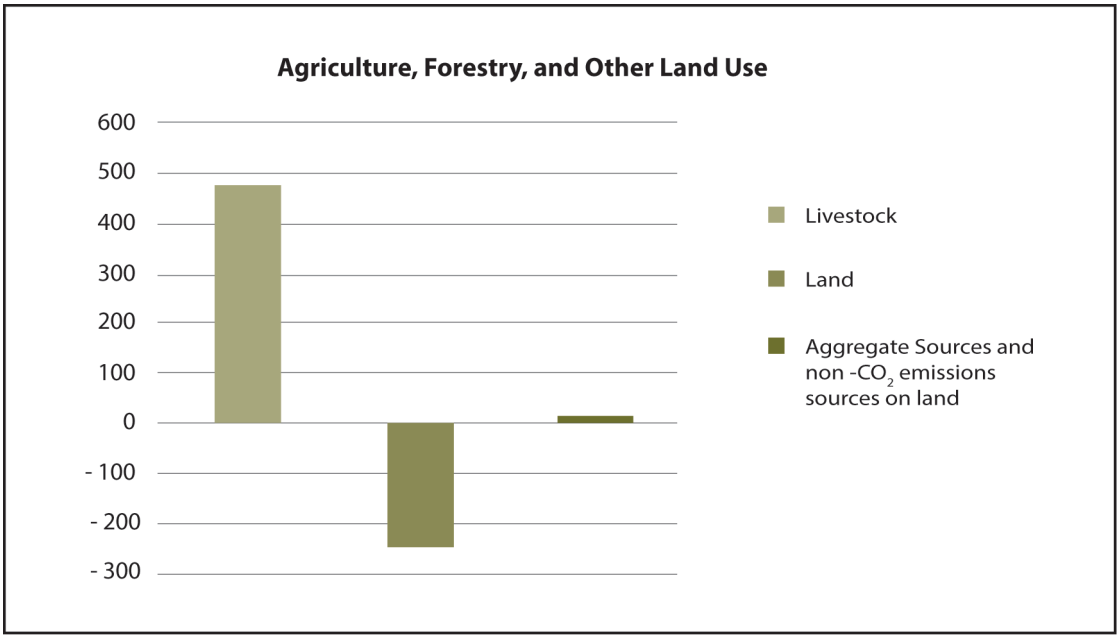
2.4.3.2 GHG emissions in 2012

The GHG emissions of the AFOLU activities accounted for 0.69% (237.29 Gg of CO_2eq) of Jordan's total GHG emissions in 2012, acting as a net emission source. The emissions were composed of methane and nitrous oxide and were generated by various subcategories. AFOLU emissions and removals are shown in Table 2.12 and Figure 2.12.

Table 2.12: Emissions of the AFOLU sector, 2012

Categories	Net CO_2 (Gg)	CH_4-CO_2eq (Gg)	N_2O-CO_2eq (Gg)	Net CO_2eq (Gg)
Agriculture, Forestry, and Other Land Use	**-245.82**	**478.15**	**4.96**	**237.29**
Livestock	NA	477.89	2.11	479.995
Land	-254.172	NA	NA	-254.172
Aggregate sources and non-CO_2 emissions sources on land	8.351	0.260	2.852	11.464

Figure 2.12: Emissions of the AFOLU sector, 2012



2.4.4 Waste sector

Solid waste management (SWM) in Jordan is a complex sector due to the wide variety of solid waste types and the involvement of different entities. The main responsible entities are the Ministry of Municipal Affairs, the Ministry of Environment, Greater Amman Municipality, and the Special Economic Zones of Aqaba and Petra.

Solid waste management is a major challenge in urban and rural areas, the concern for safe and effective SWM has been steadily increasing in Jordan, due to the political, demographic and economic conditions as well as the large numbers of refugees. The Kingdom lacks integrated practices for the collection, transportation, transfer, treatment, and disposal of MSW. While the existing municipal solid waste collection system is considered to be adequate in urban centers, services tend to be poor or non-existent in small towns and rural areas. Municipal and industrial solid waste is primarily dumped at landfills. At present, there are 18 official dumpsites in Jordan, most of which are not properly designed or operated, demonstrated by their lack of proper lining, leachate collection system, or LFG (landfill gas) management system. Al-Ghabawi is the only sanitary landfill in Jordan.

In terms of wastewater management, Jordan operated its first sewage collection system in Amman in the late 1960s. The system was meant to collect wastewater and dispose of it either in liquid dumps or randomly in Wadis. The system had adverse impacts on water resources and the environment, leading to the construction of the first wastewater treatment plant in Jordan at Ain Gazal in 1968. The government has since expanded the construction of wastewater treatment plants to increase coverage across Jordan. As of 2016, the country has 33 public working wastewater treatment plants that are either operated by the Water Authority of Jordan (WAJ) or controlled by the Project Management Unit (PMU) at the Ministry of Water and Irrigation. Samra Wastewater Treatment Plant (WWTP) receives more than 70% of wastewater diverted to WWTPs while Mansourah WWTP for septic tanks receives around 0.005% of the total wastewater discharged in 2012. The Jordan water strategy 2016-2025 considered treated wastewater as a source of water to replace part of good quality water for agricultural purposes. In 2013, amount of treated wastewater exceeded 120 MCM and currently wastewater treatment plants serve most of the urban areas in the country.

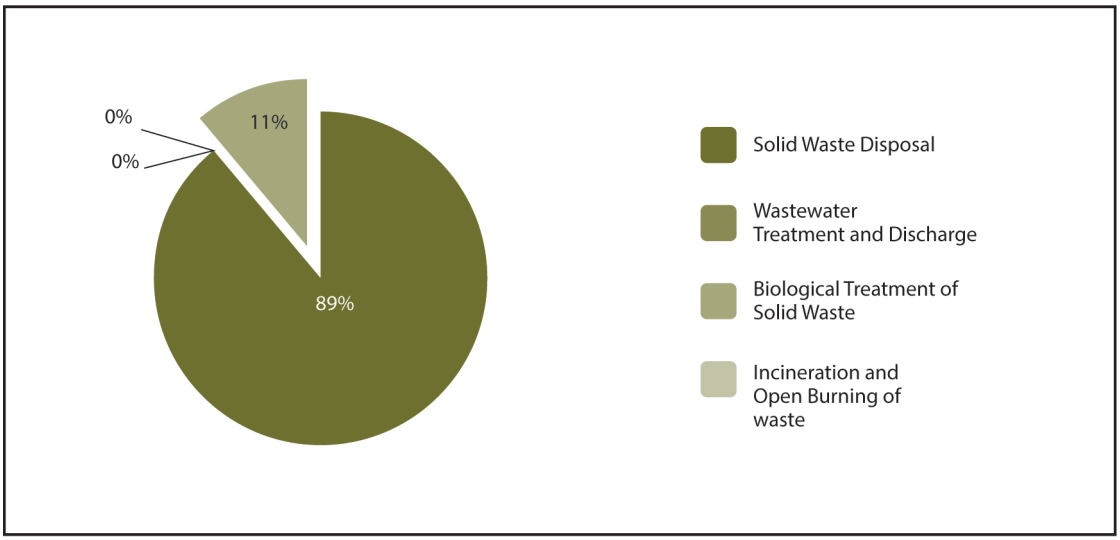
2.4.4.1 GHG emissions in 2010

In 2010, GHG emissions from the waste sector reached 1567.49 Gg of CO_2eq, accounting for 7% of Jordan's total GHG emissions. Most of the emissions were generated by domestic solid waste disposal, which accounted for 89% (1391.77 Gg of CO_2eq) of total waste emissions, while wastewater handling accounted for 11% (171.67 Gg of CO_2eq) of total waste emissions. Table 2.13 and Figure 2.13 show 2010 emissions breakdown by the waste sector.

Table 2.13: Emissions of the waste sector, 2010

Categories	CO_2 (Gg)	CH_4 (Gg of CO_2 eq)	N_2O (Gg of CO_2 eq)	Total CO_2eq (Gg)
Waste	**1.73**	**1441.868**	**123.89**	**1567.49**
Solid Waste Disposal	NA	1391.77	NA	1391.77
Incineration and Open Burning of Waste	1.73	1.83	0.49	4.0457
Wastewater Treatment and Discharge	NA	48.27	123.40	171.67

Figure 2.13: Shares of emissions (%) per subsector within the waste sector, 2010



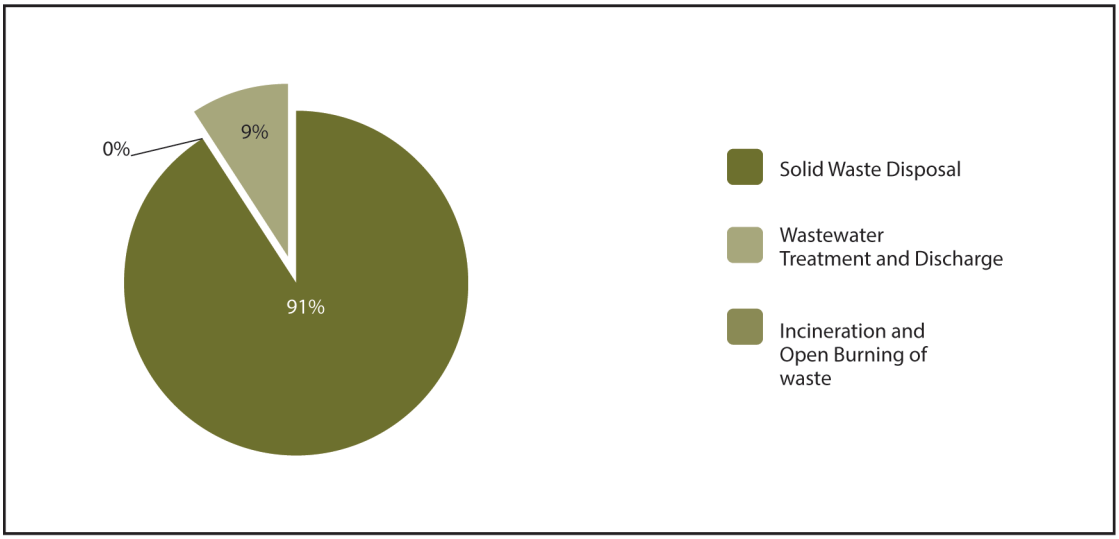
2.4.4.1 GHG emissions in 2012

In 2012, GHG emissions from the waste sector reached 1635.14 Gg of CO_2eq, accounting for 6% of Jordan's total GHG emissions. Most of the emissions were generated from domestic solid waste disposal, which accounted for 91% (1488.05 Gg of CO_2eq) of total waste emissions, while wastewater handling accounted for 9% (142.42 Gg of CO_2eq) of total waste emissions. Table 2.14 and Figure 2.14 show 2012 emissions breakdown by the waste sector.

Table 2.14: Emissions of the waste sector, 2012

Categories	CO_2 (Gg)	CH_4 (Gg of CO_2 eq)	N_2O (Gg of CO_2 eq)	Total CO_2eq (Gg)
Waste	**1.8776**	**1503.7134**	**129.549**	**1635.14**
Solid Waste Disposal	NA	1488.05	NA	1488.05
Incineration and Open Burning of Waste	1.8776	2.21	0.59	4.68
Wastewater Treatment and Discharge	NA	13.46	128.96	142.42

Figure 2.14: Shares of emissions (%) per subsector within the waste sector, 2012



2.5 GHG Inventory by Gas

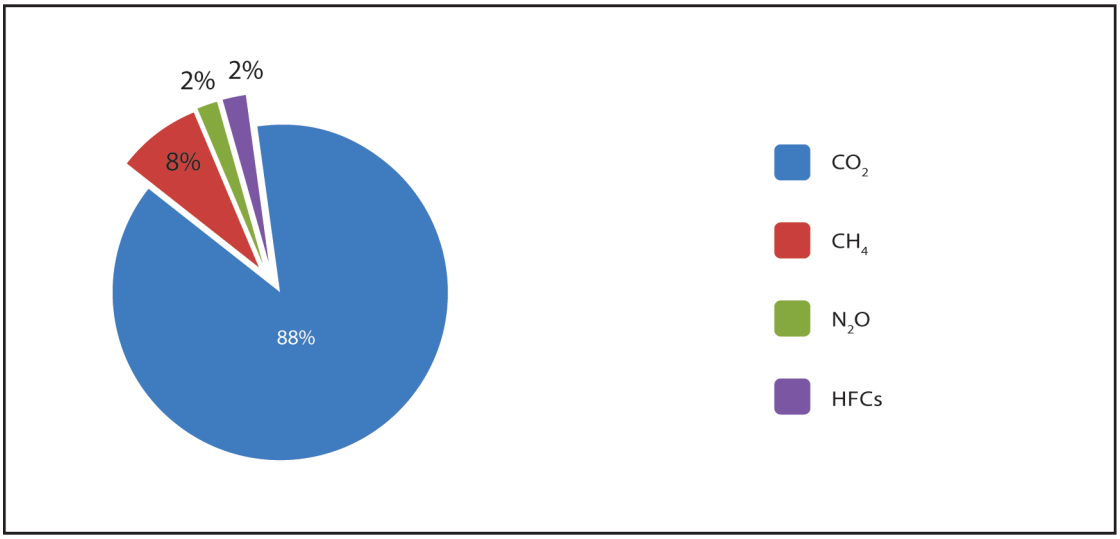
2.5.1 GHG emissions in 2010

The share of carbon dioxide was the largest with a contribution of 20438.27 Gg of CO_2eq, accounting for 88% of all GHG emissions, followed by CH_4 at only 8%, as indicated in Table 2.15 and Figure 2.15.

Table 2.15: National emissions by gas, 2010

GHG	Total National Emissions and Removals (Gg of CO_2eq)
CO_2	20438.27
CH_4	1929.76
N_2O	394.69
HFCs	377.33
NMVOCs	294.2 (No GWP)
Net Emissions and Removals	23140.05

Figure 2.15: National emissions (%) by gas, 2010



In 2010, the majority of carbon dioxide emissions resulted from the energy sector accounting for 94% followed by 7% from the IPPU sector. Methane emissions were highest from the waste sector followed by the AFOLU sector with contributions of 75% and 23%, respectively. Nitrous oxide emissions were highest from the IPPU sector, followed by the waste and energy sectors, with contributions of 42%, 31%, and 26%, respectively. As expected, the IPPU sector contributed 100% of HFCs and NMVOCs emissions.

Within the energy sector, the main emissions were in the form of CO_2 (99%). Within the IPPU sector, the key GHGs were CO_2 followed by HFCs with shares of 73% and 19%, respectively. Within the AFOLU and waste sectors, methane emissions were the highest resulting from livestock, manure management, and solid waste management, as shown in Tables 2.16 and 2.17 and Figure 2.16.

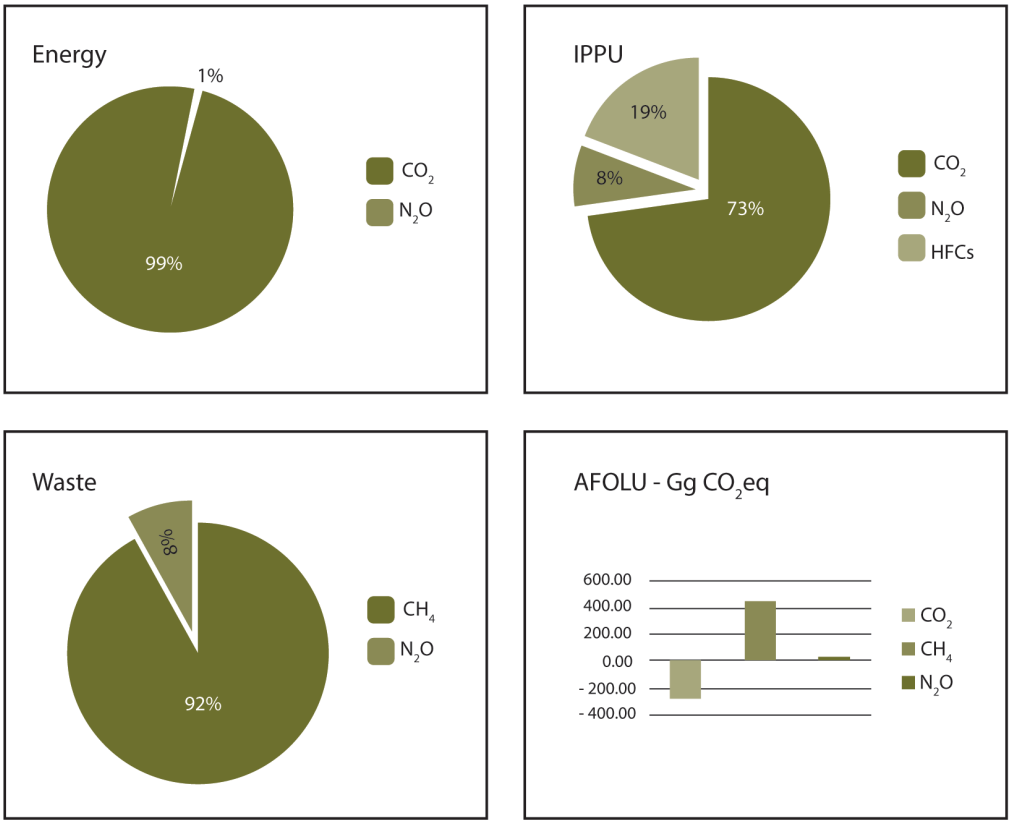
Table 2.16: National emissions by gas and by sector, 2010

Categories	CO_2 (Gg)	CH_4 (Gg of CO_2eq)	N_2O (Gg of CO_2eq)	HFCs (Gg of CO_2eq)	NMVOCs (Gg)
Total National Emissions and Removals	20438.27	91.89	1.27	377.33	294.20
Energy	19260.38	2.31	0.33	NA	NE
IPPU	1440.05	NO	0.53	377.33	294.20
AFOLU	-263.89	20.92	0.016	NA, NO	NA, NO, NE
Waste	1.73	68.66	0.399	NA	NE, NA

Table 2.17 GHG emissions (+) and removals (-) in Gg of CO_2eq by sector and by gas, 2010

Gas	Energy	IPPU	AFOLU	Waste
CO_2	19260.38	1440.05	-263.89	1.73
CH_4	48.48	NO	439.41	1441.87
N_2O	102.02	164.66	4.97	123.89
HFCs	NA	377.33	NA, NO	NA
Net Emissions per Sector	**19410.88**	**1982.04**	**180.50**	**1567.49**

Figure 2.16: GHG emissions (%) by gas for all sectors, 2010



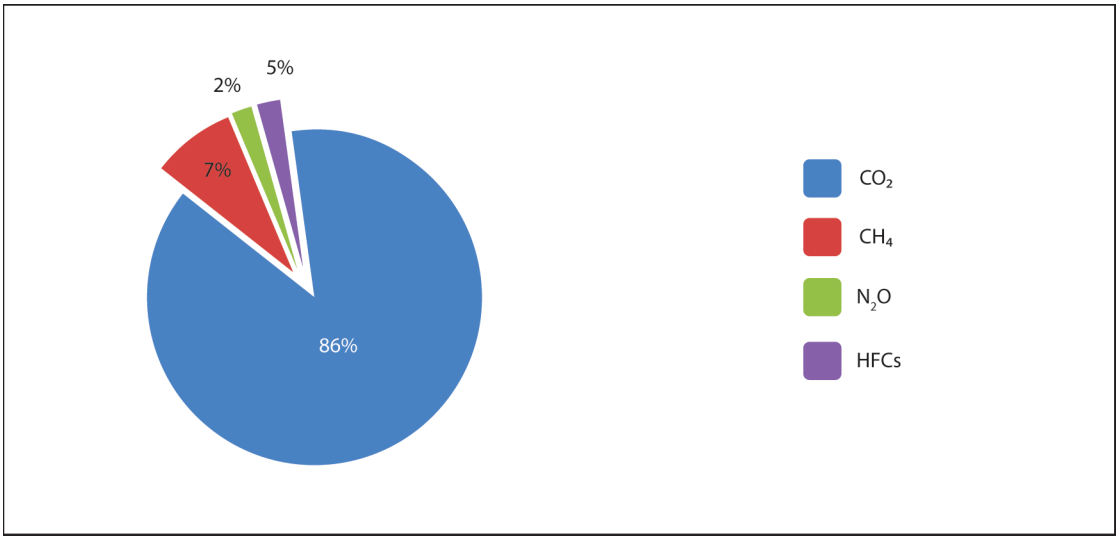
2.5.2 GHG emissions in 2012

The share of carbon dioxide was the largest with a contribution of 27997.731 Gg of CO_2eq, accounting for 86% of all GHG emissions, followed by CH_4 and HFCs accounting for only 7% and 5%, respectively, as indicated in Table 2.18 and Figure 2.17.

Table 2.18: National emissions by gas, 2012

GHG	Total National Emissions and Removals (Gg of CO_2eq)
CO_2	24112.427
CH_4	2035.27
N_2O	450.71
HFCs	1399.33
NMVOCs	221.33 (No GWP)
Net Emissions and Removals	**27997.731**

Figure 2.17: National emissions (%) by gas, 2012



In 2012, the majority of carbon dioxide emissions resulted from the energy sector accounting for 94% followed by 7% from the IPPU sector. Methane emissions were highest from the waste sector followed by the AFOLU sector with contributions of 74% and 23%, respectively. Nitrous oxide emissions were highest from IPPU sector, followed by energy and waste sectors (38%, 32%, and 29%, respectively). As expected, the IPPU sector contributed 100% of HFCs and NMVOCs emissions.

Within the energy sector, the main emissions were in the form of CO_2 (99%). Within the IPPU sector, the key GHGs were CO_2 followed by HFCs with shares of 53% and 42%, respectively. Within the AFOLU and waste sectors, methane emissions were the highest resulting from livestock, manure management, and solid waste management, as shown in Tables 2.19 and 2.20 and Figure 2.18.

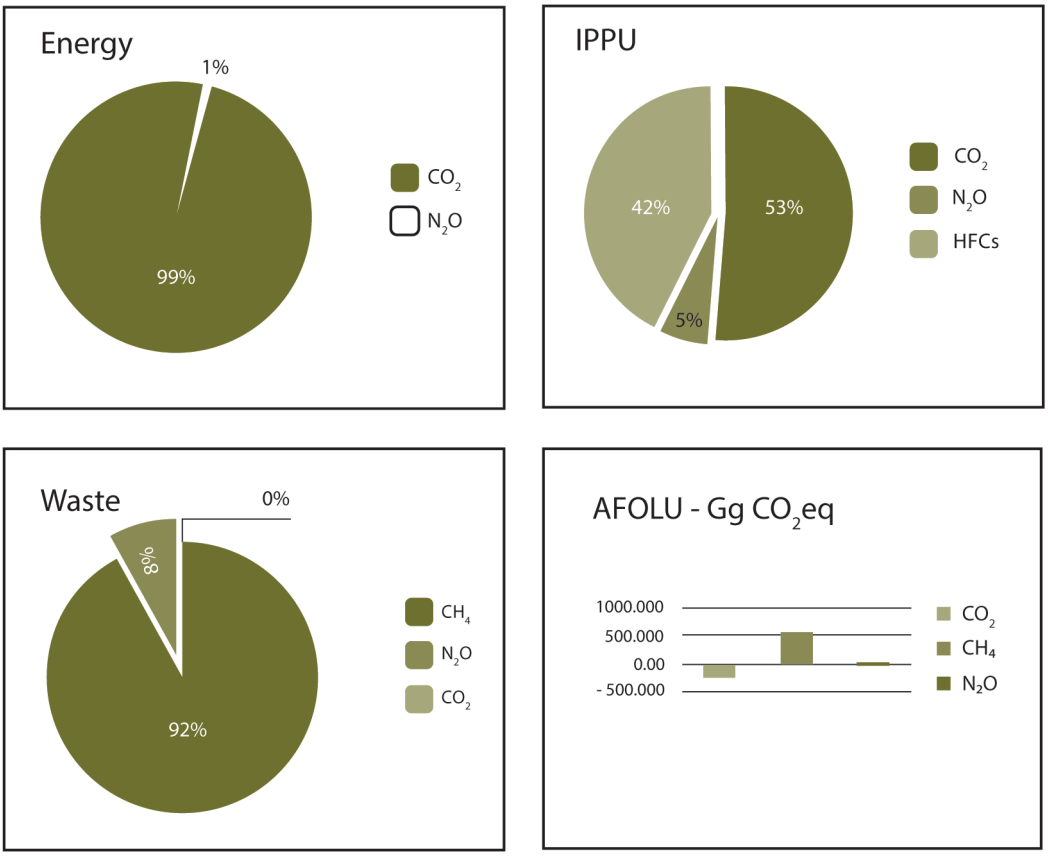
Table 2.19: National emissions by gas and by sector, 2012

Categories	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	HFCs (Gg)	NMVOCs (Gg)
Total National Emissions and Removals	24112.427	96.917	1.454	1399.33	221.328
Energy	22558.348	2.543	0.468	NA	NE
IPPU	1798.022	NO	0.552	1399.33	NO
AFOLU	-245.821	22.769	0.016	NA, NO	NA, NO, NE
Waste	1.878	71.605	0.418	NA	NE, NA

Table 2.20: GHG emissions (+) and removals (-) in Gg CO_2eq by sector and by gas, 2012

Gas	Energy	IPPU	AFOLU	Waste
CO_2	22558.35	1798.022	-245.82	1.878
CH_4	53.40	NO	478.15	1503.71
N_2O	145.08	171.12	4.96	129.55
HFCs	NA	1399.33	NA, NO	NA
NET Emissions per Sector (Gg)	**22756.83**	**3368.47**	**237.29**	**1635.14**

Figure 2.18: GHG emissions (%) by gas for all sectors, 2012



2.6 Total National Emissions and Removals

Total emissions from all sectors and subsectors in 2010 and 2012 as generated by the IPCC software (Table A) are shown in Tables 2.21 and 2.22.

Table 2.21: Overall 2010 GHG inventory (Table A from IPCC 2006 software)

Table A Inventory Summary Year: 2010	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	20438.2710	91.893	1.2732	377.33	NA,NO	NA,NO	NA,NO	NA,NO	NE	NE	294.196	NE
1 - Energy	19260.381	2.3086	0.3291	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A - Fuel Combustion Activities	19259.9337	2.2698	0.3291	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A.1 - Energy Industries	9096.0626	0.2379	0.0378						NE	NE	NE	NE
1.A.2 - Manufacturing Industries and Construction	2298.7404	0.0918	0.0184						NE	NE	NE	NE
1.A.3 - Transport	5182.7133	1.6316	0.2575						NE	NE	NE	NE
1.A.4 - Other Sectors	2266.6809	0.2568	0.0126						NE	NE	NE	NE
1.A.5 - Non-Specified	415.7365	0.0516	0.0028						NE	NE	NE	NE
1.B - Fugitive emissions from fuels	0.4471	0.0388	0.0000	NO	NO	NO	NO	NO	NA	NA	NA	NA
1.B.1 - Solid Fuels	NO	NO	NO						NA	NA	NA	NA
1.B.2 - Oil and Natural Gas	0.4471	0.0388	0.0000						NA	NA	NA	NA
1.B.3 - Other emissions from Energy Production	NO	NO	NO						NA	NA	NA	NA
1.C - Carbon Dioxide Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.C.1 - Transport of CO_2	NO								NO	NO	NO	NO
1.C.2 - Injection and Storage	NO								NO	NO	NO	NO
1.C.3 - Other	NO								NO	NO	NO	NO
2 - Industrial Processes and Product Use	1440.046	NO	0.5312	377.33	NO	NO	NO	NO	NO	NO	288.7740	NO
2.A - Mineral Industry	1214.31	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.A.1 - Cement production	1038.0000								NA	NA	NA	NA
2.A.2 - Lime production	10.7115								NO	NO	NO	NO
2.A.3 - Glass Production	NO								NE	NE	NE	NE
2.A.4 - Other Process Uses of Carbonates	165.60								NE	NE	NE	NE
2.A.5 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	0.4882	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.1 - Ammonia Production	NO								NO	NO	NO	NO
2.B.2 - Nitric Acid Production			0.4882						NO	NO	NO	NO

Table A Inventory Summary Year: 2010	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
2.B.3 - Adipic Acid Production			NO						NO	NO	NO	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			NO						NO	NO	NO	NO
2.B.5 - Carbide Production	NO	NO							NO	NO	NO	NO
2.B.6 - Titanium Dioxide Production	NO								NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO								NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NO	NO							NO	NO	NO	NO
2.B.9 - Fluorochemical Production				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	16.94	NE, NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.1 - Iron and Steel Production	16.94	NE							NO	NO	NO	NO
2.C.2 - Ferroalloys Production	NO	NO							NO	NO	NO	NO
2.C.3 - Aluminium production	NO				NO			NO	NO	NO	NO	NO
2.C.4 - Magnesium production	NO					NO		NO	NO	NO	NO	NO
2.C.5 - Lead Production	NO								NO	NO	NO	NO
2.C.6 - Zinc Production	NO								NO	NO	NO	NO
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use	208.7946	NA	NA	NA	NA	NA	NA	NA	NA, NO	NA, NO	288.7740	NA, NO
2.D.1 - Lubricant Use	208.7947								NA	NA	NA	NA
2.D.2 - Paraffin Wax Use	NO								NO	NO	NO	NO
2.D.3 - Solvent Use									NA	NA	29.8840	NA
2.D.4 - Other (please specify)	NA	NA	NA						NA	NA	258.8900	NA
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display					NO	NO	NO	NO	NO	NO	NO	NO
2.E.3 - Photovoltaics					NO			NO	NO	NO	NO	NO
2.E.4 - Heat Transfer Fluid					NO			NO	NO	NO	NO	NO
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NA	NA	NA	377.33	NA	NA	NA	NA	NA	NA	NA	NA
2.F.1 - Refrigeration and Air Conditioning				335.9100				NO	NO	NO	NO	NO

Table A Inventory Summary Year: 2010	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
2.F.2 - Foam Blowing Agents				NO				NO	NO	NO	NO	NO
2.F.3 - Fire Protection				41.4200	NO			NO	NO	NO	NO	NO
2.F.4 - Aerosols				NO				NO	NO	NO	NO	NO
2.F.5 - Solvents				NO	NO			NO	NO	NO	NO	NO
2.F.6 - Other Applications (please specify)				NO	NO			NO	NO	NO	NO	NO
2.G - Other Product Manufacture and Use	NO	NO	0.0430	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO
2.G.1 - Electrical Equipment					NO	NO		NO	NO	NO	NO	NO
2.G.2 - SF6 and PFCs from Other Product Uses					NO	NO		NO	NO	NO	NO	NO
2.G.3 - N_2O from Product Uses			0.0430						NA	NA	NA	NA
2.G.4 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NA,NO	NA,NO	NO	NA	NA	NA	NA	NA	NA,NO	NA,NO	5.4219	NA,NO
2.H.1 - Pulp and Paper Industry	NO	NO							NO	NO	NO	NO
2.H.2 - Food and Beverages Industry	NA	NA							NA	NA	5.4219	NA
2.H.3 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	-263.8867	20.9243	0.0160	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA, NO, NE	NA, NO, NE	NA, NO, NE	NA, NO, NE
3.A - Livestock	NA	20.9101	0.0069	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.A.1 - Enteric Fermentation		19.4693							NA	NA	NA	NA
3.A.2 - Manure Management		1.4408	0.0069						NA	NA	NA	NA
3.B - Land	-274.5611	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.1 - Forest land	-274.7844								NE	NE	NE	NE
3.B.2 - Cropland	0.2233								NE	NE	NE	NE
3.B.3 - Grassland	NO								NO	NO	NO	NO
3.B.4 - Wetlands	NO		NO						NO	NO	NO	NO
3.B.5 - Settlements	NO								NO	NO	NO	NO
3.B.6 - Other Land	NE								NE	NE	NE	NE
3.C - Aggregate sources and non-CO_2 emissions sources on land	10.6744	0.0142	0.0091	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C.1 - Emissions from biomass burning		0.0142	NA						NA	NA	NA	NA
3.C.2 - Liming	NO								NA	NA	NA	NA
3.C.3 - Urea application	10.6744								NA	NA	NA	NA
3.C.4 - Direct N_2O Emissions from managed soils			0.006362						NA	NA	NA	NA

Table A Inventory Summary Year: 2010	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	**Net CO_2 (1)(2)**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Other halogenated gases with CO_2 equivalent conversion factors (3)**	**Other halogenated gases without CO_2 equivalent conversion factors (4)**	**NOx**	**CO**	**NMVOCs**	**SO_2**
3.C.5 - Indirect N_2O Emissions from managed soils			0.0027						NA	NA	NA	NA
3.C.6 - Indirect N_2O Emissions from manure management			0.000035						NA	NA	NA	NA
3.C.7 - Rice cultivations		NO							NA	NA	NA	NA
3.C.8 - Other (please specify)		NO	NO						NA	NA	NA	NA
3.D - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.D.1 - Harvested Wood Products	NO								NO	NO	NO	NO
3.D.2 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
4 - Waste	1.7305	68.6604	0.3996	NA	NA	NA	NA	NA	NE, NA	NE, NA	NE, NA	NE, NA
4.A - Solid Waste Disposal	NA	66.2749	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.B - Biological Treatment of Solid Waste	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.C - Incineration and Open Burning of Waste	1.7305	0.0871	0.0016	NA	NA	NA	NA	NA	NE	NE	NE	NE
4.D - Wastewater Treatment and Discharge	NA	2.2984	0.3981	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.E - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
5 - Other	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.B - Other (please specify)	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items (5)												
International Bunkers	985.9870	0.0113	0.0275	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A.3.a.i - International Aviation (International Bunkers)	933.6305	0.0065	0.0261						NE	NE	NE	NE
1.A.3.d.i - International water-borne navigation (International bunkers)	52.3565	0.0048	0.0014						NE	NE	NE	NE
1.A.5.c - Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 2.22: Overall 2012 GHG inventory (Table A from IPCC 2006 software)

Table A Inventory Summary Year: 2012	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	24112.427	96.917	1.4539	1399.3300	NA,NO	NA,NO	NA,NO	NA,NO	NE	NE	221.33	NE
1 - Energy	22558.348	2.5430	0.4680	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A - Fuel Combustion Activities	22557.977	2.5121	0.4679	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A.1 - Energy Industries	11263.316	0.4069	0.0782						NE	NE	NE	NE
1.A.2 - Manufacturing Industries and Construction	1245.1576	0.0489	0.0097						NE	NE	NE	NE
1.A.3 - Transport	7242.1008	1.7383	0.3645						NE	NE	NE	NE
1.A.4 - Other Sectors	2324.6162	0.2608	0.0126						NE	NE	NE	NE
1.A.5 - Non-Specified	482.7866	0.0572	0.0030						NE	NE	NE	NE
1.B - Fugitive emissions from fuels	0.3711	0.0309	NO,NA	NO	NO	NO	NO	NO	NA	NA	NA	NA
1.B.1 - Solid Fuels	NO	NO	NO						NA	NA	NA	NA
1.B.2 - Oil and Natural Gas	0.3711	0.0309	NA						NA	NA	NA	NA
1.B.3 - Other emissions from Energy Production	NO	NO	NO						NA	NA	NA	NA
1.C - Carbon Dioxide Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.C.1 - Transport of CO_2	NO								NO	NO	NO	NO
1.C.2 - Injection and Storage	NO								NO	NO	NO	NO
1.C.3 - Other	NO								NO	NO	NO	NO
2 - Industrial Processes and Product Use	1798.0222	NO	0.5520	1399.3300	NO	NO	NO	NO	NO	NO	NO	NO
2.A - Mineral Industry	1530.97	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.A.1 - Cement production	1162.5000								NA	NA	NA	NA
2.A.2 - Lime production	8.4735								NO	NO	NO	NO
2.A.3 - Glass Production	NO								NE	NE	NE	NE
2.A.4 - Other Process Uses of Carbonates	360.3329								NE	NE	NE	NE
2.A.5 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	0.5066	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.1 - Ammonia Production	NO								NO	NO	NO	NO
2.B.2 - Nitric Acid Production			0.5066						NO	NO	NO	NO
2.B.3 - Adipic Acid Production			NO						NO	NO	NO	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			NO						NO	NO	NO	NO
2.B.5 - Carbide Production	NO	NO							NO	NO	NO	NO

Table A Inventory Summary Year: 2012	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
2.B.6 - Titanium Dioxide Production	NO								NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO								NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NO	NO							NO	NO	NO	NO
2.B.9 - Fluorochemical Production				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	40.1700	NO, NE	NO	NO	NO	NO	NO	NO	NO,NA	NO,NA	NO,NA	NO,NA
2.C.1 - Iron and Steel Production	40.1700	NE							NA	NA	NA	NA
2.C.2 - Ferroalloys Production	NO	NO							NO	NO	NO	NO
2.C.3 - Aluminium production	NO				NO			NO	NO	NO	NO	NO
2.C.4 - Magnesium production	NO					NO		NO	NO	NO	NO	NO
2.C.5 - Lead Production	NO								NO	NO	NO	NO
2.C.6 - Zinc Production	NO								NO	NO	NO	NO
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use	226.8787	NA	NA	NA	NA	NA	NA	NA	NA, NO	NA, NO	NA, NO	NA, NO
2.D.1 - Lubricant Use	226.8787								NA	NA	NA	NA
2.D.2 - Paraffin Wax Use	NO								NO	NO	NO	NO
2.D.3 - Solvent Use									NA	NA	32.345	NA
2.D.4 - Other (please specify)	NA	NA	NA						NA	NA	183.31	NA
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display					NO	NO	NO	NO	NO	NO	NO	NO
2.E.3 - Photovoltaics					NO			NO	NO	NO	NO	NO
2.E.4 - Heat Transfer Fluid					NO			NO	NO	NO	NO	NO
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NA	NA	NA	1399.3300	NA	NA	NA	NA	NA	NA	NA	NA
2.F.1 - Refrigeration and Air Conditioning				1192.8600				NO	NO	NO	NO	NO
2.F.2 - Foam Blowing Agents				NO				NO	NO	NO	NO	NO
2.F.3 - Fire Protection				206.4700	NO			NO	NO	NO	NO	NO
2.F.4 - Aerosols				NO				NO	NO	NO	NO	NO

Table A Inventory Summary Year: 2012	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	**Net CO_2 (1)(2)**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Other halogenated gases with CO_2 equivalent conversion factors (3)**	**Other halogenated gases without CO_2 equivalent conversion factors (4)**	**NOx**	**CO**	**NMVOCs**	**SO_2**
2.F.5 - Solvents				NO	NO			NO	NO	NO	NO	NO
2.F.6 - Other Applications (please specify)				NO	NO			NO	NO	NO	NO	NO
2.G - Other Product Manufacture and Use	NO	NO	0.0454	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO
2.G.1 - Electrical Equipment					NO	NO		NO	NO	NO	NO	NO
2.G.2 - SF6 and PFCs from Other Product Uses					NO	NO		NO	NO	NO	NO	NO
2.G.3 - N_2O from Product Uses			0.0454						NA	NA	NA	NA
2.G.4 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NA,NO	NA,NO	NO	NA	NA	NA	NA	NA	NA,NO	NA,NO	5.6731	NA,NO
2.H.1 - Pulp and Paper Industry	NO	NO							NO	NO	NO	NO
2.H.2 - Food and Beverages Industry	NA	NA							NA	NA	5.6731	NA
2.H.3 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	-245.8210	22.7689	0.0160	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA, NO, NE	NA, NO, NE	NA, NO, NE	NA, NO, NE
3.A - Livestock	NA	22.7565	0.0068	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.A.1 - Enteric Fermentation		21.3130							NA	NA	NA	NA
3.A.2 - Manure Management		1.4435	0.0068						NA	NA	NA	NA
3.B - Land	-254.1722	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.1 - Forest land	-254.3955								NE	NE	NE	NE
3.B.2 - Cropland	0.2233								NE	NE	NE	NE
3.B.3 - Grassland	NO								NO	NO	NO	NO
3.B.4 - Wetlands	NO		NO						NO	NO	NO	NO
3.B.5 - Settlements	NO								NO	NO	NO	NO
3.B.6 - Other Land	NE								NE	NE	NE	NE
3.C - Aggregate sources and non-CO_2 emissions sources on land	8.3512	0.0124	0.0092	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C.1 - Emissions from biomass burning		0.0124	NA						NA	NA	NA	NA
3.C.2 - Liming	NO								NA	NA	NA	NA
3.C.3 - Urea application	8.3512								NA	NA	NA	NA
3.C.4 - Direct N_2O Emissions from managed soils			0.006400						NA	NA	NA	NA
3.C.5 - Indirect N_2O Emissions from managed soils			0.0027						NA	NA	NA	NA

Table A Inventory Summary Year: 2012	Emissions (Gg)			Emissions Gg of CO_2-Equivalent				Emissions (Gg)				
Categories	**Net CO_2 (1)(2)**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Other halogenated gases with CO_2 equivalent conversion factors (3)**	**Other halogenated gases without CO_2 equivalent conversion factors (4)**	**NOx**	**CO**	**NMVOCs**	**SO_2**
3.C.6 - Indirect N_2O Emissions from manure management			0.000035						NA	NA	NA	NA
3.C.7 - Rice cultivations		NO							NA	NA	NA	NA
3.C.8 - Other (please specify)		NO	NO						NA	NA	NA	NA
3.D - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.D.1 - Harvested Wood Products	NO								NO	NO	NO	NO
3.D.2 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
4 - Waste	1.8776	71.6054	0.4179	NA	NA	NA	NA	NA	NE, NA	NE, NA	NE, NA	NE, NA
4.A - Solid Waste Disposal	NA	70.8593	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.B - Biological Treatment of Solid Waste	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.C - Incineration and Open Burning of Waste	1.8776	0.1053	0.0019	NA	NA	NA	NA	NA	NE	NE	NE	NE
4.D - Wastewater Treatment and Discharge	NA	0.6409	0.4160	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.E - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
5 - Other	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.B - Other (please specify)	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items (5)												
International Bunkers	1015.3249	0.0119	0.0283	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A.3.a.i - International Aviation (International Bunkers)	959.1958	0.0067	0.0268						NE	NE	NE	NE
1.A.3.d.i - International water-borne navigation (International bunkers)	56.1290	0.0051	0.0015						NE	NE	NE	NE
1.A.5.c - Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

2.7 Comparison Between Current and Previous Inventories

There are differences between the results of 2006 compared to 2010 and 2012. It was expected for GHG emissions to grow with population growth and increased economic activities. However, this was not the case. As shown in table 2.23, total national GHG emissions were 28.71, 23.14, and 27.99 Million Ton of CO_2eq in 2006, 2010, and 2012, respectively. These trends can be explained by the following:

- The current inventories were estimated using the 2006 IPCC Guidelines whereas the previous inventory of the TNC was estimated using the Revised 1996 IPCC Guidelines. The two guidelines vary in their use of emission factors and additional sources.
- The energy sector emissions were affected by the interruption of the natural gas supply from Egypt, forcing Jordan to switch to the use of more carbon intensive fuels such as heavy fuel oil (HFO).
- A significant change was made concerning land use classifications in the 2006 IPCC Guidelines compared with the Revised 1996 IPCC and GPG 2000. The 2006 Guidelines have combined the approach of Land Use, Land-Use Change, and Forestry (LULUCF) in GPG LULUCF and the Agriculture sector in GPG 2000 into a single Agriculture, Forestry, and Other Land Use (AFOLU). This change has affected the results.
- The solid waste module was affected by changes as well. The 2006 IPCC methodology for estimating CH_4 emissions from solid waste is based on the First Order Decay (FOD) method while the Revised 1996 IPCC Guidelines is based on the mass balance method. The FOD method assumes that the degradable organic carbon in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. As a result, emissions of CH_4 from waste deposited in a disposal site are highest in the first few years after deposition, after which they gradually decline, whereas the mass balance method assumes all emissions are produced in the first year of deposition.
- The phasing out of ODS in 2012, such as R-22 (that has no contribution to climate change) and replacing it with HFCs (such as R-134a) that have high GWP had an impact on increasing the overall results of the IPPU module in 2012.

Table 2.23: Comparison between national GHG inventories 2006, 2010 and 2012

Categories	Revised 1996 IPCC	2006 IPCC Guidelines	
	Year 2006 (TNC)	Year 2010	Year 2012
	CO_2 eq (Gg)		
Total National Emissions and Removals	**28717**	**23140.06**	**27997.73**
1 - Energy	20938	19410.88	22756.83
2 - Industrial Processes and Product Use	2550	1982.04	3368.47
3 - Agriculture, Forestry, and Other Land Use	Agriculture 1318 LULUCF 866	180.50	237.29
4 - Waste	3045	1567.49	1635.14
Memo Items (5)			
International Bunkers	748	994.75	1024.37
1.A.3.a.i - International Aviation (International Bunkers)	748	941.86	967.65
1.A.3.d.i - International Water-borne Navigation (International bunkers)	NE	52.89	56.69

2.8 Reference Approach

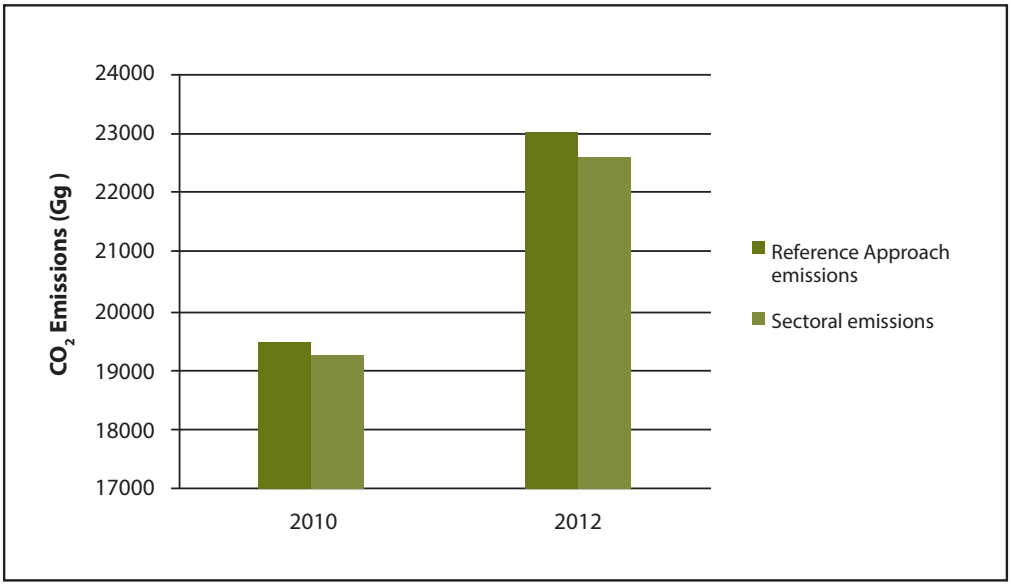
The Reference Approach and the Sectoral Approach often yield different results because the Reference Approach is a top-down approach using the country's energy supply data and has no detailed information on how the individual fuels are used in each sector. This approach provides estimates of CO_2 to compare with estimates derived using a Sectoral Approach. The Reference Approach provides an upper bound to the Sectoral Approach '1A Fuel Combustion', because some of the carbon in the fuel is not combusted but is released as fugitive emissions (as leakage or evaporation in the production and/or transformation stage). Calculating CO_2 emissions with the two approaches can lead to different results for some countries.

The Reference Approach was used to calculate energy sector emissions in 2010 and 2012 and the results were compared to those of the Sectoral Approach. The gap between the two approaches is supposed to be relatively small (5% or less). For Jordan, the calculated differences were acceptable; not more than 2%, as indicated in Table 2.24 and Figure 2.19.

Table 2.24: Reference approach vs sectoral approach, 2010 and 2012

year	Reference Approach CO_2 Emissions (Gg)	Sectoral CO_2 Emissions (Gg)	Difference
2010	19479.65	19259.93	1.14%
2012	23010.29	22557.98	2%

Figure 2.19: Reference approach vs sectoral approach, 2010 and 2012

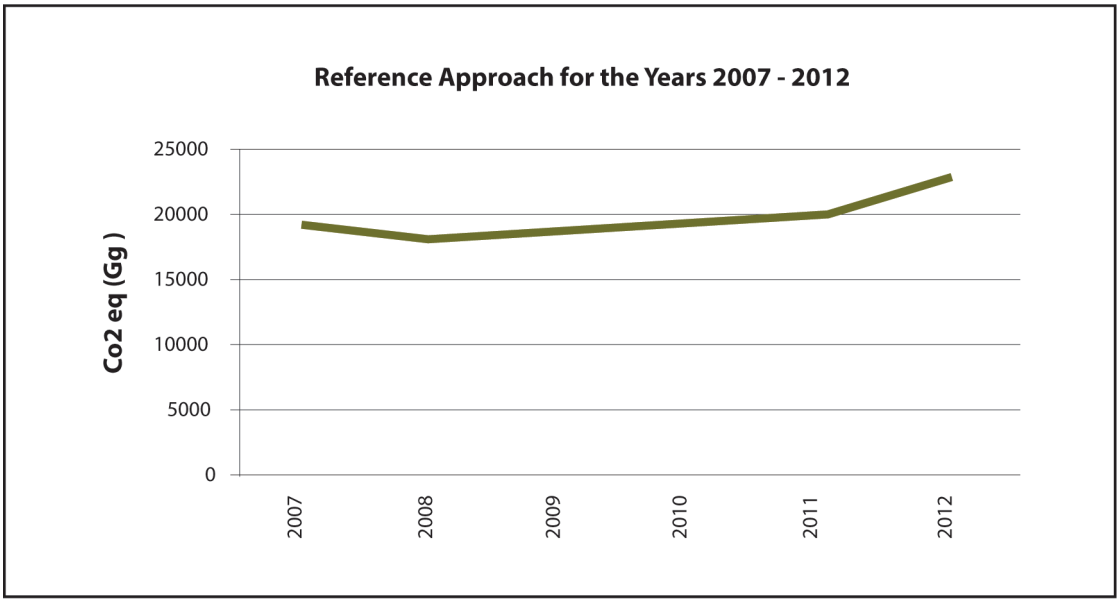


GHG emissions were also estimated using the Reference Approach for the time series (2007-2012) and yielded a harmonized trend of emissions as shown in Table 2.25 and Figure 2.20.

Table 2.25: Reference approach for time series (2007-2012)

year	Energy Consumption (TJ)	CO_2 (Gg)
2007	281336.32	19077.83
2008	270707.89	18160.63
2009	279999.32	18605.04
2010	290308.49	19479.65
2011	285718.7	20403.51
2012	320408.08	23010.29

Figure 2.20: Reference approach for time series (2007-2012)



2.9 Key Category Analysis

The key category analysis is an essential element for inventory development and a driving factor to improve its quality. Non-Annex I Parties are encouraged (Decision 17/CP.8), to the extent possible, to undertake any key category analysis to assist in developing inventories that better reflect their national circumstances. The analysis was carried out based on IPCC 2006 Guidelines and Software. Jordan used "level" key category analysis where the contribution of each source or sink category to the total national inventory level was calculated. The Key categories according to the guidelines are those that, when summed together in descending order of magnitude, add up to 95% of the sum of all level assessment.

In categories that are identified as key, Parties should try to use a recommended method, in accordance with the corresponding decision tree in the 2006 IPCC Guidelines. It is recommended that Jordan searches for alternatives to gradually apply in future inventory submissions, to the extent possible and based on software readiness and national circumstances, Tier 2 methods in the categories identified as key.

In the total national GHG emissions of 2010, various Fuel Combustion Activities subcategories were among the top five sources accounting for around 66% of all emissions, mainly: Energy Industries (Gaseous Fuels), Road Transportation, Energy Industries (Liquid Fuels), Manufacturing Industries and Construction (Liquid Fuels) and other sectors (commercial/institutional and residential-Liquid Fuels). The IPPU, AFOLU, and waste subsectors accounted for the balance, as shown in Table 2.26.

Table 2.26: Key category analysis (level assessment), 2010

A	B	C	D	F	G
IPCC Category code	IPCC Category	Greenhouse Gas	2010 Emissions CO_2eq (Gg)	2010 Emissions Level from the Given Category	Cumulative Total % of Column F
1.A.1	Energy Industries - Gaseous Fuels	CO_2	5345.70	0.187	19%
1.A.3.b	Road Transportation	CO_2	5156.63	0.180	37%
1.A.1	Energy Industries - Liquid Fuels	CO_2	3750.36	0.131	50%
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	2298.74	0.080	58%
1.A.4	Other Sectors - Liquid Fuels	CO_2	2266.68	0.079	66%
4.A	Solid Waste Disposal	CH_4	1391.77	0.072	74%
2.A.1	Cement Production	CO_2	1038	0.051	81%
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	467.68	0.049	86%
1.A.5	Non-Specified - Liquid Fuels	CO_2	415.74	0.028	89%
3.A.1	Enteric Fermentation	CH_4	408.85	0.016	91%
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	335.91	0.015	92%
3.B.1.a	Forest land Remaining Forest land	CO_2	-274.78	0.014	93%
2.A.4	Other Process Uses of Carbonates	CO_2	165.60	0.010	94%
2.B.2	Nitric Acid Production	N_2O	151.34	0.006	95%

Whereas in the total national GHG emissions of 2012, various Fuel Combustion Activities subcategories were among the top four sources accounting for around 73% of all emissions, mainly: Energy Industries (Liquid Fuels), Road Transportation, other sectors (Liquid Fuels) and Energy Industries (Gaseous Fuels). Energy Industries (Gaseous Fuels) moved down from the first place to the fourth place in 2012 compared to 2010 list due to the decrease in Egyptian Gas supply. The solid waste, IPPU, and AFOLU subsectors accounted for the remaining balance, as shown in Table 2.27.

Table 2.27: Key category analysis (level assessment), 2012

A	B	C	D	F	G
IPCC Category code	IPCC Category	Greenhouse Gas	2012 Emissions CO_2eq (Gg)	2012 Emissions Level from the Given Category	Cumulative Total % of Column F
1.A.1	Energy Industries - Liquid Fuels	CO_2	9681.67	0.29	29%
1.A.3.b	Road Transportation	CO_2	7222.27	0.22	50%
1.A.4	Other Sectors - Liquid Fuels	CO_2	2324.62	0.09	60%
1.A.1	Energy Industries - Gaseous Fuels	CO_2	1581.64	0.07	67%
4.A	Solid Waste Disposal	CH_4	1488.05	0.07	73%
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	1245.16	0.05	78%
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	1192.86	0.04	82%
2.A.1	Cement Production	CO_2	1162	0.04	87%
1.A.5	Non-Specified - Liquid Fuels	CO_2	482.79	0.04	90%
3.A.1	Enteric Fermentation	CH_4	447.57	0.01	92%
2.A.4	Other Process Uses of Carbonates	CO_2	360.33	0.01	93%
3.B.1.a	Forest land Remaining Forest land	CO_2	-254.40	0.01	94%
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	226.88	0.01	95%

2.10 Uncertainty Analysis

The uncertainty analysis is one of the main activities of the inventory process. Uncertainty information is intended to help prioritize efforts to improve the accuracy of inventories and guide decisions on the methodological choice.

The analysis was carried out based on IPCC 2006 Guidelines and Software. "Approach 1: Propagation of Error" was used. Approach 1 is based upon error propagation and is used to estimate uncertainty in individual categories in the inventory as a whole, and in trends between 2012 and the base year 2010. The uncertainty analysis was based on Tier 1 approach and covers all source-categories and all direct greenhouse gases. The uncertainty estimation for the activity data and emission factors was based on typical values of the IPCC.

The results indicate that net emissions in 2012 were 34575.36 Gg of CO_2eq with an uncertainty of ±5%, which corresponds to a 95% probability range of 26737.83 to 29257.63 Gg of CO_2eq. Based upon the total base year of 2010 and year 2012 inventories, the average trend is a 21% increase in emissions from 2010 to 2012. The uncertainty in the trend is ±6% (percentage points), which corresponds to a 95% probability range for the trend of 26% to 38% with respect to base year emissions.

2.11 GHG Inventory Review

The national GHG inventory was subjected to two levels of review, as follows:

- An internal review was performed by the RSS project management team throughout the lifetime of the project. The review covered all sectoral reports and changes that have been introduced to the reports as new versions.
- An international review was coordinated by the UNDP-UNEP Global Support Program (GSP) and was conducted in June 25-28, 2017, by a consultant expert in national GHG emissions inventories. This was based on the indications included in Annex III to Decision 2/CP.17 (UNFCCC, 2011) and the IPCC Guidelines and guidance required in this decision to be used for the non-Annex I Parties to present biennial update reports (BURs) to the Convention.

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GREENHOUSE GAS MITIGATION ANALYSIS

3.1 Introduction and Methodology

This chapter provides an updated baseline scenario and updated view on mitigation actions at the national level; providing information on their status of implementation while updating their reduction potential and feasibility analysis.

The GHG mitigation analysis assesses potential human interventions that can be implemented at the national level to reduce anthropogenic emissions of greenhouse gases in different sectors to support the overall global efforts to limit the magnitude and/or rate of long-term induced global warming.

The abatement analysis is sector-specific. The sectors considered for their mitigation potential in this report are those that were addressed in the Third National Communication (TNC), namely, energy (primary energy, renewable energy, energy efficiency and transport), waste, industrial processes, and agriculture, forestry, and other land use (AFOLU).

For this purpose, two updated scenarios were constructed; baseline and mitigation scenarios:

- The baseline scenario reflects a future in which there are no policies or programs designed to encourage or require actions that reduce GHG emissions or enhance carbon sinks. Defining a reasonable baseline scenario is considered a critical element in the abatement assessment since the benefits and incremental costs of mitigation options are directly linked to the sound definition of the baseline scenario. The updated baseline scenario in this chapter was constructed based on the trends, plans and policies prevailing in the Jordanian context during the time of preparation of this chapter (2016 and 2017). The development of this scenario required a projection of the current levels to future levels of each type of activity for the interval 2015-2040. Such projection drew on assumptions made about population growth, GDP, and other macro variables, which were obtained from official institutions.
- The mitigation scenario in the TNC was structured according to a set of criteria reflecting country-specific conditions such as the potential for significant impact on greenhouse gas emissions, direct and indirect economic impacts, consistency with national development goals, the potential effectiveness of implementation policies, sustainability of an option, data availability for evaluation, and other sector-specific criteria. In this chapter, the mitigation scenario is updated in terms of mitigation options status. All mitigation options that became part of the baseline scenario or became invalid were removed from the current scenario, while all other remaining mitigation options were counted in after adjustments were made in their expected implementation timeline and in their associated GHG emission reductions. Some newly identified options were added as well to the current mitigation scenario.

The overall baseline and mitigation scenarios are constructed to cover the period 2015-2040. The analytical methodology of the energy sector is based on the LEAP Model, the Long-Range Energy Alternative Planning System. LEAP is an integrated modelling tool developed to track energy consumption, production, and resource extraction in all sectors of an economy. In addition to tracking GHGs, LEAP can also be used to analyze emissions of local and regional air pollutants, making it well-suited to studies of the climate co-benefits of local air pollution reduction. The LEAP tool is used for the first time in Jordan in the energy mitigation analysis. In former national communications to the UNFCCC, the Energy and Power Evaluation Program (ENPEP) was used.

The energy baseline scenario delineates 2015 as a base year and considers the policies, programs, and projects that have been incorporated in the energy strategy for 2015-2025 as committed and confirmed inputs for building up the baseline scenario up to 2040 using the LEAP Model. For non-energy sectors (IPPU, AFOLU, and Waste), linkages to demographic, macroeconomic, and other sector specific factors were used to build up the scenario utilizing statistical and economic tools.

3.2 Importance of TNC Update

Since submission of the TNC to the UNFCCC in November 2014, new developments have affected the national economy and social conditions. This gives added importance to the need to update the mitigation analysis for all sectors. The major changes that took place in 2015 and 2016, can be summarized as follows:

In 2015, "Jordan 2025" was launched and adopted as a national strategy. The document articulated a vision for promoting the rule of law, upholding equal opportunity, increasing participatory policy making, achieving fiscal sustainability, and strengthening institutions. The Jordan 2025 vision aspires to achieve real economic growth rates of 7.5% in 2025, at an annual rate of 5.7% within the vision period. The energy sector was one of the main sectors addressed in the document aiming at securing Jordan's sustainable development efforts.

A new census was conducted and published in December 2015, the main findings were:

- The population of Jordan was 9,531,712 (compared to 6.9 million used in the TNC baseline scenario for 2015).
- The population doubled more than 10 times over the past 55 years; most of the increase took place during the past decade, especially after 2011 due of influxes of refugees.
- The population of those of Jordanian origin was 6,613,587 accounting for 69.4% of the total population.
- Non-Jordanian population made up 30% of the total population. Almost half of them are Syrians (1.3 million) and one third of them (about 436 thousand) live in Amman Governorate.
- The population of Amman Governorate exceeded 4 million.

A new energy strategy for the period 2015-2025 was prepared and approved in December 2015. The strategy provided a plan for the future energy mix, particularly for electricity generation, and the consequences of increasing the generating capacity of renewable sources of energy on the electricity generation and transmission system and on the share of nuclear energy in electricity generation. Additional energy relevant changes will be outlined under the energy baseline section of this chapter.

3.3 Sources of Data and the Main Macroeconomic and Demographic Considerations

The main macroeconomic data considered for the baseline scenario were obtained from official sources as follows:

- Economic Growth Rate: The economic growth rate or the gross domestic product (GDP) considered in the baseline scenario is consistent with that targeted in "Jordan 2025: a National Vision and Strategy", which seeks to achieve a real economic growth rate of 7.5% in 2025 at an annual growth rate of 5.7%.
- The value-added figures considered for the economic sectors were those that are stated in "Jordan 2025".
- Population figures for Jordanians and non-Jordanians and family size data were based on the findings of the census of 2015, while population growth rates for Jordanians and non-Jordanians were obtained from the Department of Statistics-Jordan.
- The official discount rate used was 8%, as determined by the Ministry of Planning and International Cooperation.
- Historical energy data for 2013- 2015 were obtained from the energy balances issued by the Ministry of Energy and Mineral Resources (MEMR) for 2013, 2014, and 2015, which illustrate the energy flow from the supply side, transformation and into the demand side.
- Detailed data for historical energy consumption patterns by each sector and for the technologies used for 2013- 2015 were obtained from the energy surveys conducted by MEMR as follows:

- Energy consumption survey in the transport sector, 2012.
- Energy consumption survey in the household sector, 2013.
- Energy consumption survey in the services sector, 2014.
- Energy consumption survey in the agricultural sector, 2014.
- Energy consumption survey in the commercial sector, 2013.
- Energy consumption survey in the industrial sector, 2013.

Table 3.1 shows the economic growth rate of GDP in real terms, the structural composition of GDP, and the growth rate (GR) of population.

Table 3.1: GDP and population, 2015-2040

Item	2015	2020	2025	2030	2035	2040
Population (million)*	9.531					
Jordanian (%GR) *	6.613	2.9	2.7	2.3	2.0	1.9
Non-Jordanian (%GR)	2.918	2.4	2.2	1.8	1.5	1.5
GDP (million JD) **	26640	34790	46510	62820	80150	102300
GDP (%GR) **	3.1	4.91	7.53	6.2	5.0	5.0
Structural Composition of GDP (Value Added) %						
Services Sector	68.1	61.4	58	52	50	48
Industrial Sector	22.4	27.4	29.5	32	33	34
Construction Sector	4.2	5.8	6.6	8	8.8	9.8
Agricultural Sector	2.9	3.4	4.1	5.9	6.0	6.0
Non-Profit Organization	2.4	2.0	1.8	2.1	2.2	2.2

*Department of Statistics

**Jordan Vision 2025

Non-Jordanians are comprised of three major groups. The first group is made up of Syrians who entered Jordan during the 1984-1986 Syrian conflict and stayed in Jordan to this date. The size of this first group is 700,000 (2015). This first group is regarded as Jordanian for the purpose of calculating population growth rates. The second group is made up of Syrian refugees who entered Jordan during 2011-2016 Syrian conflict with an estimated size of 630,000. The presence of this second group is driven by the political and security situation in Syria. The third group is Egyptian workers, whose stay is driven by economic considerations and regulated by government labor policies.

3.4 Baseline Scenario for the Different Sectors

3.4.1 Baseline scenario for the energy sector

3.4.1.1 Updates on TNC baseline scenario

a. Energy Demand and Supply Updates

- Throughout the period 2011-2014, the energy sector has experienced several setbacks caused by the rise, at the time, in the price of crude oil and oil derivatives, the interruption of the Egyptian gas supply, and the shift to more expensive fuel for electricity generation. And with a rise in the demand for electricity during the same period from 2.8% and 6.4% in 2011 and 2014, respectively, energy imports have reached 4.1 billion JD in 2013 and 4.5 billion JD in 2014, an increase of around 10%.
- One of the main drivers behind the high growth rate in the demand for energy and electricity is the presence of 1.3 million Syrian refugees comprising 20% of Jordan's population and to whom Jordan is obliged to provide essential water and energy services.
- In 2015, the energy sector was affected by the fall in crude oil prices in the global market to USD 30 per barrel. This decrease led to delays in implementing many infrastructure energy projects listed in the TNC baseline scenario.
- The liquefied natural gas (LNG) jetty in Aqaba was put in operation in September 2015, allowing Jordan to meet the country's needs of LNG for electricity generation. Concurrently, government electricity subsidies for the electricity generation sector were phased out.
- As a result, the heavy burden on Jordan's economy has been decreased. Government energy expenditures in 2015 were 2.5 billion JD, equal to 13% of GDP, compared to 4.5 billion JD in 2014 (18% of GDP).

b. Delayed energy infrastructure projects listed in the TNC baseline scenario

- Oil shale projects for electricity generation: Construction of an oil shale 470 MW power plant to generate electricity via direct burning was considerably delayed because of a failure in reaching a financial closure. The new expected date for commercial operation has moved to 2020. In addition, the construction of another oil shale 600 MW power plant by a consortium of Emirati and Chinese companies was cancelled. Consequently, achieving the 11% target for oil shale contribution in the energy mix by 2020 is no longer attainable. The updated share of oil shale in the energy mix will be up to 8% by 2025.
- Oil shale surface restoration projects: Change in the economic feasibility have affected the ability of companies working in surface restoration of oil shale fields to fulfill their agreed-upon obligations on schedule. All oil shale companies were asked to postpone their development period for five to eight years. Some oil shale companies have completely stopped their projects in the aforementioned fields in the meantime.
- Oil and gas exploration: The British Petroleum Company has completely stopped its development and exploration operations in the Risha natural gas field in 2014 because the reserves of natural gas discovered were not deemed commercially viable.
- Expansion of Jordan Oil Refinery Project: The Jordan Oil Refinery was unsuccessful in pushing ahead with the 2015 refinery expansion project, designed to convert heavy petroleum derivatives to light products and to improve the specifications of petroleum products.
- Due to regional political instability, construction of the Iraqi crude oil pipeline was delayed. The pipeline was supposed to transport Iraqi crude oil across Jordan to the export terminal in Aqaba.

c. Infrastructure projects, policies, laws, and by-laws of the TNC - under implementation "as planned"

- Crude oil and oil products storage: All strategic stock projects of Jordan to increase the storage capacities of crude oil and oil products will be completed and put in operation by the end of 2017.
- Natural gas projects: The construction of LNG jetty at Aqaba seaport, the connection to the Arab gas pipeline, and the leasing of a floating storage and regasification unit (FSRU) were successfully implemented and put in commercial operation in September 2015.
- Renewable energy: Considerable progress has been achieved in utilizing renewable energy for electricity generation. Currently, confirmed renewable energy generation capacity has exceeded the renewable generating capacity of 960 MW by 2020 projected in the TNC baseline scenario. As of end of 2015, 300 MW of solar and wind projects have been connected to the grid. By the end of 2017, around 550 MW of solar and wind is scheduled to be connected to the grid. Furthermore, small scale consumers have been given the opportunity in 2016 to generate their own electricity and sell the excess (if any) to the distribution utilities at a fixed tariff. Currently, around 70 MW of installed capacity as rooftop systems have been installed.
- Energy Efficiency: Previously, all the activities in the energy efficiency field were considered in the mitigation scenario. A huge progress was done by establishing the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF).
- The laws and by-laws considered in the TNC baseline scenario:

- The Renewable Energy and Energy Efficiency law was approved as a permanent law in 2012 and amended in 2014. The law allows investors to identify and develop grid-connected electricity production projects through the so called unsolicited or direct proposal submission.
- The bylaw of Direct Proposals of Renewable Energy Projects has been issued in Mid-2015.
- A well-founded reference price list (ceiling prices) for different renewable energy technologies was set by the Energy and Mineral Regularity Commission (EMRC).
- Net-metering for small renewable energy (RE) systems (roof tops) with fixed purchase prices for excess power has been set.
- Tax incentive: a bylaw was issued granting tax exemptions for RE and EE systems and equipment.
- Grid expansion and reinforcement plans are ongoing through the implementation of the Green Corridor project.
- The JREEEF has been established.

Table 3.2 summarizes the status of the energy baseline scenario projects as stated in TNC.

Table 3.2: The status of the energy baseline scenario projects as stated in TNC.

No.	Project	Status	Date of operation	Capacity
Renewable Energy				
Wind Energy				
1	Wind Project in Tafila	In operation	Sept. 2015	117 MW
2	Wind Project in Ma'an /Gulf Grant	In operation	March 2016	80 MW
Solar PV				
3	Solar PV Project in Mafraq	In operation	2015	10 MW
4	Solar PV Project in Azraq/Spanish Grant	In operation	March 2016	5 MW
5	Solar PV Projects/Direct Proposal Submission- Stage I - 12 Projects - 9 of which in Ma'an	Under construction	2016-2017	200 MW
6	Solar PV Projects/Direct Proposal Submission- Stage II - Northern & Eastern parts of Kingdom	Under construction	2016-2017	200 MW
7	Solar PV Project in Qweira /Gulf Grant	Under construction	2017	100 MW
Natural Gas LNG				
8	LNG terminal/Aqaba	In Operation	2015	
9	Development of Risha Natural Gas Field	Cancelled		50 MMcfd
Oil Shale				
10	Oil Shale Direct Burning 1 Estonian	Delayed	2020	470 MW
11	Oil Shale Direct Burning 2 Chinese Consortium	Cancelled	-	600 MW
Oil and Oil Products				
13	Storages of Crude Oil & Oil Products	Under construction	2017	430 Kt
Electricity Generation				
14	IPP3	In operation	2015	573 MW
15	IPP4	In operation	2015	

3.4.1.2 The energy baseline scenario up to 2040

As mentioned earlier, changes in the economy and the energy sector since 2015 have affected the sector's strategies, policies, plans, activities, and projects. Therefore, the baseline scenario for the period 2015-2040 has been reviewed and rebuilt, consistent with the new energy strategy of 2015-2025.

a. The new energy strategy of 2015-2025

Based on the changes that have affected the energy sector since 2015 driven by reduced oil prices and the remarkable progress in the adoption of renewable energy projects, which was facilitated by the declining cost of renewable energy technologies, a new strategy for the energy sector, consistent with "Jordan 2025", was adopted and approved by the Ministerial Council in December 2015.

The new energy strategy seeks to:

- Achieve a secure sustainable supply of energy and optimal utilization of natural resources.
- Increase the contribution of local energy resources in the country's energy mix.
- Reduce the burden of energy costs on the Jordanian economy.
- Study the impacts of renewable energy projects on the power generation system.

According to the energy strategy 2015-2025 and its components, the most probable baseline scenario in the energy sector will be based on the current situation in the energy sector, the government's efforts being made to achieve security of energy supply, the adopted goals, policies, and laws in the energy sector, and the planned and committed projects within the energy strategy.

b. Energy baseline scenario during the energy strategy period 2015-2025

The policies, projects, and activities considered in the baseline scenario up to 2025 and beyond to the year 2040 are described below:

1. The field of oil and oil products

Securing the Kingdom's oil products needs will be achieved by the following:

- The Jordan Petroleum Refinery will continue to produce 14 thousand tons per day (100 thousand barrels), and the remaining need of oil products will be imported. This arrangement is supposed to last up to 2040.
- The Jordan Petroleum Refinery will proceed forward with implementing the expansion of the oil refinery to increase its capacity of converting heavy petroleum derivatives to light products and to improve the specifications of petroleum products. The expansion will be completed by 2022.
- Jordan will continue to meet its crude oil needs by importing Saudi Arabian oil via sea. The crude will then be shipped by trucks to the oil refinery. This arrangement is supposed to last up to 2022.
- Construction of a pipeline will proceed forward to ship 1 million barrels per day of Iraqi crude oil across Jordanian territory to the export terminal in Aqaba, in addition to a branch to supply JPR with 150 thousand barrels per day of crude oil. The pipeline will be completed by 2022.
- The policy of petroleum products price liberalization will be sustained, as well as pricing oil products on a monthly basis in accordance with changes in international oil prices as a tool to improve the efficiency of consumption.
- The implementation of the oil sector restructuring program and the establishment and operation of the logistics companies will be completed.
- Project work for the storage of strategic stocks of petroleum products sufficient for 60 days will be implemented by:
  - The construction of 100 thousand tons of storage capacity for crude oil in Aqaba on engineering, procurement, and construction (EPC) basis.

- The construction of strategic storage capacities for light oil products with a capacity of 250-300 thousand tons, and for LPG with a capacity of 8 thousand tons for LPG in the middle of Jordan on EPC basis to be commercially operated in 2017.
- The establishment of the Oil Logistics Company to secure the strategic storage capacity of oil and oil products needed for the country.

If the refinery expansion project does not get implemented, the government will study the following options:

- Open the way and announce the investment opportunity to build new oil refinery in Jordan.
- Discontinuing operations in the existing refinery.
- Importing oil products to meet Jordan's needs.

This arrangement will achieve the following goals:

- Linearization of oil products markets on competitive basis.
- Improving the specifications of the oil products in the local market.
- Improving the quality of services delivered to the consumers.

2. The field of natural gas

As stated earlier, Jordan has the ability to meet the country's needs of natural gas for electricity generation and for industrial uses following construction of LNG terminal in Aqaba, which was put in commercial operation in September 2015. In 2016, 90% of electricity generation in the Kingdom was based on natural gas delivered via the Aqaba LNG terminal.

The demand for natural gas for electricity generation during the period 2016-2022 was estimated to be 350-420 MMcfd. During the period 2023-2025, the estimated demand dropped to 150-250 MMcfd due to substitution by oil shale and nuclear power which will come online during the period in question. The demand for natural gas by the industrial sector was estimated to be 150 MMcfd during the same period.

In addition to the LNG terminal in Aqaba, other regional options to supply Jordan with natural gas include Egypt and Gaza. Locally, the National Petroleum Company (NPC) plans to develop the Risha gas field to increase LNG production to 50 MMcfd as a 1st stage. The company is working on attracting strategic investors and partners, while seeking to create a favorable investment opportunity to develop Risha gas field.

3. The field of renewable energy

Under construction and committed projects during 2015-2021

Tremendous progress has been made in utilizing renewable energy resources to generate electricity. Table 3.3 contains a list of electricity-generating renewable energy projects with a capacity of 1150 MW, some of which have become operational, some are under construction, and some have been committed during the period 2015-2021.

Table 3.3: Wind and solar projects currently under development

	Project	Capacity MW	Operation
Wind Projects	Wind Project in Tafila	117	Sept. 2015
	Wind Project in Ma'an /Gulf Grant	80	First Quarter 2016
	Wind Projects/Direct Proposal Submission - Stage I	330	Mid 2018
	Al Fujej Wind	90	Mid 2019
Solar Energy Projects	Solar PV Project in Mafraq	10	Sept. 2015
	Solar PV Project in Azraq/Spanish Grant	5	March 2015
	Solar PV Projects/Direct Proposal Submission - Stage I - 12 Projects - 9 of which in Ma'an	200	2016
	Solar PV Projects/Direct Proposal Submission - Stage II - Northern & Eastern parts of Kingdom	200	2016-2017
	Solar PV Project in Qweira /Gulf Grant	103	2017
	Small Scale PV Systems, Roof tops	100	On going

The total capacity of RE by the end of 2020 will be around 1350 MW, representing 25% of all installed generating capacity and contributing 20% of generated electricity. The electricity grid expansion and reinforcement plan (green corridor project) will be implemented by the end of 2019 at a cost of 160 million JD. This will allow expansion in installed capacity in southern Jordan from 400 MW to 1000 MW.

In addition to the mentioned renewable energy large-scale projects projects, other small-scale renewable energy systems, the so-called net metering (rooftops) systems, have been installed on residential buildings, agricultural land, schools, mosques, and churches. In 2015 and 2016, around 70 MW of net metering systems have been installed and this capacity is expected to double by the end of 2018.

Renewable energy projects planned during 2021-2025

Additional renewable energy projects (solar and wind) with a capacity of 900 MW are expected to be connected to the grid during the period 2021-2025, and thus are considered part of the updated baseline scenario. The status of these projects is as follows:

- A framework agreement was signed between the Ministry of Energy and Mineral Resources and the UAE-based Masdar Company to develop 200 MW solar projects.
- Letters of intent were signed with public universities to build 25 MW solar PV projects at four universities.
- 200 MW PV projects - third round of direct proposals in Ma'an.
- 100 MW wind projects - third round in south Jordan.

- Investment opportunities granted to electricity generation companies in Jordan to build renewable projects near existing thermal generation power plants.

In accordance with the government arrangements approved in 2013 to deal with the private sector to generate electricity from waste, the following two projects will be implemented:

- A 50 MW waste-to-energy power plant using solid waste incineration will be built at the Ghabawi landfill site.
- A 25 MW biogas power plant will be built in 2020 at the Al-Ekader Landfill Site.

Table 3.4 shows profiles of existing and planned renewable energy projects up to 2021, (status updated on February 15, 2017)

Table 3.4: Renewable energy projects in Jordan as of February 15, 2017

1.Expected Share of RE Projects by 2021						
Year	**Capacity (MW)**		**Generated Energy (GWh)**		**Share of Renewables in the Total Generated Energy (%)**	
	Wind	**Solar**	**Wind**	**Solar**	**Wind**	**Solar**
2021	700	1500 (including wheeling projects)	2085	3022	8.5%	12.5%
Total	2200		5107		21%	

Direct Proposal Submission for solar PV Projects/ Round I			
Project	**Capacity MW**	**Location**	**Commercial Operation Date-COD**
Philadelphia Solar	10	Al-Mafraq	October 2015
Jordan Solar One	20	Al-Mafraq	03/09/2016
Ennera Company	10	Ma'an Development Area	04/08/2016
Shams Ma'an	50	Ma'an Development Area	27/09/2016
Saqer Ma'an	20	Ma'an Development Area	18/10/2016
Anwar Al Ardh	20	Ma'an Development Area	26/08/2016
Al-Zanbaq For Energy Generation	10	Ma'an Development Area	22/09/2016
Zahrat Al-Salam For Energy Generation	10	Ma'an Development Area	21/09/2016
Al-Ward Al-Joury For Energy Generation	10	Ma'an Development Area	21/09/2016
Ardh Al Amal For Solar Energy Generation	10	Ma'an Development Area	21/07/2016
Shamsuna Power Company project	10	Aqaba	20/02/2016
SunEdison Italia project	20	Ma'an	05/07/2016
Total	210		

Direct Proposal Submission for Wind Projects/ Round I				
Project	**Capacity MW**	**Location**	**PPA signature**	**Commercial Operation Date**
Jordan Wind (JWPC)	117	Al-Tafila	2013	Sept. 2015
Hecate Energy LLC	45	Al-Shobak	29/09/2016	01/08/2019
Abour Energy Company Psc (XENEL)	49.5	Al-Tafila	31/03/2016	01/03/2019
Kospo	49.5	Al-Tafila	31/03/2016	01/03/2019
Green Watts Renewable Energy LLC	86.1	Al-Rajef	12/10/2015	31/10/2018
Kepco	90	Al-Fujiej	13/12/2015	31/10/2018
Mass energy	100	Al-Tafila	05/09/2016	01/04/2019
Total	537			
Direct Proposal Submission for solar PV Projects/ Round II				
SunRise PV Systems	50	Al-Mafraq	20/01/2016	09/2017
Saudi Oger	50	Al-Safawi	27/12/2015	06/2018
Fotowatio Renewable Ventures	50	Al-Mafraq	22/11/2015	12/2017
Hareon Swiss Holding	50	Al-Mafraq	06/12/2015	03/2018
Total	200			
Abu Dhabi Future Energy Company (Masdar), Solar PV Project				
Abu Dhabi future energy company (Masdar)	200	Al-Muwaqqar	October 2016	July 2019
Electrical Generation Companies				
AES/Mitsui	50	East Amman	Under Negotiation	End of 2018
ACWA Power	50	Al-Reesha	Under Negotiation	Under Negotiation
EPC Projects (Wind and Solar) through Gulf Grant				
Wind Project in Ma'an/Kuwati Fund	80	Ma'an	September 2013	Stage I (66 MW) Sept. 2016 Stage II (14 MW) Mid 2017
Solar PV Project in Qweira/Abu Dhabi Fund	103	Aqaba	December 2015	End of 2017

EPC Projects (Solar PV) through Spanish Grants				
Project	**Capacity MW**	**Location**	**Agreement Signature**	**Commercial Operation date**
2 Projects at Azraq/Debt Swap Fund	5.17	Al-Azraq	2014	April 2015
Solar PV project at Azraq/Remaining amount of Debt Swap Fund	(0.6-0.8)	Al-Azraq	2017 (expected)	2018 (expected)
EPC Projects (Solar PV) through German Grants/KFW				
Solar PV project in Zaatari Camp	11.26	Zaatari	Sept. 2016	End of 2017
Solar PV project in South of Amman	25-40	South of Amman	2017 (expected)	2019 (expected)
EPC Projects (Solar PV) through the European Grant (REEE II)				
Solar PV project in Azraq	5	Azraq	2017 (expected)	2018 (expected)

4. The Field of Oil Shale

- Oil shale projects for electricity generation

  According to the new energy strategy, the new expected date for commercial operation of the oil shale direct burning project for electricity generation with a capacity of 470 MW was postponed to 2020.

- Oil shale projects for extraction of oil

  Oil shale companies were asked to postpone the development period for five to eight years. Some oil shale companies have completely stopped implementing projects. The oil shale companies that asked for development period extension included Jordan Oil Shale Company (JOSCO), which intended to produce 20,000 barrels of oil in 2019, Jordan Oil Shale Energy Company (JOSE), which intended to produce 20,000 barrels/day in 2019, Karak International Oil Company (KIO), which intended to produce 25,000 barrels/day in 2024, and Saudi Arabian Corp for Oil Shale (SACOS), which intended to produce 20,000 barrels/day in 2025.

5. The Field of Nuclear Energy

Jordan's interest in nuclear energy stems from the need to address the challenges represented by the scarcity of domestic energy and water supplies. To provide domestic long-lasting sources of energy, the National Strategy of Energy of 2007 has strengthened the role of developing domestic and diversified sources of energy by introducing nuclear energy as an alternative to electricity generation. Hence, the Jordan Atomic Energy Commission (JAEC) was created in 2008 to achieve two major goals:

- To transfer, develop, and sustain the peaceful use of nuclear energy and radiation technology in the Kingdom; and
- To promote investment projects in radiation technology and nuclear energy such as electricity generation and water desalination as well as other nuclear projects that boost the national economy.

The JAEC has selected the nuclear power plant site in Amra. JAEC announced that Rosatom's reactor export subsidiary, Atom Story Export (ASE), would supply two nuclear units on a build, own, and operate (BOO) basis with a capacity of 1000 MW each. The first reactor will be commissioned in 2023 and the second in 2025 as stated in the new energy strategy 2015-2025. The two nuclear power plants include third generation technology of Russian reactors which upholds the highest standards of nuclear safety and security.

3.4.1.3 Primary and final energy demand

- Primary energy demand

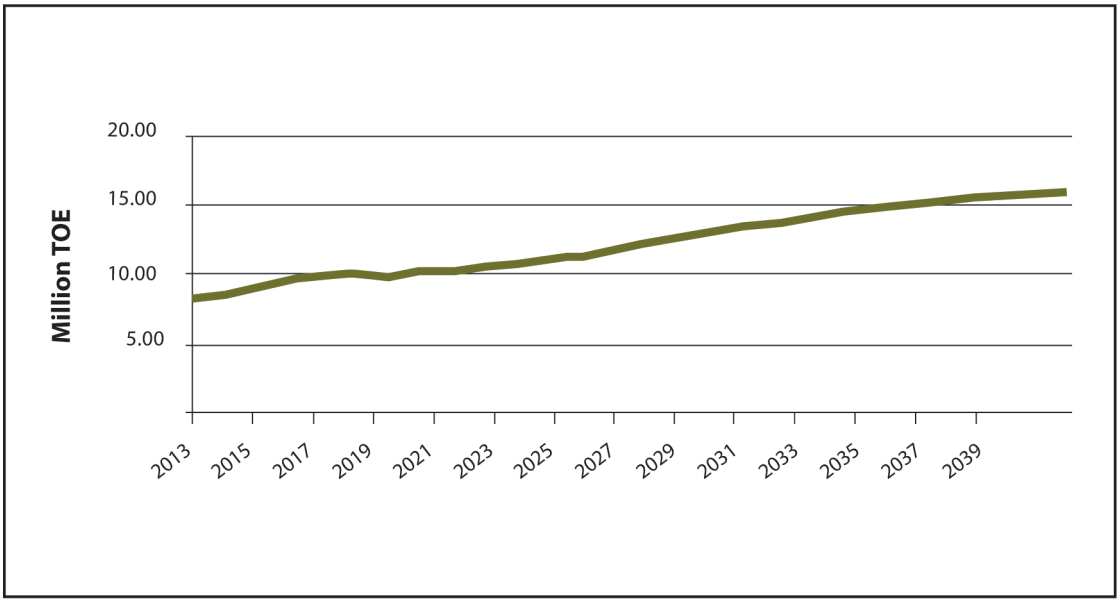
Based on the baseline scenario analysis taking into account all committed projects as well as the economic variables, the LEAP output shows that the primary energy required will be 10.3 Mtoe, 11.53 Mtoe, and 16.33 Mtoe in 2020, 2025, and 2040, respectively, with an annual growth rate of 2.4% during the period 2015-2040 (full data are presented in Table A.1, Appendix A).

Table 3.5 and Figure 3.1 show the total primary energy requirements for selected years during the period 2015-2040.

Table 3.5: Primary energy requirements (million tons of oil equivalent)

Baseline scenario	2015	2016	2017	2018	2020	2025	2030	2035	2040
Emissions	9.24	9.69	9.93	10.11	10.3	11.53	13.68	15.31	16.33

Figure 3.1: Primary energy requirements



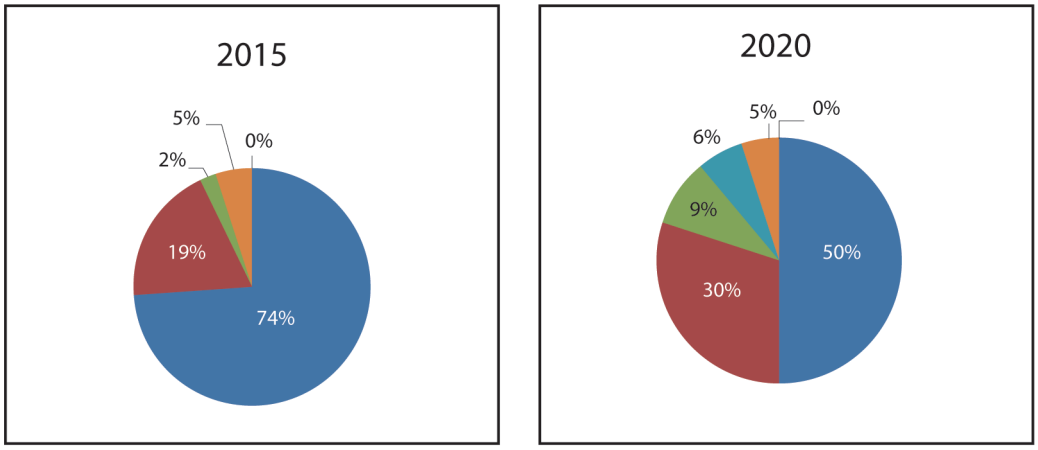
- Primary energy mix

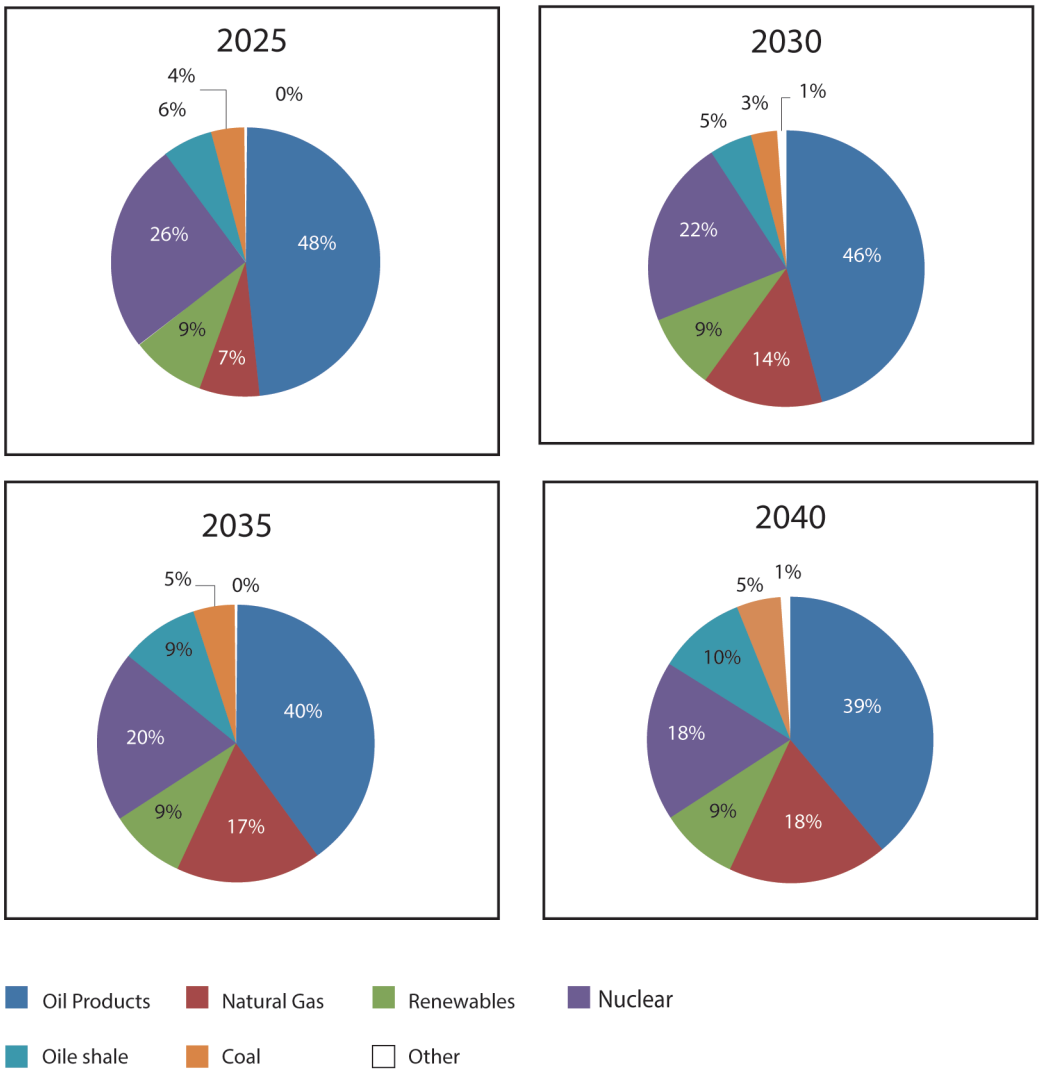
The primary energy mix for some selected years within the study period is shown in Table 3.6 and Figure 3.2. The primary energy mix in 2020 will consist of 50% oil products, 30% natural gas, 9% renewable energy, and 6% oil shale, while in 2025 the primary energy mix will consist of 48% oil products, 7% natural gas, 9% renewable energy, 22% nuclear, and 5% oil shale. The decline in natural gas contribution in the energy mix is attributed to the introduction of nuclear power into the mix in 2023 and 2025.

Table 3.6: Primary energy mix (thousand toe), 2015-2040

Fuels	2015	2020	2025	2030	2035	2040
Oil products	6885	5177	5590	6283	5960	6370
Natural gas	1752	3113	823	1972	2550	2970
Renewables	170	955	1030	1290	1410	1490
Nuclear	-	-	2945	3010	3010	3010
Oil shale	-	620	645	645	1300	1630
Coal	420	448	450	420	700	750
Others	13	17	47	60	80	110
Total	**9240**	**10330**	**11530**	**13680**	**15010**	**16330**

Figure 3.2: Primary energy mix (%), 2015-2040





Final energy demand by sector

Final energy demand (consumption) is the total energy consumed by end users, such as transportation, household, industry, and agriculture.

It is the energy which reaches final consumers' door and excludes energy used by the energy sector itself. In Jordan, it is mainly oil products and electricity.

The final energy demand by sectors for the baseline scenario up to 2040 is driven by GDP, population size, population growth rate, and the value added by each sector over the period in question. The final demand is also driven by behavioral changes by the end users, modernization, and the price of the final energy consumed. All of these variables have been factored in the LEAP model. Table 3.7 and Figure 3.3 show the final energy demand by sector for selected years during the period 2015-2040 (full data are presented in table A.2, Appendix A).

Final energy demand in the transportation sector

The transportation sector accounted for 48% of the total final energy demand in 2015. The current energy intensity of the transportation sector, measured at 0.07 Kgoe/Km per person and 0.05 Kgoe/ton per kilometer traveled, is considered too high as a result of a low specific load per vehicle (1.3 passenger/vehicle) and a lack of modern public transport system. This share of the transportation sector is expected to decrease to 46% and 42% in 2020 and 2025, respectively, due to the improvement measures that will be introduced to the sector including the Bus Rapid Transit, service upgrade in public transport, and increased penetration of hybrid and electric cars.

Final energy demand in other sectors

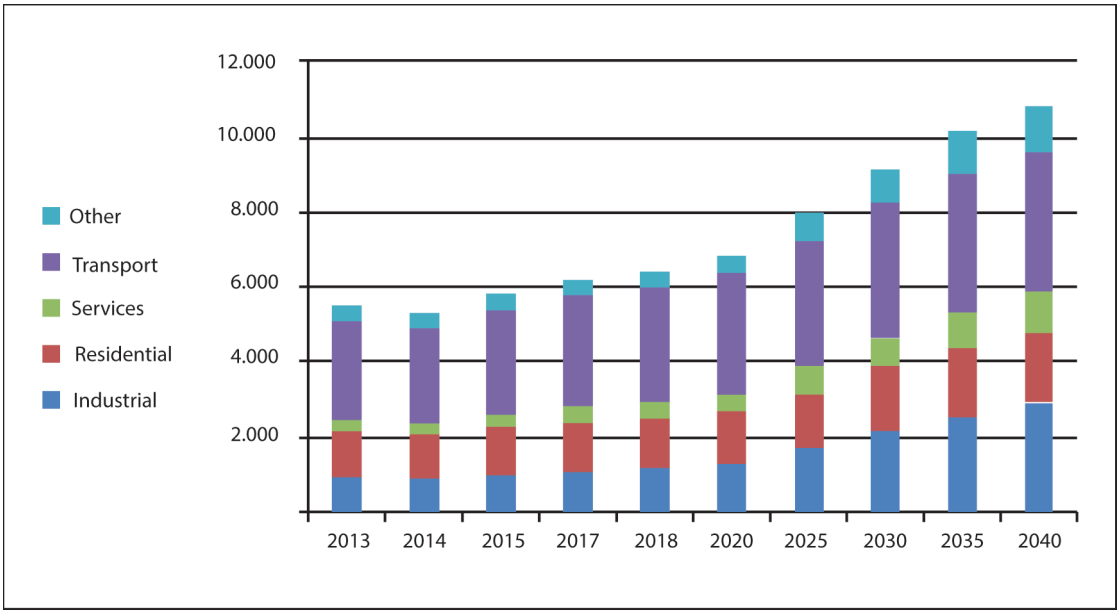
The industrial sector's final energy consumption as a percentage of the total final energy will increase from 17% in 2015 to 27% in 2040, consistent with the sector's targeted value added stated in "Jordan 2025". The services sector will experience a high average growth rate of 5% annually, capturing 10% of the total final energy consumption in 2040, up from 6% in 2015.

As for the share of the household final energy consumption, it will decrease from 22% in 2015 to 17% in 2040. The household sector will experience a medium growth rate of 1.4% annually. This is primarily attributed to the pricing mechanism used and to the shift towards more efficient devices.

Table 3.7: Final energy (thousand toe) demand by sector, 2015-2040

Branches	Industrial	Residential	Services	Transport	Other	Total
2015	991	1,272	367	2,810	387	5,828
2020	1,307	1,443	484	3,133	510	6,876
2025	1,722	1,592	637	3,401	672	8,024
2030	2,192	1,706	811	3,639	855	9,203
2035	2,630	1,778	973	3,784	1,026	10,191
2040	2,974	1,800	1,101	3,822	1,161	10,857

Figure 3.3: Final energy (thousand toe) demand by sector, 2015-2040



For more details, Tables A.3-A.6 in Appendix A show the projected energy balances generated by LEAP for the selected years 2020, 2025, 2030, and 2040. The energy balance reveals the relationship between supply (inputs to the energy transformation processes) and the output as well as actual energy consumption by different end users. The energy balance expresses all forms of energy in a common accounting unit.

Electricity demand

According to the baseline scenario, electricity generation requirements will grow during the period 2015-2040 at an average annual growth rate of 4.1%.

Demand for electricity which reached 17980 GWh in 2015 is expected to reach 23150 GWh in 2020 and 28900 GWh in 2025, rising to 44500 GWh in 2040. Table 3.8 and Figure 3.4 show electricity generation requirements during the period 2015-2040. Table 3.8 also shows electricity generation capacity over the baseline period, where the capacity will reach 6025 MW in 2020 and surge to 8290 MW and 8975 MW in 2030 and 2040, respectively.

Table 3.8: Electricity generation requirements and generation capacity, 2015-2040

Scenario	2015	2018	2020	2023	2025	2030	2035	2040
Electricity requirements (TWh)	17.98	21.14	23.15	26.47	28.90	34.99	40.45	44.50
Average annual growth rate (%)	4.1							
Total electricity generation capacity (MW)	4043	5085	6025	7255	8255	8290	8375	8975

Figure 3.4: Electricity requirements (TWh), 2013-2040

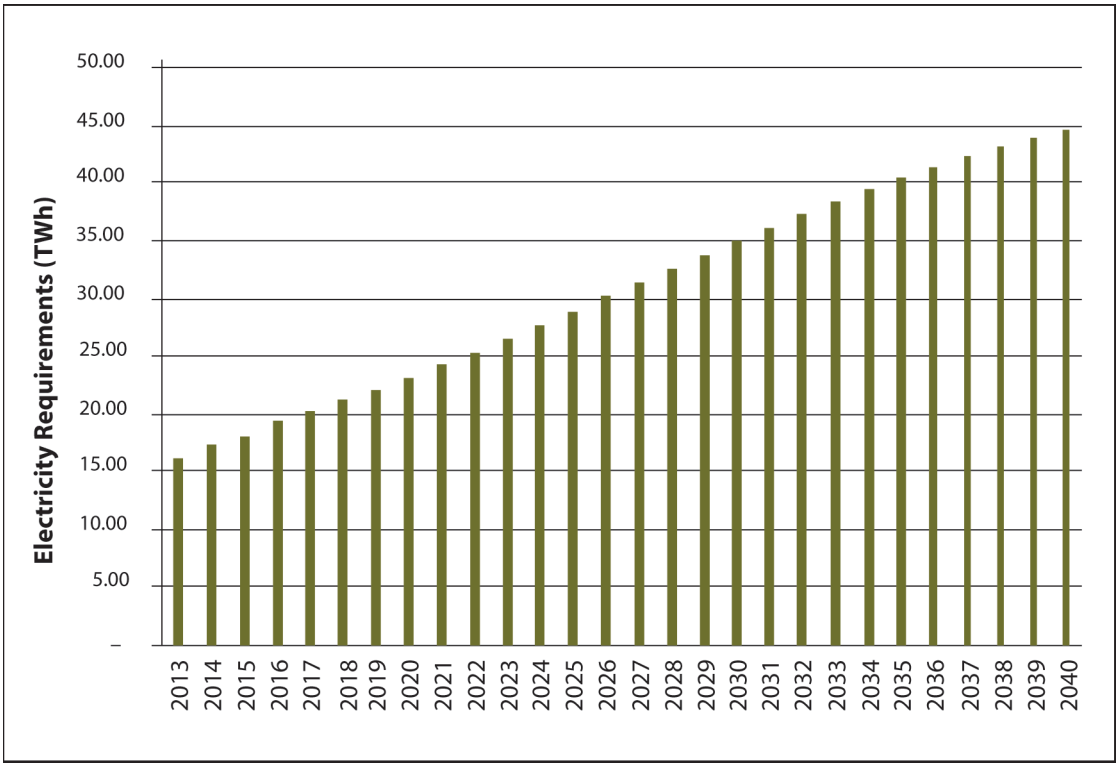


Table 3.9, Figure 3.5, and Figure 3.6 show the share of electricity generation by fuel type in the baseline period for selected years. Wind and solar power sources will account for 4.28 TWh or 20% of total electricity generation in 2020. Heavy fuel oil (HFO) will be completely phased out between 2025 and 2040. Nuclear power's share of electricity generation will exceed 50% in 2025-3030.

Table 3.9: Electricity generation (thousand GWh) by fuel type, 2015-2040

	2015	2020	2025	2030	2035	2040
Natural Gas	8.55	14.34	5.73	12.36	10.92	15.13
Residual Fuel Oil	8.08	1.82	1.82	-	-	-
Wind	0.12	2.08	2.37	2.37	2.55	2.82
Solar	-	2.6	2.7	2.9	3.1	3.2
Nuclear	-	-	15.77	15.77	15.77	15.74
Oil Shale	-	3.5	2.9	2.9	4.5	4.5
Total	16.75	24.34	31.29	36.3	36.84	41.39

Figure 3.5: Electricity generation (TWh) by fuel type, 2015-2040

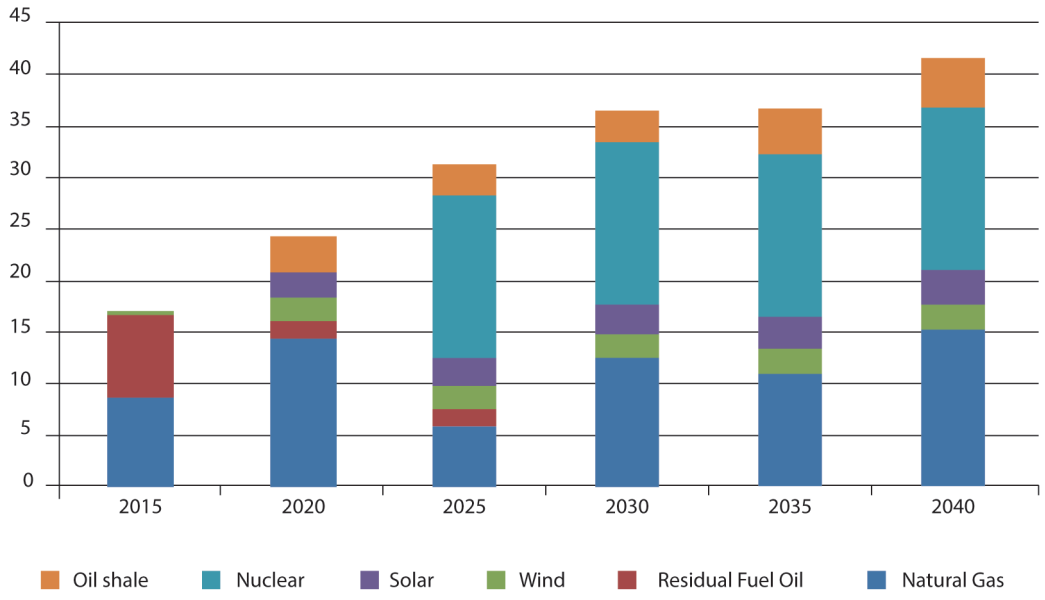
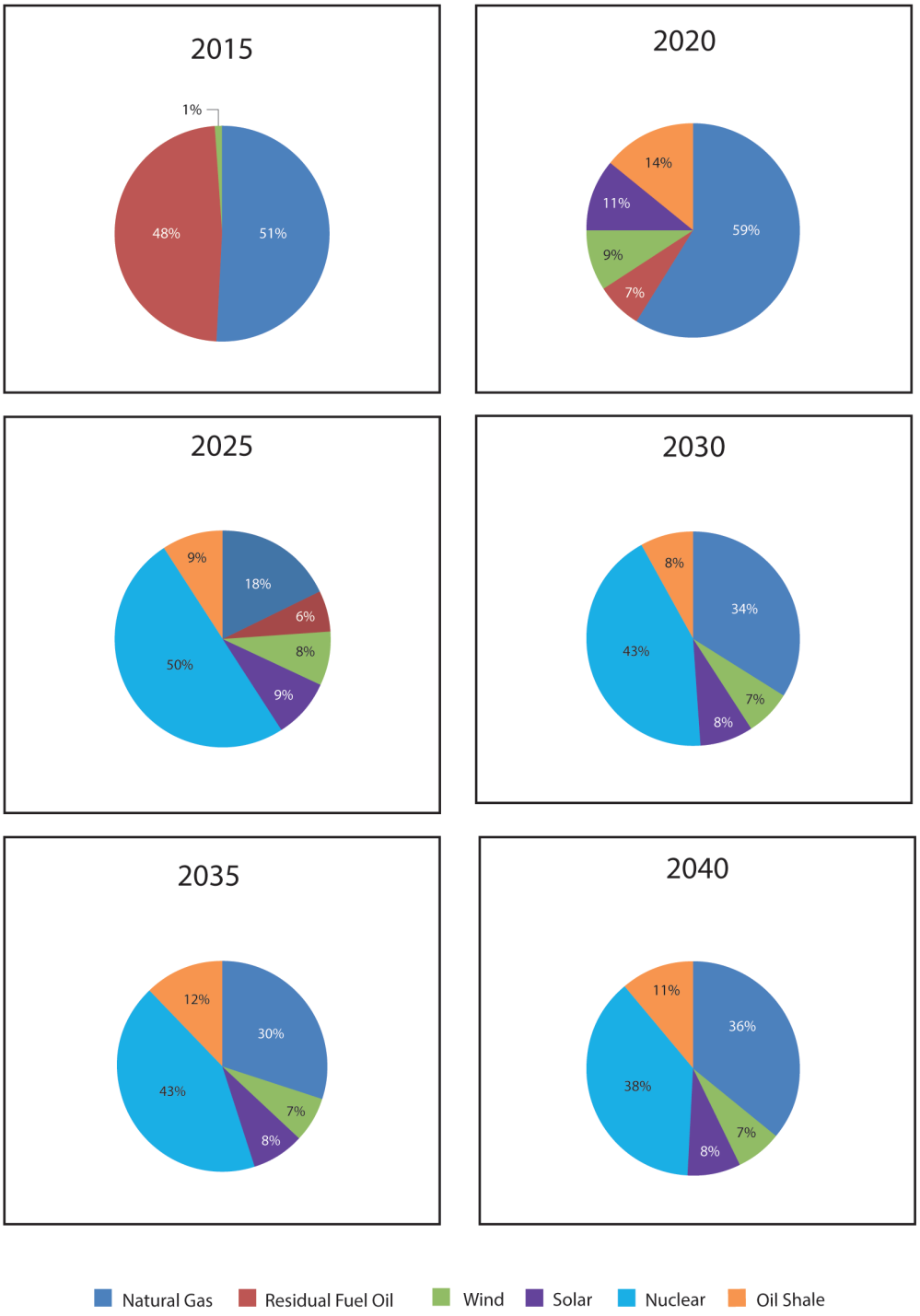


Figure 3.6: Electricity generation (%) by fuel type, 2015-2040



3.4.2 Baseline scenario for industrial processes and product use (IPPU) sector

The industrial sector in Jordan is considered one of the main pillars of the Jordanian economy. The sector contributed 25% of GDP in 2014 to become the second-largest economic sector after the services sector. It contributed directly and indirectly to about 40% of GDP through its linkages with other key sectors such as transportation, insurance, and trade.

The industrial sector consists of two subsectors, manufacturing and mining. The manufacturing (converting) subsector includes chemicals, electrical, engineering and construction, food and beverages, glass and ceramic, tobacco and cigarettes, paper and cartoon, pharmaceuticals and medical, printing and packaging, and textile and leathers. The mining subsector includes phosphate, potash, salt, carbonate, lime and limestone, fertilizers, cement and construction. Mineral extraction from mines and quarries is also included.

Governmental strategies, policies, plans, and projects to improve the industrial sector as well as plans by relevant companies have been reviewed to build the baseline scenario. The documents that have been examined include the Ministerial Statement (governmental working plan 2013-2016), the national industrial policy (industrial support program 2010-2014), and Ministry of Trade, Industry, and Supply strategy (2014-2016).

In addition, "Jordan 2025" addresses the industrial sector with a focus on assisting in financing and incentivizing the development and sustainability of Small and Medium Enterprises (SMEs). Also, in 2014, a High-Level Committee and a Unit for Green Economy were established by a decree by the Prime Minister, on the basis of which a National Green Growth Plan for Jordan was developed by the Ministry of Environment to be followed by an action plan for transitioning towards a green economy.

Based on this review, the following are a summary of the main plans/activities of the government to improve the industrial performance in Jordan:

- Support the development of the industrial sector and improve its competitiveness to effectively contribute to economic development of the country.
- Protect intellectual and innovation rights in business and establish the principles of the free market's rules.
- Support small and medium enterprises (SMEs).
- Improve the investment environment to attract foreign investments in all Governorates.
- Improve infrastructure services needed for industrial activities.
- Improve education and vocational training to prepare qualified labor for industrial jobs.
- Enhance communication between research and development centers and industries to catalyze technology transfer and improve the utilization of knowledge.
- Enhance the adaptation of Best Available Technology (BAT) and Best Environmental Practices (BEP) in industrial processes.
- Improve regulations and policies to encourage industrial investment.
- Enhance cooperation between the private and public sectors.
- Establish a national strategy to improve the penetration of local products into international export markets.
- Improve the financial support mechanism to encourage industrial investments.
- Provide technical support to industries to help them comply with technical and environmental standards.

GDP growth rates, as stated in" Jordan 2025", and population growth rates during the period 2015-2040 have been used to update the projections of production, extraction, and import of industrial products that generate GHGs in Jordan up to 2040. The list of industrial products includes cement production, lime production, nitric acid production, limestone, and soda ash.

Table 3.10 shows the actual and estimated production, extraction, and import of selected products for selected years, while Table A.7 in Appendix A shows the full data set for the period 2014-2040.

Table 3.10: Actual and estimated production, extraction, and import of relevant industrial products for selected years

Year	Clinker produced (Ton)	Lime produced (Ton)	Limestone extracted (Ton)	Soda ash imported (Ton)	Nitric acid produced (Ton)
2015	3973131.8	11315.6	904065.0	6566.7	88866
2020	4845553.5	13800.3	1102579.9	8008.6	96000
2025	5909541.9	16830.6	1344684.8	9767.2	102000
2030	6817587.0	19416.8	1551305.7	11268.0	108000
2035	7865160.0	22400.3	1789675.3	12999.4	108000
2040	9073700.4	25842.3	2064672.3	14996.8	110000

3.4.3 Baseline scenario for agriculture, forestry, and other land use (AFOLU) sector

Natural ecosystems in Jordan support human activities in agriculture, forestry, animal husbandry, tourism, traditional and pharmaceutical health products, and traditional medicine, among others. According to the Ministry of Agriculture, less than 5% of the country's total area is arable land and 90% is grazing land with 100-200 mm annual rainfall. Natural and human-made forests cover around 1% of the country's area. The number of farm holdings is 80,000, with an average area of 40 dunum per holding (56,000 are plant production holdings and 14,000 are animal production holdings). Plant production holdings are mostly field crops, olives, fruit trees, and vegetables.

The contribution of agriculture to the GDP in relative terms declined sharply from 40% in the 1950s to 4% in 2016. Irrespective of how humble the contribution of agriculture is to GDP and economic performance, farming remains important. The importance of the agricultural sector stems from the fact that it is not only a major source of food, particularly dairy products, fruits and vegetables, but it is also a source of livelihood for 25% of the total poor population (livestock keepers, smallholder farm households, and landless former agriculturalists) living in rural areas.

The following were common objectives among all policies, strategies, plans, and programs announced by the Ministry of Agriculture:

- Promotion of sustainable and long-term use of resources in agricultural production.
- Conservation of biodiversity and promotion of sustainable use in agricultural production.
- Combating desertification and strengthening technical capacities of people working in the agricultural sector to cope with probable climate and environmental changes.
- Control urban expansion on agricultural and forest land.
- Restore degraded ecosystems of rangelands and forests through community based rangeland rehabilitation.

The baseline scenario for this sector was constructed based on available governmental plans, programs, policies, and strategies announced and published by the Ministry of Agriculture, the Directorate of Forests, and other relevant institutions. Consistent with these plans, the following considerations have shaped the baseline scenario:

- Field crops production: Increase productivity per unit area, promote water harvesting techniques to expand planting areas, and maintain productivity under predicted decrease in rainfall.
- Animal production: Promote high productive animal species under increase in prices of fodder, and other production inputs.
- Fodder production: Reclamation of rangelands and control overgrazing of rangelands, introduce species with high productivity under drought conditions and promote wastewater reuse in fodder production.
- Forestry conservation: Maintain forests which are threatened by predicted drought cycles, urban and rural expansion, expected fire occurrences, and illegal deforestation.

Tables A.8 to A.12 in Appendix A summarize actual and projected numbers of livestock, actual and projected production of annual crops, actual and projected areas for forest plantation, and number of perennial crops during the period 2015-2040. The assumptions that directed the projections in the agricultural activities up to 2040 are as follows:

- An assumed annual increase in livestock numbers by 3% at the national level (taking into consideration the positive annual population growth and the need to secure food supply under scarce resources and production limitations that is projected to increase with climate change adverse impacts).
- An assumed increase in the annual production of different crops by 3% at the national level and an associated 7% increase in the amount of added fertilizer.
- Changes in forest land
  - An assumed increase in forest plantation areas by 1%.
  - An assumed increase in the private forest holdings by 1%.
  - Protected natural forests with maintained constant areas.

3.4.4 Baseline scenario for waste sector

The waste sector in Jordan handles three categories of waste: municipal solid waste, domestic wastewater, and industrial wastewater. Municipal solid waste is transported directly to landfill sites or to transfer stations, where it is compacted and retransferred to landfills using larger trucks to improve operational efficiency and reduce cost. Dumpsites are managed by Joint Services Councils except for the Al-Ghabawi landfill, which is operated and managed by the Greater Amman Municipality. Fifty percent of municipal waste is dumped in Al-Ghabawi landfill, the only sanitary landfill in Jordan, while most of the remaining waste is dumped into well controlled dumpsites. Open

dumping of solid waste accounts for not more than 5% of all solid waste generated. According to the Sweep Net Report of 2010 and 2014, the rate of solid waste generation in Jordan is 0.9 kg/day per capita, with a 90% collection coverage in urban areas compared with 70% in rural areas. Only 10% of collected waste is recycled, while the remaining 90% is dumped in landfills. Although there are 18 working landfills in Jordan, Al-Ghabawi and Al-Ekader landills are by far the largest, receiving more that 60% of all waste sent to landfills. A sanitary cell is planned to be constructed in Al-Ekader landfill in 2017. The Ministry of Municipal Affairs plans to decrease the number of landfill sites and shift the load to transfer stations that will in turn convey compacted waste to central landfills.

Different laws and regulations govern solid waste management and handling. Municipalities' law No. 13/2011 assigns the responsibility of waste collection to municipalities, while the general framework law of waste management, under development by the Ministry of Environment, seeks to provide general guidance for waste management. Public health law No. 47/2008 seeks to prevent nuisances resulting from illegal and inappropriate dumping.

Liquid waste in Jordan is divided into domestic and industrial wastewater. Domestic wastewater is collected by sewerage networks and tankers and transported to wastewater treatment plants, which are mostly operated by the Water Authority of Jordan with a few plants operated by the private sector through agreements with the Ministry of Water and Irrigation. Reclaimed wastewater is considered as a water source, according to the Jordan water strategy. Treated wastewater is used primarily to supplement clean water for irrigation purposes. According to the Ministry of Water and Irrigation, 14377 dunum of agricultural land was irrigated with treated wastewater in 2014. The practice of using treated wastewater for industrial purposes is limited to the city of Aqaba. In 2007, treated domestic wastewater was 87 MCM accounting for 10.3% of the water budget, while treated industrial wastewater was 4 MCM accounting for 1.3%. In 2022, treated domestic wastewater is predicted to reach 220 MCM accounting for 13.3% of the water budget, while treated industrial treated wastewater is expected to reach 27 MCM accounting for 2.3% of the water budget.

As of 2016, there were 33 working wastewater treatment plants (WWTP) in Jordan. Samra is the largest wastewater treatment plant treating more than 70% of all generated wastewater. Anaerobic digestion is used at Samra to treat biosolids, generating methane gas which is then combusted for electricity production. Other wastewater treatment plants plan to utilize biosolids for electricity production.

Different laws, regulations, and instructions govern the wastewater treatment sector in Jordan. Sewerage system regulation No. 66/1994 regulates connections to the sewer network. Treated wastewater must comply with JS 893/2006. Ministry of Agriculture according to agriculture law has set the instructions no 4/2004 to use treated wastewater for irrigation.

Most of the industries in Jordan are small and medium enterprises (SMEs). They are located within Industrial Estates, Qualified Industrial Zones or located separately. The Amman-Zarqa region is the largest urban center, where the majority of Jordanian industry is concentrated. According to MWI figures, the ratio of industrial to total water use in 2013 was very small (4.3%). Industrial wastewater is usually pre-treated at on-site units before being discharged to the central wastewater treatment plant within the industrial estate for further treatment or to locations to be used for trees irrigation or to nearby Wadis. Many industrial entities (e.g., food industries) generate wastewater that complies with the connection requirements to the sewerage network, and therefore, divert their wastewater to the public sewer system. It is assumed that aerobic treatment is used at the industrial estates' wastewater treatment plants, which results in negligible GHG emissions.

The waste sector has been reviewed and the baseline scenario updated taking into account the following:

- In line with Jordan water strategy, all possible cubic meter of wastewater is to be treated to replace fresh water in agricultural purposes.
- Current wastewater treatment plants will regularly be modified to account for increased generation of domestic wastewater driven by population growth. However, expansion will primarily take place at plants that serve urban areas.
- Current water consumption and generated wastewater per capita is assumed to be fixed.
- All future needed WWTPs will be mechanical with activated sludge method of operation.
- Biogas utilization from the digestion of sludge is mainly practiced at the Samra plant. However, other plants, such as Shalalah, have started to utilize biogas and other plants are planning to do so in the future.
- Most of the sludge produced from other treatment plants will be dried and disposed of in landfill sites.
- Solid waste production rate per capita is assumed to be fixed at 0.9 kg/capita/day.
- Protein consumption per capita is fixed at 29.6 kg/capita/year.
- Factories and industrial plants are located within industrial cities or outside of them. All plants located within the industrial cities are connected to central well managed aerobic wastewater treatment plants. Plants located outside the industrial cities are mostly connected to domestic wastewater plants in accordance with Water Authority regulations.

Tables A.13-A.16 in Appendix A show actual and projected generated amounts of domestic solid waste (2010-2040), quantities of wastewater discharged to WWTPs (2010-2015), and influent organic load to WWTPs in 2015.

3.5 GHG Emissions in Baseline Scenario for Different Sectors

3.5.1 GHG emissions from the energy sector

This section presents the energy sector's GHG emissions profile in the baseline scenario as generated by the LEAP model. GHG emissions by the energy sector in the baseline scenario are shown in Table A.17 in Appendix A. The data indicates that the energy sector is the primary source of GHG emissions in Jordan accounting for 81% and 84% of all emissions in 2010 and 2012, respectively, according to the 2010 and 2012 GHG Inventory. The role of the energy sector and subsectors as the leading emitter of GHGs is expected to continue in the future. However, it is expected that the sector's share will decline to 69% of all emissions in 2040 due to the assumed introduction of nuclear power as well as the inclusion of more renewable energy sources in the total energy mix. Therefore, the energy sector will be the focus of mitigation efforts.

The most significant GHG sources in energy demand and supply sector are in order; electricity generation, transportation, industrial, residential and commercial. As shown in Figure (3.7) in 2015, energy sector GHG emissions reached 25.71 million metric Tons (Mt) CO_2eq.

Emissions will increase at an average rate of 1.1% annually between 2015 and 2040 and reach a total of 31.42 M tons of CO_2eq in 2040, compared with 25.71 M tons of CO_2eq in 2015.

Table 3.11 shows the total GHG emissions from the energy demand and supply sector in the baseline scenario in selected years. Figure 3.8 shows a graphical representation of those same emissions during the period 2012-2040.

Figure 3.7: Share (%) of GHG emissions by energy subsector, 2015

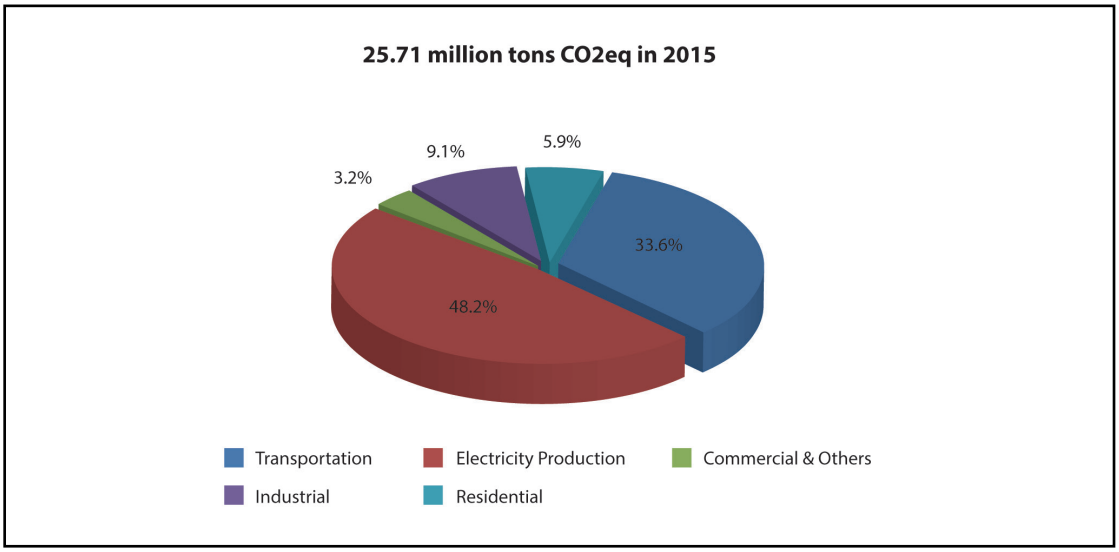
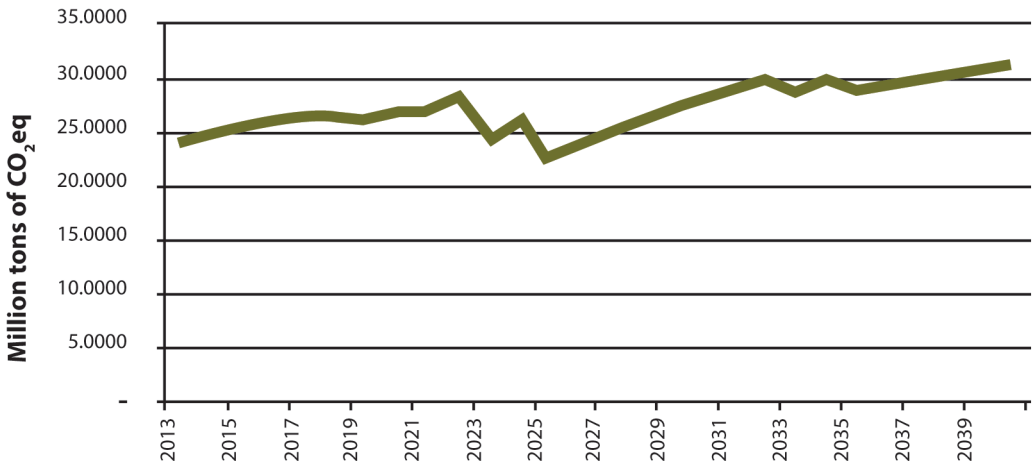


Table 3.11: Total GHG emissions (Million tons of CO_2eq) from energy demand and supply in the baseline scenario for selected years

Baseline scenario	2013	2015	2020	2025	2030	2035	2040
Emissions	24.23	25.71	26.90	22.61	27.96	29.05	31.42

Figure 3.8: Total GHG emissions (Million Tons of CO_2eq) from energy demand and supply in the baseline scenario, 2013-2040



The GHG emissions from various energy demand and supply subsectors are described below:

- The most significant change in sectoral contribution is in the power sector where emissions will decline at an average annual rate of 1.6% attributed to the introduction of a 2000 MW nuclear power plant, and the increasing share of renewable sources in electricity generation, and the shift to increased use of natural gas, which is less carbon intensive than oil products, fuel oil, and diesel, even when taking into account the increased use of oil shale.
- The transportation sector's GHG emissions will grow at an average annual rate of 1.2% during the period 2015-2040. The emissions will increase to 11.69 M Tons of CO_2eq in 2040, compared to 8.62 M Tons of CO_2eq and 10.7 M Tons of CO_2eq in 2015 and 2020, respectively. This is mostly attributed to an increase in fleet size and to growth in transportation services.
- Industrial GHG emissions will grow at a high average rate of 4.5% annually in the period 2015-2040, reaching to 7.03 M Tons of CO_2eq in 2040 compared with 2.34 M Tons of CO_2eq in 2015. The growth in emissions is due to a more developed sector and to government policies designed to increase the contribution of value-adding industrial growth opportunities to GDP.
- The share of GHG emissions from the residential sector will increase slightly from 5% (1.52 M Tons of CO_2eq) in 2015 to 6% (1.73 M Tons of CO_2eq) in 2020 and to 6.2% (2.16 M Tons of CO_2eq) in 2040.

Table 3.12 and Figure 3.9 show the sectoral GHG emissions from energy demand and supply in the baseline scenario for selected years. Table 3.13 shows the emissions by greenhouse gas in the energy baseline scenario for selected years. Carbon dioxide dominates other GHGs in the energy sector, a trend expected to continue over many years.

Table 3.12: GHG emissions (Million tons of CO_2eq) from energy demand and supply subsectors in the baseline scenario in selected years

Branches	2015	2020	2025	2030	2035	2040
Demand	13.30	15.48	17.79	20.15	22.07	23.31
Industrial	2.34	3.09	4.07	5.18	6.22	7.03
Residential	1.52	1.73	1.91	2.04	2.13	2.16
Services	0.35	0.46	0.61	0.77	0.93	1.05
Transport	8.62	9.60	10.41	11.13	11.58	11.69
Others	0.46	0.61	0.80	1.02	1.22	1.38
Transformation	12.41	11.42	4.82	7.81	6.97	8.11
Electricity generation	12.41	11.42	4.82	7.80	6.97	8.11
Total	**25.71**	**26.90**	**22.61**	**27.96**	**29.04**	**31.42**

Figure 3.9: GHG emissions (Million tons of CO_2eq) by energy subsector in the baseline scenario for selected years

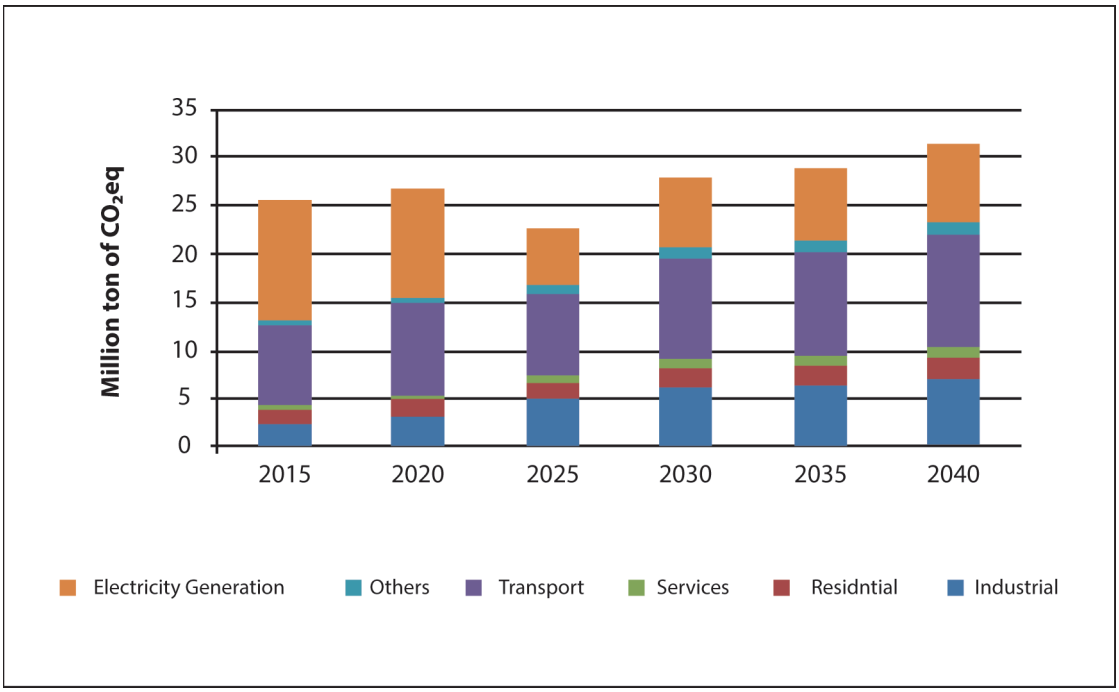


Table 3.13: GHG emissions (Million tons of CO_2eq) by gas in the energy baseline scenario for selected years

GHG	2015	2020	2025	2030	2035	2040
Carbon dioxide	25.49	26.68	22.39	27.71	28.78	31.15
Methane	0.07	0.0.6	0.07	0.07	0.08	0.08
Nitrous oxide	0.16	0.15	0.16	0.17	0.18	0.19

3.5.2 GHG emissions from the IPPU sector

The IPPU sector contributed 9% and 12% in 2010 and 2012, respectively, to the overall GHG emissions in Jordan, ranking in second place after the energy sector. It is expected to contribute 5890 Gg of CO_2eq in 2040, accounting for 13% of all GHG emissions. The cement industry is the main contributor to the IPPU sector's GHG emissions. Other contributors include the production and use of lime, limestone, soda ash, and nitric acid. Baseline emissions from the IPPU sector during the period 2015-2040 are listed in Table A.21 of Appendix A. Table 3.14 shows GHG emissions from the IPPU sector in the baseline scenario by gas in selected years.

Table 3.14: GHG emissions (Gg of CO_2eq) by gas in the IPPU baseline scenario for selected years

Year	N_2O	CO_2	Total
	Gg of CO_2eq		
2015	0.62	2474.8	2667.6
2020	0.67	3018.2	3226.5
2025	0.71	3680.9	3902.2
2030	0.76	4246.5	4480.9
2035	0.76	4899.0	5133.4
2040	0.77	5651.8	5890.5

3.5.3 GHG emissions from AFOLU sector

The AFOLU sector contributed 1% in 2010 and 2012 to the overall GHG emissions in Jordan. It is projected to contribute 3180 Gg of CO_2eq in 2040, accounting for 7% of all GHG emissions. The main contributor to AFOLU emissions is the livestock subsector. Baseline emissions from the AFOLU sector for the period 2015-2040 are listed in Table A.19 of Appendix A. Table 3.15 shows the total GHG emissions from the AFOLU sector in the baseline scenario by gas in selected years. For the AFOLU sector, the baseline scenario (the net emissions sources and sinks) was estimated using the same categories in the IPCC 2006 Guidelines.

Table 3.15: GHG emissions (Gg of CO_2eq) by gas in the AFOLU baseline scenario for selected years

Year	CH_4 emissions from livestock	N_2O emissions from managed soils	Net CO_2 emissions from land	Total CO_2eq
	Gg of CO_2eq			
2015	27.89	0.020	-197.73	394.10
2020	39.12	0.028	-137.58	692.52
2025	54.87	0.039	-95.7	1068.52
2030	76.96	0.054	-66.58	1566.30
2035	107.94	0.076	-46.32	2243.88
2040	151.39	0.106	-32.22	3179.9

3.5.4 GHG emissions from the waste sector

The waste sector is the third largest contributor to GHG emissions in Jordan according to the 2010 and 2012 GHG Inventory, accounting for 7% and 6% of all GHG emissions, respectively. Solid waste contributes the most emissions. The waste sector contribution is expected to increase to 5070 Gg of CO_2eq in 2040, accounting for a share of 11% of the total GHG emissions.

As AsSamra WWTP (the largest in Jordan) converted its operation from natural treatment method (partly anaerobic) to aerobic mode, the emissions of methane were considered to be negligible. Baseline emissions for the waste sector for the period 2015-2040 are listed in Table A.20 of Appendix A. Table 3.16 below provides a summary for selected years.

Table 3.16: GHG emissions (Gg of CO_2eq) by gas in the waste sector baseline scenario for selected years

Year	Wastewater (Gg of CO_2eq)		Solid waste (Gg of CO_2eq)	Total (Gg of CO_2eq)
	CH_4	N_2O	CH_4	
2015	0.0197	0.6225	141.00	3154.39
2020	0.0237	0.6940	156.68	3505.86
2025	0.0284	0.7738	172.69	3866.97
2030	0.0340	0.8628	185.96	4173.33
2035	0.0408	0.9619	203.05	4563.12
2040	0.0489	1.0725	225.58	5070.65

3.5.5 Overall GHG emissions in the baseline scenario

Jordan's anthropogenic emissions by sources, and removals by sinks, of all GHGs in 2010 and 2012 were 23140 Gg of CO_2eq and 27998 Gg of CO_2eq, respectively. These emissions are expected to grow according to the baseline scenario to 34330 Gg of CO_2eq, 31450 Gg of CO_2eq, 38180 Gg of CO_2eq, and 45560 Gg of CO_2eq in 2020, 2025, 2030, and 2040, respectively.

Table 3.17 shows the total GHG emissions in the baseline scenario for selected years in Jordan. Figure 3.10 and Table A.21 of Appendix A illustrate the overall GHG emissions in the baseline scenario and those of the emitting sectors of energy, industrial processes, waste, and AFOLU. Figure 3.11 shows the share of the different sectors in the baseline scenario for selected years.

Table 3.17: GHG emissions (Gg of CO_2eq) in the baseline scenario for selected years in Jordan

Year	IPPU	AFOLU	Wastewater	Solid Waste	Waste	Energy
2016	2.77	0.45	0.20	3.06	3.26	26.19
2020	3.23	0.69	0.22	3.29	3.51	26.90
2025	3.90	1.07	0.24	3.63	3.87	22.61
2030	4.48	1.57	0.27	3.91	4.17	27.96
2035	5.13	2.24	0.30	4.26	4.56	29.04
2040	5.89	3.18	0.33	4.74	5.07	31.42

Figure 3.10: GHG emissions (Gg of CO_2eq) in the baseline scenario by sector in Jordan, 2016-2040

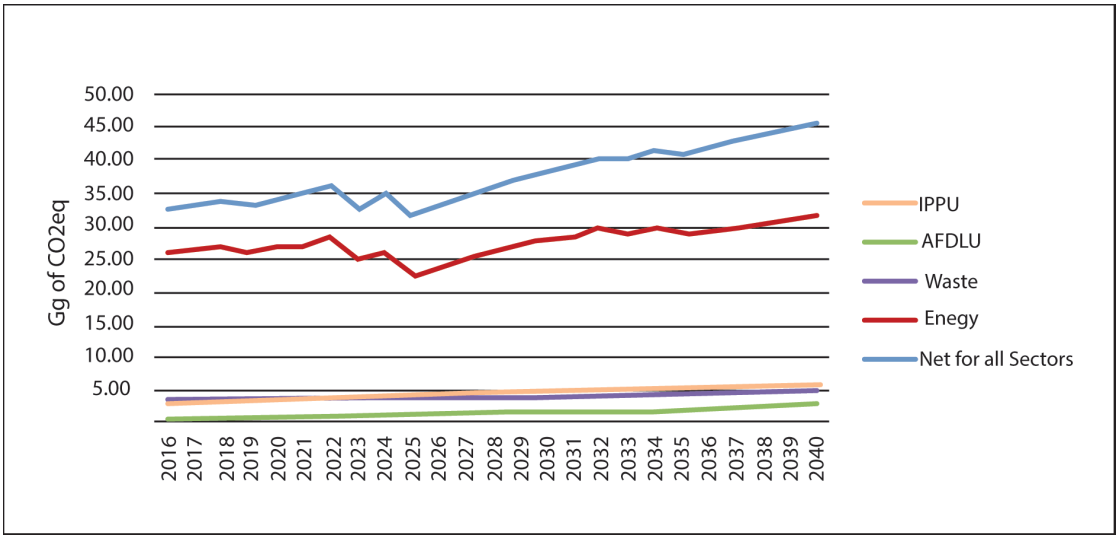
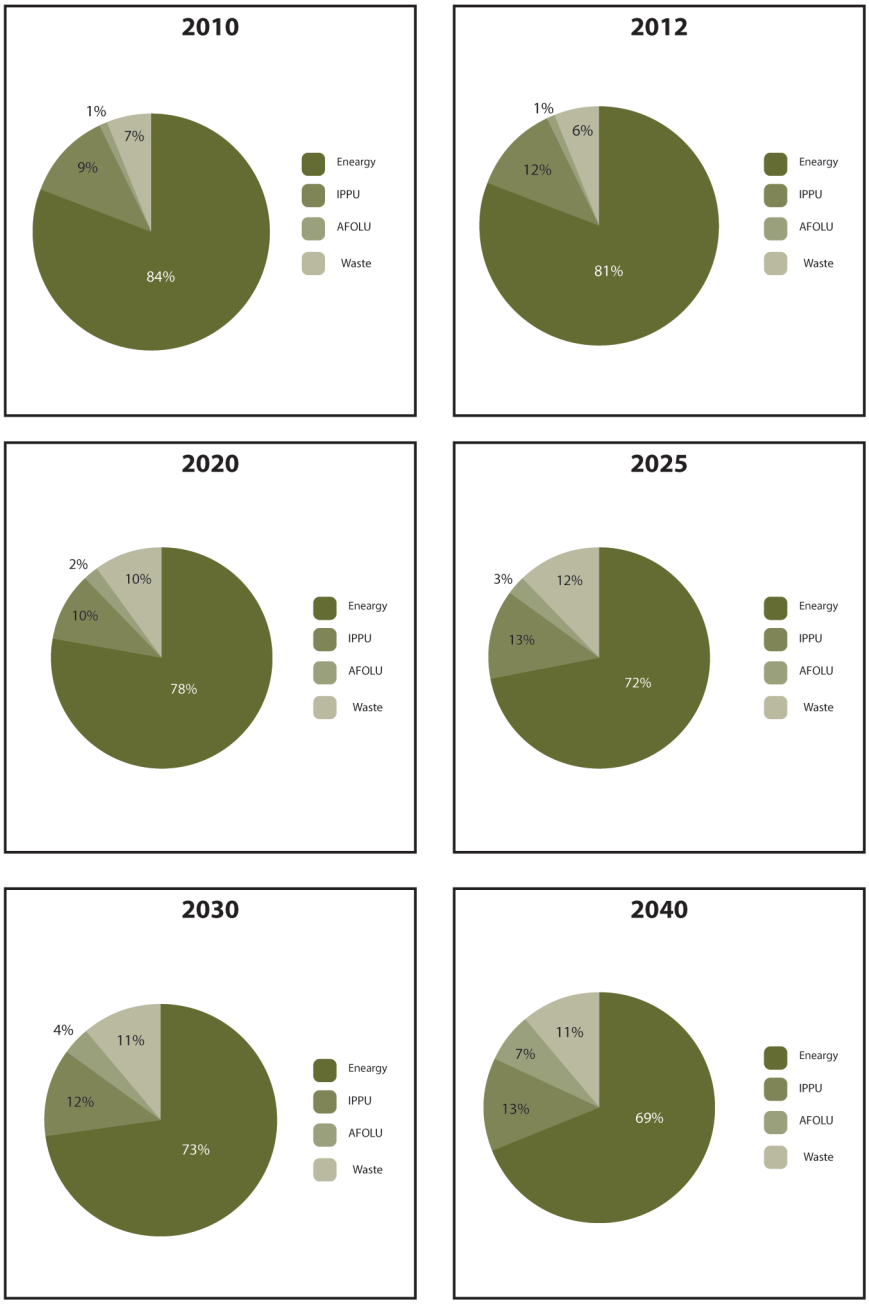


Figure 3.11: GHG emissions (%) in the baseline scenario by sector for selected years in Jordan



3.6 Mitigation Scenario for Different Sectors

According to Annex III of Decision 1/CP.17 related to the guidelines for the preparation of national BURs, non-annex I parties should provide information, in a tabular format, on actions to mitigate climate change, by addressing anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol.

For each mitigation action or groups of mitigation actions including, as appropriate, those listed in document FCCC/AWGLCA/2011/INF.1, developing country Parties shall provide the following information to the extent possible:

(a) Name and description of the mitigation action, including information on the nature of the action, coverage (i.e. sectors and gases), quantitative goals, and progress indicators;

(b) Information on methodologies and assumptions;

(c) Objectives of the action and steps taken or envisaged to achieve that action;

(d) Information on the progress of implementation of the mitigation actions and the underlying steps taken or envisaged, and the results achieved, such as estimated outcomes (metrics depending on type of action) and estimated emission reductions, to the extent possible;

(e) Information on international market mechanisms.

In the preparation of this chapter of Jordan's BUR, all mitigation projects proposed in the TNC have been reviewed and assessed to identify those options considered to be still valid and applicable. The cost-benefit analysis and the CO_2 emissions reduction have been updated for each proposed mitigation project. Additional GHG mitigation measures have also been identified, analyzed, and added to the list of the updated mitigation measures. Net present value was used in the financial calculations, by converting all present and future revenues and costs over the lifetime of the project to a base of today's cost. The same approach was followed in calculating CO_2 emissions reduction over the lifetime of the proposed projects. A discount rate of 8% was used in all calculations. The discounted unit cost of reduced emissions is the quotient of the discounted net cash flow to the discounted emissions reduction.

The LEAP software model was used to perform the energy mitigation analysis, while analysis of non-energy sectors was conducted separately and then merged with the energy analysis in the LEAP model to generate the overall national scenario. The impact of the mitigation options was assessed versus the baseline scenario. The updated mitigation scenario includes 39 GHG mitigation projects in the following areas:

- Primary energy;
- Renewable energy;
- Energy efficiency;
- Industrial processes;
- Waste; and
- Agriculture and forestry.

The results of the mitigation analysis are presented in the following sub-sections.

3.6.1 Mitigation options for primary energy

3.6.1.1 Updates on the TNC projects

The GHG mitigation options in the primary energy demand and supply that were considered in the TNC report have been reviewed and assessed. All information is presented in a tabular format in Appendix A, Table A.22. Table 3.18 is a summary of the TNC mitigation projects and their status.

Table 3.18: Status of the TNC primary energy mitigation projects

Project Name	Status
Loss Reduction in Electricity Transmission and Distribution Network	Still valid and considered in the current mitigation scenario
Improving Combustion in Rehab Power Plant	Cancelled -no longer valid
Combined Cycle Gas Turbine in Risha Plant	Cancelled due to reduction of natural gas production and delay in implementation of Risha field development
Distribution Network of Natural Gas in Aqaba	Still valid and considered in the current mitigation scenario to include Zarqa and Amman in addition to Aqaba
Demand Side Management	Still valid and considered in the current mitigation scenario
Nuclear Power Plant (1000 MW)	Moved from the TNC mitigation scenario and considered within current BUR baseline scenario according to the updated energy strategy 2015-2025

3.6.1.2 Mitigation scenario for primary energy up to 2040

Newly identified projects for the primary energy subsector as well as those that have been updated from the TNC are briefly described below.

- Loss Reduction in Electricity Transmission and Distribution (T&D) Network (TNC updated project)

This project seeks to reduce the T&D losses to 12% in 2020 compared to 16.5% in 2015. The duration of the project is 6 years and will be implemented gradually. The main components of the project will be optimizing the utilization of distribution and generation, improving the system power factor, and upgrading or replacing existing conductors and insulators with lower-resistance equipment. The cost is estimated to be USD 275 per KW. This project can lead to a significant reduction in fuel consumption and eliminate 8435 thousand tons of CO_2eq discounted emissions over the next 23 years.

- Natural Gas Distribution Network in Amman, Zarqa, and Aqaba (TNC updated and modified project)

The natural gas needed for the electricity generation during the period 2016-2022 is estimated to be 350-420 MMcfd, while in the period 2023-2025 the quantity will be decreased to 150-250 MMcfd due to the oil shale and nuclear power plant projects. The demand of the industrial sector for natural gas is estimated to be 150 MMcfd while the demand of the residential and transportation will be around 90 MMcfd in the same period.

According to the energy strategy 2015-2025, Jordan will enhance the usage of Natural Gas in all sectors such as the Industrial, Residential, Commercial and Transportation.

In 2016, 90% of the electricity generation of the Kingdom based on natural gas imported via terminals.

To deliver natural gas to smaller customers it will be necessary to construct new low-pressure gas distribution in Amman, Zarqa and Aqaba networks and to connect customers to the new infrastructure. Investments required in this industry are large. The duration of this project will be for 10 years, starting in 2020 and will be executed gradually with a capital cost of USD 110 million.

Natural gas combustion emits 1.2 times less CO_2 than that of oil, which indicates that using natural gas in demand side sector as an alternative for diesel, fuel oil, LPG and gasoline will reduce a significant quantity of CO_2 emissions. Using the natural gas in distributing network in Amman, Zarqa and Aqaba will reduce about 3442 thousand tons of CO_2eq discounted emissions in the next 20 years.

- Demand Side Management -DSM (TNC updated project)

DSM includes any actions implemented to reduce the contribution to system peak load or reduce overall energy consumption. The basic objective of DSM is to reduce costs (operating and capital costs) through improving efficiency of end uses of electricity or modifying their electricity consumption pattern which save the equivalent of adding annually 100 MW to the system. The duration of the project is about five years starting in 2018. This project will be very efficient and can lead to significant reduction in CO_2 emissions which account to 2842 thousand tons CO_2 discount emissions through the next 22 years.

- Adding a 100 MW Combined cycle in Samra Power Plant (newly identified project)

It is suggested to convert two gas turbines into combined cycle power plant by adding 100 MW steam turbine, in this configuration, a natural gas is burned to operate the two-gas turbine to generate electricity. The hot turbine exhaust gasses are passed through a steam boiler to produce steam to feed steam turbine. The steam turbine utilizes waste heat from the turbine that, in a simple cycle would have been rejected to the atmosphere. This project will add 100 MW to the plant capacity without any extra cost for additional fuel. The additional electricity increases the overall system efficiency. It is suggested that the project be implement in 2018, 2019, with a total cost of USD 80 million. The estimated CO_2 emission reduction is 3564 thousand tons CO_2eq (discounted emissions) through 21 years from 2019-2040.

The costs and CO_2 emissions reduction for the four proposed projects have been analyzed. Table 3.19 shows a summary of the results.

Table 3.19: Emissions reduction (Gg of CO_2eq) and emissions reduction unit cost (JD/ton CO_2eq) for the primary energy mitigation projects

Project Name	Total emission reductions (Gg of CO_2eq)	Reduction unit cost (JD/ ton of CO_2eq)
Loss Reduction Electricity Transmission and Distribution Network	8435	-35.61
Natural Gas Distribution Network in Amman, Zarqa and Aqaba	3442	-67.03
Demand Side Management	2842	-27.41
Adding a 100 MW Combined cycle in Samra Power Plant	3564	-24.11

3.6.2 Mitigation options for renewable energy (RE)

3.6.2.1 Updates on the TNC projects

Renewable energy (RE) GHG mitigation options that were considered in the TNC report have been reviewed and assessed. All information is presented in a tabular format in Appendix A, Table A.23. Table 3.20 is a summary of their status.

Table 3.20: Status of renewable energy (RE) mitigation projects

Project Name	Status
150 MW Wind farm	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario according to the updated energy strategy 2015-2025
100 MW Concentrated Solar Power (CSP)	Still valid and considered in the current mitigation scenario
Photo Voltaic (PV) 1-200 MW	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario according to the updated energy strategy 2015-2025
Photo Voltaic (PV) 2- 200 MW	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario according to the updated energy strategy 2015-2025
300 MW Concentrated Solar Power (CSP)	Still valid and considered in the current mitigation scenario as an additional project
Biogas Power Plant- 15 MW	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario according to the updated energy strategy 2015-2025
Solar Water Heaters 1-30000 Houses	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario according to the updated energy strategy 2015-2025
Solar Water Heaters2-30000 Houses	Still valid and considered in the current mitigation scenario as an additional project
Solar Water Heaters 3-30000 Houses	Still valid and considered in the current mitigation scenario

3.6.2.2 Mitigation scenario for renewable energy (RE) up to 2040

Newly identified projects in the RE subsector as well as those that have been updated from the TNC are briefly described below.

- 100 MW Concentrated Solar Power (CSP) (TNC updated project)

  This project has been selected based on the current development of Concentrated Solar Power in the world and it is expected that the concentrated technology will play a major role in producing electricity with a great possibility of using thermal storage to utilize excess heat during night time to ensure the continuity of power production. The proposed capacity of this project will be 100 MW as a first large-scale project of its kind with an estimated annual electricity production of around 236,520,000 KWh and a total cost of around MJD 350. It is expected that this project will be in operation by 2019.

- 300 MW CSP (TNC updated project)

  It is expected that the cost of CSP technology will decline by time and might reach 2500 JD/KW. The proposed capacity of this project will be 300 MW with an estimated annual electricity production of around 709.56 GWh and a total cost of around MJD 750. It is expected that this project will be in operation by 2023.

- Solar Water Heaters 2 - 30000 houses (TNC updated project)

  Solar water heaters are widely used in Jordan many years ago. It can save a lot of energy which is used to heat water for domestic use. It is assumed that solar water heaters will replace electric heaters and every house requires a solar water heater of 4.6 m^2 and every m^2 can produce around 740 KWh/year (applies for all proposed projects on solar water heaters in this chapter). This proposed project includes the installation of 30000 solar water heaters. The installed capacity of this project will be 54 MW with an estimated annual electricity reduction of around 102 GWh and a total cost of around MJD 13.5 (the cost is expected to decline by time). It is expected that this project will be in operation by 2018.

- Solar Water Heaters 3 - 30000 houses (TNC updated project)

  This proposed project includes the installation of 30000 solar water heaters. The installed capacity of this project will be 54 MW with an estimated annual electricity reduction of around 102 GWh and a total cost of around MJD 12 (the cost is expected to decline by time). It is expected that this project will be in operation by 2020.

- 120 MW PV-Wheeling and Net Metering (newly identified project)

  This proposed project originates as an electric power wheeling scheme, which is a methodology whereby electric power is generated by renewable energy systems and delivered over the transmission and/or distribution network and its associated facilities to a specific customer, which may be used to offset the electric power provided by the electricity company to the same customer during a billing period.

The cost and the CO_2 emissions reduction for the five RE proposed projects have been analyzed. A summary of the results is shown in Table 3.21.

Table 3.21: Emissions reduction (Gg of CO_2eq) and emissions reduction unit cost (JD/ton of CO_2eq) for renewable energy mitigation projects

Project Name	Total emissions reduction (Gg of CO_2eq)	Reduction unit cost (JD/ ton of CO_2eq)
100 MW Concentrated Solar Power (CSP)	3158	57.22
300 MW Concentrated Solar Power (CSP)	7415	-25.59
Solar Water Heaters 2-30000 Houses	1362	-145.62
Solar Water Heaters 3-30000 Houses	1362	-145.62
120 MW PV-Wheeling and Net Metering	8380	1.21

3.6.3 Mitigation options for energy efficiency (EE)

3.6.3.1 Updates on the TNC projects

Energy efficiency (EE) GHG mitigation options that were considered in the TNC report have been reviewed and assessed. All information is presented in a tabular format in Appendix A, Table A.24. Table 3.22 is a summary of their status.

Table 3.22: Status of the energy efficiency (EE) mitigation projects

Project Name	Status
Replacing High Thermal Mass with Low Thermal Mass (LTM) in Ceramic factories	Still valid and considered in the current mitigation scenario
Returning Un-Returned Condensate to the Feed Water Tanks in Food Industry	Still valid and considered in the current mitigation scenario
Insulating the un-insulated pipes, fittings and tanks in food industries	Still valid and considered in the current mitigation scenario
Replacing the Fluorescent lamps fixtures with LED lamps fixtures in commercial buildings	Still valid and considered in the current mitigation scenario
Insulating walls and roofs in 35000 new houses	Still valid and considered in the current mitigation scenario
Street Lighting: Replacing 125 W Mercury lamps with 70 W high Pressure Sodium lamps	Still valid and considered in the current mitigation scenario
Using Regenerative burners instead of conventional burners in Steel Reheating Industry	Still valid and considered in the current mitigation scenario
Using Variable Speed Drives in the Pumps	Still valid and considered in the current mitigation scenario

3.6.3.2 Mitigation scenario for energy efficiency up to 2040

The newly identified projects and the valid ones from the TNC in the EE subsector are briefly described below:

- Replacing High Thermal Mass with Low Thermal Mass in Ceramic Factories (TNC updated Project)

  This proposed project will be implemented gradually starting from 2019 up to 2040, with 0.4 kton CO_2eq as average rate of GHGs reduction annually.

- Returning Un-returned condensate to the feed water tanks in food industry (TNC updated Project)

  This proposed project will be implemented gradually starting from 2020 up to 2040, with 0.74 kton CO_2eq as average rate of GHGs reduction annually.

- Insulating Un-Insulated Pipes, Fitting and Tanks in Food Industries (TNC updated Project)

  This proposed project will be implemented gradually starting from 2020 up to 2040, with 0.78 kton CO_2eq as average rate of GHGs reduction annually.

- Replacing The Florescent Lamps Fixtures with LED Lamp Fixture In Commercial Buildings (TNC updated Project)

  Fluorescent tubes units (4X18 watt) are widely used in commercial office buildings. All these fluorescent tubes have conventional ballasts. Replacing these units with (18X4) LED fixtures will result in 60 Watts saving in each fixture. The Government of Jordan represented by the MEMR and particularly JREEEF will initiate this process and distribute 100 000 LED lamps.

- Insulating Walls and Roofs In 35 Thousand Houses (TNC updated Project)

  This proposed project will be implemented gradually starting from 2018 up to 2040, with 8.53 kton CO_2eq as average rate of GHGs reduction annually.

- Street Lighting: Replacing 125 W Mercury lamps with 70 W high Pressure Sodium lamps (TNC updated Project)

  In street lighting, it is suggested to replace 200,000 lamps that are now of Mercury type with lamps of High Pressure Sodium (HPS).

- Using Regenerative Burners Instead Of Conventional Burners in Steel Reheating Industry (TNC updated Project)

  This proposed project will be implemented gradually starting from 2018 up to 2040, with 7.47 kton CO_2 eq as average rate of GHGs reduction annually.

- Using variable speed drives in the pumps (TNC updated project)

  This proposed project will be implemented gradually starting from 2019 up to 2040, with 8.53 kton CO_2 eq as average rate of GHGs reduction annually.

- LED Lighting in Public Buildings (Newly identified project)

  This measure intends to distribute 10-watt Tube- 35000 LED Lamps in public buildings. The LED lamps will replace the existing 4x18 watt fluorescent lamps. By distributing these lamps, it is estimated that energy savings will be more than 40% of the fluorescent lighting consumption. Every 18-watt fluorescent lamp will be replaced by 10-watt LED lamp.

- Improving Energy Efficiency in Small and Medium Hotels (newly identified project)

  The program that will be initiated by JREEEF aims at improving energy efficiency in small and medium existing hotels in Jordan. The owners of these hotels have limited internal funds to invest in EE projects and poor access to commercial financing and lack of knowledge and awareness of the available technologies. The program will consist of financial and technical support, combined with awareness and communication campaigns to undertake appropriate energy efficient measures in this category of hotels. All energy efficiency measure

can be eligible, including envelope insulation, improvement of air conditioning and heating equipment, efficient lighting, etc. The program can target 100 to 120 small and medium hotels throughout Jordan. The program will lead to an annual energy savings of 10,000,000 KWh with a reduction in emissions of around 5.8 kt CO_2

- LED Lighting in Households (newly identified project)

  This measurer intends to distribute 150 000 E27-LED Lamps for residential sector (specifically for low consumption households class (< 600 KWh/month). In addition, energy efficiency, the objective is also to reduce energy poverty and vulnerability of the poor and medium classes.

  The Government of Jordan represented by MEMR and particularly JREEEF will initiate this process and distribute 150 000 LED lamps.

The costs and the CO_2 emissions reduction for the proposed EE projects have been analyzed. A summary of the results is shown in Table 3.23.

Table 3.23: Emissions reduction (Gg of CO_2eq) and emissions reduction unit cost (JD/ton of CO_2eq) for the energy efficiency mitigation projects

Project Name	Total emissions reduction (Gg of CO_2eq)	Reduction unit cost (JD/ton of CO_2eq)
Replacing high thermal mass with low thermal mass (LTM) in ceramic factories	8	-26.43
Returning un-returned condensate to the feed water tanks in food processing	140	-62.95
Insulating un-insulated pipes, fittings, and tanks in food processing	150	137.12
Replacing fluorescent lamp fixtures with LED lamp fixtures in commercial buildings	130	-8.16
Insulating walls and roofs in 35,000 new houses	186	-137.64
Street lighting: Replacing 125 W mercury lamps with 70 W high pressure sodium lamps	740	-14.75
Using regenerative burners instead of conventional burners in steel reheating	164	-13.21
Using variable speed drives in pumps	187	-16.21
LED lighting in public buildings	40	6.12
Improving energy efficiency in small and medium size hotels	160	6.44
LED lighting in households	1700	-24.21

3.6.4 Mitigation options in the transportation sector

GHG mitigation options in the transportation sector that were considered in the TNC report have been reviewed and assessed. Table 3.24 is a summary of their status. All TNC projects are now considered as part of the baseline scenario. No new projects have been suggested in this FBUR because of the lack of expertise in this sector at the national level as well as the lack of clarity in responsibilities and mandates among different acting institutions within the sector.

Table 3.24 Status of mitigation projects in the transportation sector

Project Name	Status
Reduction by using hybrid cars for public passengers	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario
Reduction by Amman – Zarqa Bus Rapid Transit (BRT)	Moved from the TNC mitigation scenario and considered as part of the current BUR baseline scenario

3.6.5 Mitigation options in the IPPU sector

3.6.5.1 Updates on the TNC projects

GHG mitigation options in the IPPU sector that were considered in the TNC report have been reviewed and assessed. Relevant information is presented in a tabular format in Appendix A, Table A.25. Table 3.25 is a summary of their status.

Table 3.25: Status of the IPPU mitigation projects

Project Name	Status,
Use of steel slag and/or fly ash to substitute the raw materials needed to produce clinker	Still valid and considered in the current mitigation scenario
Increase the percentage of Pozzolana in CEM II cement	Still valid and considered in the current mitigation scenario
Produce new cement product CEM IV with 45% of Pozzolana	Still valid and considered in the current mitigation scenario
Use of biomass (MSW or/and Sewage Sludge) as alternative fuels	Still valid and considered in the current mitigation scenario
Catalytic Reduction of N_2O inside the Ammonia Burner of the Nitric Acid Plant	Still valid and considered in the current mitigation scenario

3.6.5.2 Mitigation scenario for the IPPU sector up to 2040

Updated and valid projects from the TNC in the IPPU sector are briefly described below.

- Use of steel slag and/or fly ash to substitute the raw materials needed to produce clinker at the selected cement plant (TNC updated project)

Certain steel slag and fly ash materials (de-carbonated kiln feedstocks) could be added to the raw material feed to reduce the amount of raw material needed to produce a given amount of clinker. Jordan has more than 5 steel melting and galvanizing factories, therefore; there is available stock of steel slag and fly ash to be used in cement industry.

In this mitigation project, it is suggested to produce new type of cement CEM V (Composite Cement) at one of the cement industries; mainly the one that has a neighbor steel manufacturing company and can try the production of such type of cement with minor additional costs in comparison to other existing companies. The percentages of blast-furnace slag and natural pozzolana ranges between 31-49% per each to produce CEM V/B. Accordingly, a 40% substitution of steel slag/fly ash and a 10% production of new CEM V/B will be assumed at this company.

The price of steel slag and/or fly ash is estimated to be 23.1 JD/ton available cost of 25-40 USD/ton). The cost of energy and raw materials reach 61% of total cost and based on the assumption of production cost of 49 JD/ton cement, this option will reduce the cost by 29.9 JD/ton cement. No annual increase in the production costs will be assumed for the period (2018 – 2040). Investment cost to grind the steel slag will be estimated as 911,564 JD (based on the maximum produced tons of CEM II in 2040) based on the estimated cost of 0.75 USD/ton cement.

- Increase the percentage of Pozzolana in CEM II (TNC updated project)

Blended cement is a mixture of clinker and additives containing less than 95% clinker. Blended cement types are distinct products with different uses that have different additives and different shares of clinker. More than 90% of cement produced at the local cement companies is CEM II (Portland–Pozzolana Cement) with a percentage of Pozzolana ranges between 21-32%. Therefore; there is an area to increase the percentage of Pozzolana in CEM II by improving the reactivity of the produced clinker and the raw mix to produce CEM II/B-P to achieve the required strength of 42.5N that cause the use of Pozzolana of less than 32% (the 3% is substituted by gypsum). Based on the provided data from one of the Cement Companies, the average percentage of Pozzolana in CEM II is around 32% (65% clinker as per the following information and calculations and 3% Gypsum), so this option is not required to be implemented for this company. A reasonable 2% more substitution could be assumed on average and so a reduction of CO_2 emissions by 2% could be assumed as well.

Since all local cement companies produce CEM II, there is no need for investment to construct the equipment needed to receive, store, grind and meter Pozzolana to the cement product. The operational cost includes the price of extraction to Natural Resources Authority (NRA) and transportation. However; this option will reduce the cost of raw materials (mainly limestone) and energy needed to produce the saved clinker that will be substituted by Pozzolana. To have time for the experimental trials, it is expected to start the implementation of such project in 2018. The project lifetime will be as the lifetime of Cement Plants which expected to be more than 50 years.

The price of pozzolana is estimated to be 20 JD/ton. And as mentioned above, this option will reduce the cost by 29.9 JD/ton cement to save both energy and raw materials and no extra investment cost is needed.

- Produce new cement product CEM IV with 45% of Pozzolana (TNC updated project)

It is estimated that 10% of currently produced CEM II/B-P will be changed to CEM IV, strength 22.5X in which the Pozzolana substitution will reach 45% (more by at least 13% (=45-32)). CO_2 reduction will be calculated by multiplying the annual CO_2 emissions by the reduced percentage of 13% regarding that for our case this percentage will be also multiplied by the percentage of the products that will be converted from CEM II/B-P to CEM IV which is assumed to be 10% of CEM II/B-P. Therefore; annual CO_2 emissions from producing CEM II/B-P will be multiplied by 1.3% to calculate the CO_2 emissions reduction because of implementing this option.

To have time for the experimental trials, marketing the new product, set the legally binding regulations and enforcement measures to control its use, it is expected to start the implementation of such project in 2018. The project lifetime will be as the lifetime of Cement Plants which expected to be more than 50 years. The price of pozzolana is estimated to be 20 JD/ton. And as mentioned above, this option will reduce the cost by 29.9 JD/ton cement to save both energy and raw materials and no extra investment cost is needed.

- Use of biomass (MSW or/and Sewage Sludge) as alternative fuels (TNC updated project)

A potential reduction of CO_2 emissions in cement industry could be achieved by switching from a traditional fossil fuel to a biomass fuel which is based on the specific emission factor for the fuel as related to its calorific value and carbon content. Most organic materials have a calorific value of 9-16 GJ/ton cement, while the main firing of a cement kiln requires at least 18-20 GJ/ton cement. Therefore; biomass shall be blended with other fuels.

Since most of local cement factories are licensed to burn coal, petcoke and alternative fuels such as waste tires, oil shale and used oil to replace the expensive heavy fuel oil, they are equipped with multi-purpose burners which reduce the investment costs for using biomass as alternative fuels. However, the required capital cost depends on the needed storage, segregation, handling, grinding and metering as well as environmental pollution control measures.

To have time for the experimental trials, studies of the maximum percentage of MSW and dried sewage sludge to be used, availability of stocks at market, testing the emissions, conduct EIA study and get the environmental clearance; it is expected to start the implementation of such project in 2018. The project lifetime will be as the lifetime of Cement Plants which expected to be more than 50 years.

- Catalytic reduction of n_2o inside the ammonia burner of the nitric acid plant (TNC updated project)

The project activity involves the installation of a new N_2O abatement technology that is not commonly used in nitric acid plants. The abatement technology is a pelleted catalyst that will be installed inside the ammonia burner just underneath the precious metal gauzes. This technology is capable to reduce approximately 75% to 80% of the N_2O formed at the precious metal gauzes inside the ammonia burner to atmospheric N_2 and O_2.

The precious metal gauzes suffer a continuous loss of metal therefore; they are replaced during specific period known as campaign. The average production per campaign is 30,000 tons of 100% nitric acid). The selected N_2O abatement technology depends on replacing some of Al_2O_3 balls that support the platinum-rhodium catalyst by base metal secondary catalyst, which is capable of reducing N_2O by at least 75%.

There are no economic benefits, enforcement regulations or pollution abatement benefits of implementing such project, it only aims at reducing the GHG emissions, therefore; its implementation strongly depends on having economic incentives. The project is assumed to start in 2018 and its lifetime is estimated to be same as the lifetime of KEMAPCO plant which is estimated to be 25 years (till the year 2040).

The costs and the CO_2 emissions reduction for the proposed IPPU mitigation projects have been analyzed. A summary of the results is shown in Table 3.26.

Table 3.26: Emissions reduction (Gg of CO_2eq) and emissions reduction unit cost (JD/ton of CO_2eq) for the IPPU mitigation projects

Project Name	Total reduction for the project lifetime (Gg of CO_2eq)	Mitigation cost (JD/ton of CO_2eq)
Use of steel slag and/or fly ash to substitute the raw materials needed to produce clinker	226.9	-9.4
Increase the percentage of Pozzolana in CEM II cement	591.3	-19.0
Produce new cement product CEM IV with 45% of Pozzolana	312.7	-19.0
Use of biomass (MSW or/and Sewage Sludge) as alternative fuels	1,427.6	-32.0
Catalytic Reduction of N_2O inside the Ammonia Burner of the Nitric Acid Plant	1,433.3	0.9

3.6.6 Mitigation options in the AFOLU sector

3.6.6.1 Updates on the TNC projects

GHG mitigation options in the AFOLU sector that were considered in the TNC report have been reviewed and updated. Relevant information is presented in a tabular format in Appendix A, Table A.26. Table 3.27 is a summary of their status.

Table 3.27: Status of the AFOLU mitigation projects

Project Name	Status
Forestry- Introduce new plantations in urban areas	Still valid and considered in the current mitigation scenario
Forestry- Introduce new plantations in Northern Area	Still valid and considered in the current mitigation scenario
Rangeland 1- Restoration of rangeland areas	Still valid and considered in the current mitigation scenario
Rangeland 2- New Protected rangeland area as Natural Reserve	Still valid and considered in the current mitigation scenario
Promoting for Climate-smart agricultural practices in the Jordan Valley	Still valid and considered in the current mitigation scenario

3.6.6.2 Mitigation scenario for the AFOLU sector up to 2040

Updated and valid projects from the TNC in the AFOLU sector are briefly described below:

- Forestry- Introduce new plantations in Urban Areas

No formal estimations were published for the losses in urban trees due to snow storms, however some numbers estimations were published in the local newspapers. A review of those articles on average they were as follows:

Greater Amman municipality estimated a loss of 2100 pine and coniferous trees from public parks.

Jordan University estimated a loss of 1000 trees.

Royal Scientific Society estimated a loss of 400 trees.

Total number of trees suggested by the project= 3500 medium size coniferous trees.

A medium growth coniferous tree, planted in an urban setting and allowed to grow for 10 years, sequesters 0.039-ton CO_2 per planted tree.

- Forestry- Introduce new plantations in Northern Area

No formal estimations were published for the losses in trees, but numbers in the local newspapers on average declared losses from Ajloun and Jerash were 26 000 trees.

26 000 trees will be planted over five years

10 000 Jerash ➔ 2000 tree per year

16 000 Ajloun ➔ 4000 first year and then 3000 trees per year

- Rangelands Project 1: Restoration of Rangeland Areas

Jordan natural rangelands play an important role in covering the livestock feed requirements. In spite of the damage, they sustained during the past five decades the livestock feed. They cover feed requirements for a period of 2- 3 months without complimentary feeding or 30% of food requirements. The productivity of rangelands is highly dependent on rainfall, topography and soil. Feed unit productivity of rangelands is estimated at 40 kilograms of dry feed matter per dunum in areas with 100-200 mm of annual rainfall; and 100 kilograms per dunum in the areas that receive more than 200 mm. The Project suggest planting rangelands with perennial fodder shrubs in the Badia (AlJafr and AlHusseinieh) sub-districts within the Ma'an Governorate.

- Rangelands Project 2: New Protected Rangeland Area as Natural Reserve

The total area of natural grazing land in the Desert (Badia) is approximately 70 million dunum which are concentrated in the area that receives less than 100 mm/year rainfall as short thundershowers and rainfall amounts decrease towards the east and the south till it reaches 50 mm/year or even less. Of these 70 million dunum only 1 million dunum is considered as natural reserves. The project suggests increasing the protected area by another 100 000 dunum namely in the wide desert valleys south Badia. The project will harness direct benefit for protection of floral biodiversity through controlling the grazing of the indigenous Atriplex halimus shrubs. Much of this area is covered with chert and an underlying thin layer of fine textured soil.

Artemisia herba- alba, Retama raetam, Achillea fragrantissima, Atriplex halimus and Poa bulbosa are common in the wadi beds. Despite its deterioration this region is known to be the main grazing land in Jordan. The project will achieve reductions through CO_2 emissions offset from natural soil carbon release caused by rangeland deterioration. The project will harness direct benefit for soil resources through rain harvest techniques as well as soil erosion control techniques (erosion is caused from flash floods flow).

The average annual dry matter production is 4 kg/dunum in normal years and when protected can be increased to 15 kg/dunum in the range reserves.

It is assumed to have an average of 35 average sized shrub/dunum and the sequestration rate is 4 g SOC/m^2/year. A lifetime of 15 years will be assumed for calculations purposes.

- Promoting for Climate-smart agricultural practices in the Jordan Valley

Climate smart agriculture is not a new agricultural system, nor is it a set of practices. It is a new approach, a way to guide the needed changes of agricultural systems, given the necessity to jointly address food security and climate change. It contributes to the achievement of sustainable development goals and integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. It is composed of three main pillars: Sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; reducing and/or removing greenhouse gases emissions, where possible.

Sustainable crop production, controlled grazing and maintained forest systems can sequester substantial and variable amounts of carbon from the atmosphere and store it in soils and vegetation. Carbon sequestration will not only stabilize climate but will also make agricultural increase the overall resilience of the agro-ecosystems. Widespread adoption of climate-smart practices has the potential to make major contributions to the achievement of national food security and development goals. The costs and the CO_2 emissions reduction for the proposed AFOLU mitigation projects have been analyzed. A summary of the results is shown in Table 3.28.

Table 3.28: Emissions reduction (Gg of CO_2eq) and emissions reduction unit cost (JD/ton of CO_2eq) for the AFOLU mitigation projects

Project Name	Total reduction for the project lifetime (Gg of CO_2eq)	Mitigation cost (JD/ ton of CO_2eq)
Forestry- Introduce new plantations in urban areas	2730	56
Forestry- Introduce new plantations in Northern Area	18330	58
Rangeland 1- Restoration of rangeland areas	12736.8	1356
Rangeland 2- New Protected rangeland area as Natural Reserve	21228	1922
Promoting for Climate-smart agricultural practices in the Jordan Valley	9540	-1335

3.6.7 Mitigation options in the waste sector

3.6.7.1 Updates on the TNC projects

GHG mitigation options in the waste sector that were considered in the TNC report have been reviewed and assessed. Relevant information is presented in a tabular format in Appendix A, Table A.27. Table 3.29 shows a summary of their status.

Table 3.29: Status of the waste sector mitigation projects

Project Name	Status
Biogas collection and utilization from Al-Dhulil domestic solid waste landfill	Still valid and considered in the current mitigation scenario
Biogas collection and utilization from Al-Ekader domestic solid waste landfill	Moved from the TNC mitigation scenario and considered in the current baseline scenario
Biogas collection and utilization from Al-Salt (Homra) domestic solid waste landfill	Still valid and considered in the current mitigation scenario
Biogas collection and utilization from Al-Karak domestic solid waste landfill	Still valid and considered in the current mitigation scenario
Biogas collection and utilization from Maddaba domestic solid waste landfill	Still valid and considered in the current mitigation scenario
Biogas generation by utilizing the sludge generated from Baqa'a tertiary domestic wastewater treatment plant	Still valid and considered in the current mitigation scenario
Biogas generation by utilizing the sludge generated from Maddaba domestic wastewater treatment plant	Still valid and considered in the current mitigation scenario
Biogas generation by utilizing the sludge generated from Ramtha domestic wastewater treatment plant	Still valid and considered in the current mitigation scenario
Biogas generation by utilizing the sludge generated from Salt domestic wastewater treatment plant	Still valid and considered in the current mitigation scenario
Biogas generation by utilizing the sludge generated from Wadi Arab domestic wastewater treatment plant	Still valid and considered in the current mitigation scenario

3.6.7.2 Mitigation scenario for the waste sector up to 2040

The updated and still valid projects from the TNC in the waste sector are briefly described below:

- Biogas collection and utilization from Al-Dulail, Al-Karak, Al-Salt and Madaba domestic solid waste landfill sites (TNC modified- four projects grouped together based on similarities)

  A considerable amount of biogas produced from the four landfills without any utilization. The four proposed projects aim at collecting the generated biogas, treating the biogas from impurities, generating the electricity using biogas generator and connecting the generated electricity to the national electricity grid. The suggested projects will contribute in reducing the amount of fuel used for the electricity generation.

- Biogas Generation By Utilizing The Sludge Generated From Ramtha, Wadi Arab, Baqa, Salt And Madaba Domestic Wastewater Treatment Plant (TNC modified- five projects grouped together based on similarities)

  A considerable amount of sludge produced from the wastewater treatment plants without any utilization. The five proposed projects aim at generating biogas from the sludge and connecting the generated electricity to the national electricity grid. These projects will contribute in reducing the amount of fuel used for the electricity generation.

The following assumptions were used during the update of waste projects:

- The starting year for implementing the proposed projects is 2018.
- Construction activities, commissioning, and testing will take 1 year (the actual operation for the proposed projects will be in 2019).
- Density of methane is 0.717 kg/m3.
- The captured methane from all landfills is calculated according to the PRIF study (Environment and use of methane from municipal waste in Amman, 1993), where the average value is used.
- Electricity-specific emission factors for grid electricity $kgCO_2/KW$ adopted from www.ecometric.com
- The calculation of generated electricity in MW is based on 8,000 working hours per year.
- The generated electricity will be sold at a fixed price of 0.06 JD/kWh.
- The cost of a 1 MW biogas electricity generation system (generator, wells, piping, etc.) is 1,500,000 JD, according to the International Renewable Energy Agency (ARENA).
- The fixed annual cost is the sum of maintenance, operation, overhead, and supervision costs (10% of capital investment, according to ARENA).

All mitigation options under the waste sector were considered as energy measures because the biogas will be used for electric power generation. The cost and the CO_2 emission reduction are analyzed for the 9 proposed projects. A summary of the results is shown in following table.

Table 3.30: Emissions reduction (Gg of CO_2eq) and emissions reduction unit cost (JD/ton of CO_2eq) for the waste mitigation projects

Project Name	Total reduction for the project lifetime (Gg of CO_2eq)	Mitigation cost (JD/ton of CO_2eq)
Biogas collection and utilization from Al-Dhulil domestic solid waste landfill	721.36	3.6
Biogas collection and utilization from Al-Salt (Homra) domestic solid waste landfill	1443.43	3.6
Biogas collection and utilization from Al-Karak domestic solid waste landfill	1443.43	4.5
Biogas collection and utilization from Maddaba domestic solid waste landfill	721.36	4.5
Biogas generation by utilizing the sludge generated from Ramtha domestic wastewater treatment plant	218.98	-1.8
Biogas generation by utilizing the sludge generated from Wadi Arab domestic wastewater treatment plant	701.32	0.98
Biogas generation by utilizing the sludge generated from Baqa'a tertiary domestic wastewater treatment plant	353.29	-5.2
Biogas generation by utilizing the sludge generated from Salt domestic wastewater treatment plant	482.35	0.43
Biogas generation by utilizing the sludge generated from Maddaba domestic wastewater treatment plant	263.39	1.8

3.6.8 Main results of the mitigation analysis

3.6.8.1 Overall GHG mitigation scenario

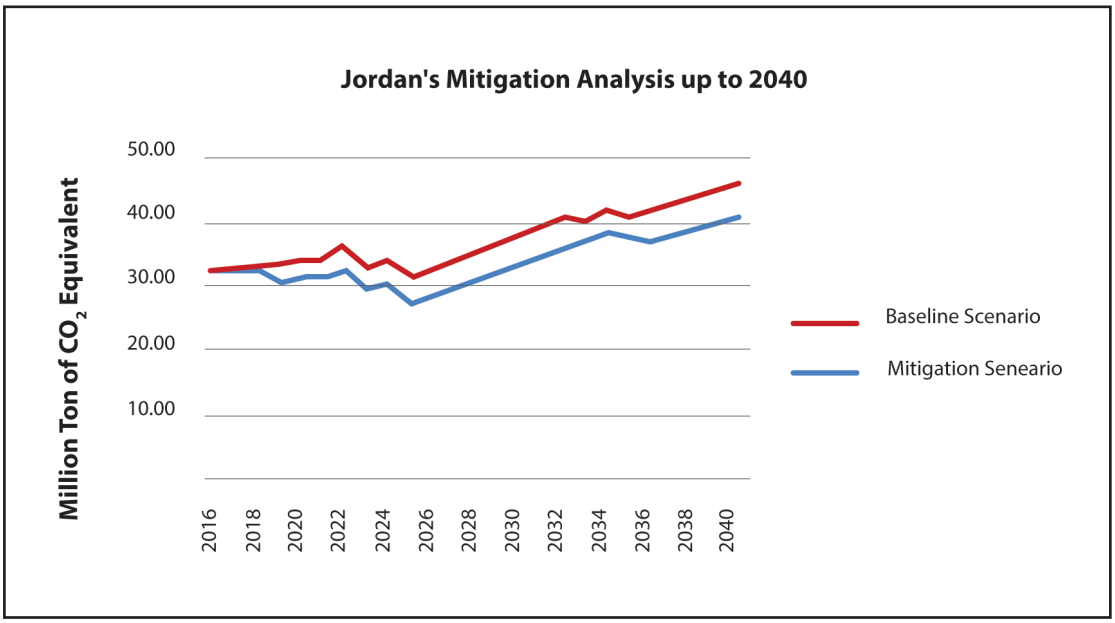
Thirty-nine GHG mitigation projects have been proposed in several sectors and subsectors including primary energy, renewable energy, energy efficiency, waste, and agriculture. The cumulative GHG emissions reduction in 2025 and 2040 were 7.85 and 9.32 million Ton of CO_2eq, respectively.

The complete data set to 2040 is presented in Table A.28, Appendix A. Table 3.31 shows net emissions reduction from the mitigation scenario and cumulative reduction for selected years. Figure 3.12 shows the mitigation scenario compared with the baseline scenario up to 2040.

Table 3.31: GHG net emissions reduction (Mton of CO_2eq) from the baseline scenario and the mitigation scenario, and cumulative emissions reduction for selected years

Year	Baseline Scenario	Mitigation Scenario	Avoided	Cumulative Reduction
	Million Ton of CO_2 Equivalent			
2020	34.33	31.65	2.68	4.95
2025	31.45	27.44	4.01	7.85
2030	38.18	33.64	4.53	9.46
2035	40.99	38.07	2.92	5.96
2040	45.56	40.73	4.83	9.32

Figure 3.12: Mitigation scenario compared with the baseline scenario, 2016-2040



3.6.8.2 GHG mitigation abatement cost analysis

Thirty-nine GHG mitigation projects have been proposed in several sectors and subsectors including primary energy, renewable energy, energy efficiency, waste, and agriculture. In addition to CO_2 emissions reduction, a cost-benefit analysis has been performed for each proposed mitigation project.

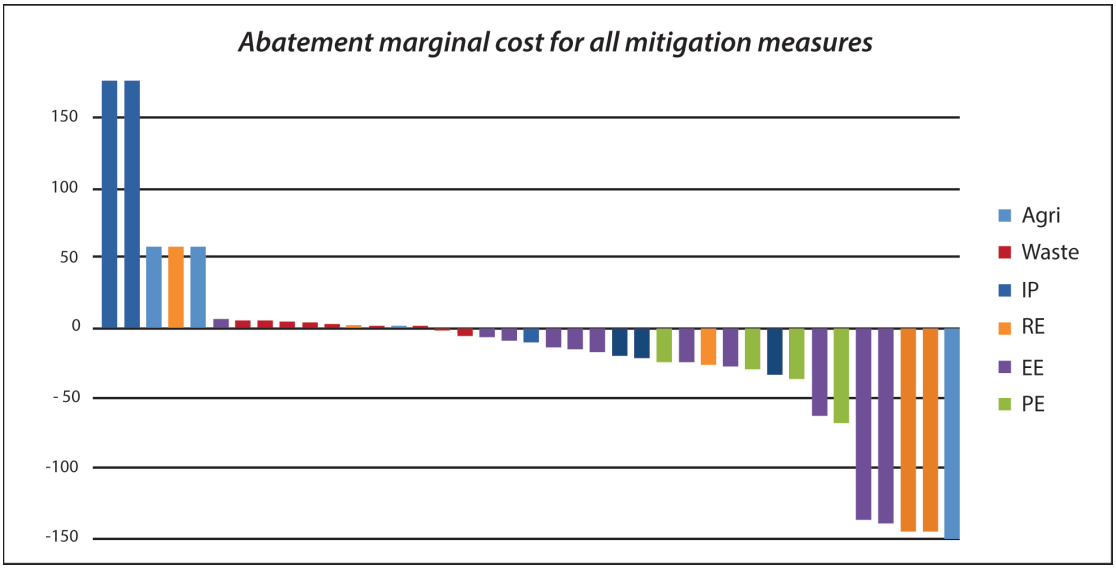
Based on calculated unit abatement costs and the abatement marginal cost curve, in general; the most feasible options are the energy mitigation projects. The findings indicate that energy efficiency and renewable energy should receive the most attention. Table 3.32 and Figure 3.13 show the abatement marginal cost for all mitigation measures ranked from the highest to the lowest. Figure 3.14 shows the mitigation projects grouped by sector.

Table 3.32: All proposed mitigation projects ranked from the highest GHG reduction cost (JD/ ton CO_2 eq) to the lowest cost

	Project Name	Emissions Reduction Unit Cost (JD/ton of CO_2eq)
1	Rangeland 2- New Protected Rangeland Area as Natural Reserve	1922
2	Rangeland 1- Restoration of Rangeland Areas	1356
3	Forestry- Introduce new plantations in Northern Area	58
4	100 MW Concentrated Solar Power (CSP 1)	57.22
5	Forestry- Introduction of new plantations in Urban Areas	56
6	Improving Energy Efficiency in Small and Medium Hotels	6.44
7	Biogas collection and utilization from Al-Salt (Homra) domestic solid waste landfill	4.5
8	Biogas collection and utilization from Al-Karak domestic solid waste landfill	4.5
9	Biogas collection and utilization from Maddaba domestic solid waste landfill	3.6
10	Biogas collection and utilization from Al-Dhulil domestic solid waste landfill	3.6
11	Biogas generation by utilizing the sludge generated from Madaba domestic wastewater treatment plant	1.8
12	120 MW PV-Wheeling and Net Metering	1.21
13	Biogas generation by utilizing the sludge generated from Wadi Arab domestic wastewater treatment plant	0.98
14	Catalytic Reduction of N_2O inside the Ammonia Burner of the Nitric Acid Plant	0.9
15	Biogas generation by utilizing the sludge generated from Baqa'a tertiary domestic wastewater treatment plant	0.43

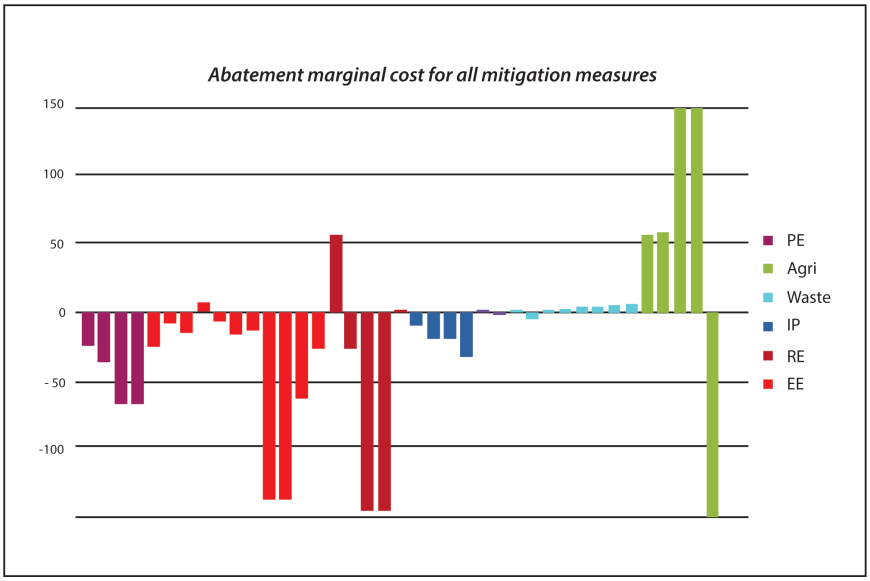
	Project Name	Emissions Reduction Unit Cost (JD/ton of CO_2eq)
16	Biogas generation by utilizing the sludge generated from Ramtha domestic wastewater treatment plant	-1.8
17	Biogas generation by utilizing the sludge generated from Salt domestic wastewater treatment plant	-5.2
18	LED Lighting in Public Buildings	-6.12
19	LED Lighting in Commercial Buildings	-8.16
20	Use of steel slag and/or fly ash to substitute the raw materials needed to produce clinker	-9.4
21	Using regenerative burners instead of conventional burners in steel industry	-13.21
22	High Pressure Sodium Street Lighting	-14.75
23	Using variable speed drives in pumps	-16.21
24	Increase the percentage of Pozzolana in CEM II	-19
25	Produce new cement product CEM IV with 45% of Pozzolana	-19
26	Samra Combined Cycle	-24.11
27	LED Lighting in Households	-24.21
28	300 MW Concentrated Solar Power (CSP 2)	-25.59
29	Replacing high thermal mass with low thermal mass in ceramic factories	-26.43
30	Demand side management	-27.41
31	Use of biomass (domestic solid waste or/and sewage sludge) as alternative fuels in cement plants	-32
32	Loss reduction in transmission and distribution	-35.61
33	Returning un-returned condensate to the feed water tanks in food industry	-62.95
34	Natural gas distribution network in amman, zarqa and aqaba	-67.03
35	Insulating pipes, fittings and tanks in food industries	-137.12
36	Insulating walls and roofs in 35000 houses	-137.64
37	Solar water heaters 2- 30000 houses	-145.62
38	Solar water heaters 3- 30000 houses	-145.62
39	Promoting climate-smart agricultural practices in the jordan valley	-1335

Figure 3.13: Abatement marginal cost (JD/ton of CO_2eq) for all mitigation measures ranked from the highest reduction cost to the lowest (for projects 1, 2, and 39, reduction costs are 1922, 1356 and -1335 JD/ton of CO_2eq, respectively)



* Legend: Agri- Agriculture projects, waste- waste projects, IP- Industrial Processes projects, RE- Renewable Energy Projects, EE- Energy Efficiency Projects and PE-Primary Energy Projects)

Figure 3.14 Abatement marginal cost (JD/ton of CO_2eq) for all mitigation measures grouped by sector



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DOMESTIC MEASUREMENT, REPORTING, AND VERIFICATION

4.1 Introduction

The historic Paris Agreement sealed in December 2015 established universal and harmonized measurement, reporting, and verification (MRV) provisions for climate change mitigation actions. MRV is central to effectively implement the Nationally Determined Contributions (NDCs), which describes countries' mitigation goals and policies submitted under the Paris Agreement.

Measurement is needed to identify emissions trends, determine where to focus greenhouse gas (GHG) emissions reduction efforts, track mitigation-related support, assess whether mitigation actions planned under the NDCs are effective, evaluate the impact of support received, and monitor progress achieved in reducing emissions. Reporting and verification are important for ensuring transparency, good governance, accountability, and credibility of results, and for building confidence that resources are being utilized effectively.

This chapter is prepared as part of Jordan's first Biennial Update Report to the UNFCCC. It addresses three types of MRV, namely:

- MRV of GHG emissions, conducted at national level to understand the emissions profile and report it in the form of emissions inventory.
- MRV of mitigation actions (e.g., policies and projects) to assess GHG mitigation efforts as well as monitor their implementation.
- MRV of support (e.g., climate finance, technology transfer, and capacity building) to track provision and receipt of climate support.

This chapter also seeks to describe the current status of GHG inventory estimation and reporting as well as of GHG mitigation. It will also suggest an integrated national MRV system for climate change action.

The main objective of UNFCCC is to "achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The UNFCCC requests reporting information from countries to have a better understanding and tracking the progress with commitments or pledges, providing confidence and enhancing accountability in quantified information measured and reported, and providing background information on the scope and ambition of national climate responses. UNFCCC requirements and IPCC guidance on MRV leave considerable flexibility for countries to decide how to meet reporting requirements. The IPCC Guidelines also set out methodological options that provide countries with flexibility. This flexibility has strong advantages for countries, but it can also affect the quality and details of reporting.

Parties to the UNFCCC are obliged to communicate to the Conference of the Parties (COP), through the Secretariat, information on the actions they have taken or envisage they will take to implement the Convention. This is seen as a key implementation aspect of the Convention, as it allows Parties to inform one another of their national level actions and serves as a basis for the COP to assess the implementation of the Convention by Parties. The reporting provisions contained in the Convention were further enhanced through the Bali Action Plan adopted at COP 13 in 2007. The Bali Action Plan introduced the principle of MRV for both developed and developing country Parties in the context of enhancing action at the international and national level to mitigate climate change. This principle was further elaborated through a number of subsequent COP decisions, resulting in a comprehensive MRV framework under the Convention.

The Paris Agreement adds the obligation to prepare, communicate, and maintain successive NDCs and to pursue mitigation actions aligned with these contributions. Key reporting provisions of the Paris Agreement are that all Parties shall regularly submit national inventory reports and information on implementation and achievement of NDCs, and all Parties shall account for their NDCs. The Paris Agreement also proposes an Enhanced Transparency Framework (ETF) as a system for MRV of climate action and support. The purpose

of the ETF is to provide a clear understanding of mitigation actions, track progress towards NDCs, and inform a global stocktake to be undertaken every 5 years. The ETF will build on existing transparency mechanisms under the UNFCCC, and specific modalities, procedures, and guidelines are being developed for presentation at COP 24 (2018).

Developing countries mostly submit their national GHG inventory reports through National Communications (NCs) or Biennial Update Reports (BURs). NCs are to be submitted every 4 years and BURs every 2 years, with flexibility for countries based on capacities, data availability, and resources available for MRV. Inventory reports should be compiled using methods set out in the IPCC Guidelines for National GHG Inventories. Inventory compilation should adhere to five principles: transparency, accuracy, completeness, comparability, and consistency. The IPCC Guidelines also set out methodological options that provide countries with flexibility. Countries should report on mitigation actions as part of their BURs, giving information on methodologies "to the extent possible".

4.2 Current Practices at the National Level

Based on the decisions adopted at COP 16 and 17 as mentioned previously, non-Annex I Parties now need to measure the specific effects of national mitigation actions as well as the support needed and received, and to provide this information, including a national inventory report, as part of their BURs. Therefore, introducing an MRV system in Jordan should be implemented based on the country's national circumstances and national priorities and built on existing domestic systems and capacities while considering the international best practices. It implies institutional improvements aimed at coordination of all activities for the development of national communications and biennial reports and will seek to define the responsibilities of the authorized body.

4.2.1 GHG inventories estimation

The current practices for the preparation of the national GHG inventories are as follows:

- The GHG Inventory estimation is prepared only for climate change reporting to the UNFCCC (National Communications and BURs).
- The process is not periodical on a set date. The activity is only carried out to fulfil the country's commitment to UNFCCC Secretariat, and it is prepared through national efforts within projects normally supported by GEF-UNDP.
- To this date, Jordan has prepared GHG national inventories for 1994, 2000, and 2006 as well as for 2010 and 2012 as part of the current FBUR.
- Estimates for the earlier reports were determined using the Revised 1996 IPCC Guidelines, whereas for the current FBUR, GHG Inventories for 2010 and 2012 have been estimated using 2006 IPCC Guidelines.
- To this date, the collection of activity data for the GHG Inventory estimation is carried out through a traditional method. A bottom-up data collection approach is followed for all sectors and a top-down approach is followed for the energy sector reference approach.
- Activity data collection is a long and tedious process and mostly requires internal personal connections as well as the support of the members of the National Committee of Climate Change.
- For the activity data collection during each National Communication process and the current FBUR, formal letters were issued from the Ministry of Environment (as project owner and UNFCCC focal point) to all sister Ministries and national stakeholders and institutions requesting activity data. Tables were attached to the formal letters describing the needed data and its format (Appendix B includes a list of the needed activity data that were used for Jordan's national GHG inventory estimation and their data sources (entities)).

- Follow-up visits were arranged by national experts to ensure getting the needed activity data.
- The data in most sectors are not readily available in the IPCC format, and they are often scattered among multiple departments and organizations.
- At national organizations, data are mostly kept as paper copies that might be lost or destroyed.
- National data for the AFOLU and Waste Sectors have lots of gaps and there is a need for capacity building in collecting and documenting data.
- National Emissions Factors are not available.

4.2.2 Climate change mitigation measures tracking

Jordan's experience with GHG mitigation analysis has been limited to national communications and reporting to UNFCCC. In addition, Jordan has had limited experience with clean development mechanism (CDM) projects, as stated in the Proposal for Market Readiness. Out of 15 project proposals that received letters of approval from the Ministry of Environment, the Designated National Authority (DNA), only 4 CDM projects have been registered with UNFCCC.

The limited CDM experience in Jordan highlights the lack of technical capacity among local experts on project identification and development including crediting methodologies, which led to increased transaction costs for developing CDM projects. In addition to the need to recruit an independent, credible reference body for the accreditation and verification of reductions, Jordan had to seek an international entity because such expertise is not available at the local level.

The lessons learnt from Jordan's experience with CDM development indicated that there is a need to significantly strengthen institutional frameworks and technical capacity in order to deliver a pipeline of verified mitigation activities. This includes the need to develop capacities for gathering data and for monitoring and verifying the effect of mitigation actions. There is also a need to enhance the capacities of decision makers in the public sector.

4.2.3 Tracking received support

Climate finance sources at the national level

National institutions that are responsible for receiving and distributing climate change funds include:

- Ministry of Environment
- Ministry of Finance
- Ministry of Planning and International Cooperation
- Other Line Ministries
- Development Banks: AFD, KFW, UNDP, EBRD, IFC, EU, etc.
- Direct aid: USAID, Abu Dhabi Fund for Economic Development
- Specialized climate finance: EBRD, EIB, KfW, and Jordan Sustainable Finance Facility supported by EU NIF Grants
- Domestic public funding: Public sector funding through line Ministries
- Local funding institutions: Agricultural Credit Corporation funding, JEDCO, ACI, CBJ, GDF

More details are provided hereafter on the sources of finance in Jordan for climate change and green projects.

- International funding sources: As a developing economy, Jordan has received international aid from development banks and other sources.
- Development banks are a major source of finance for green growth projects and initiatives. The list of development banks includes (though not limited to) the Agence Française de Developpement (AFD), KfW, the United Nations Development Program (UNDP), the European Bank for Reconstruction and Development (EBRD), International

Finance Corporation (IFC), the European Union (EU), the Kuwait Fund for Arab Economic Development (KFAED), and others. Aid from these institutions is commonly coordinated through MOPIC, which plays a key role in donor coordination and project engagement.

- Direct aid plays a part in Jordan's green economy sector.
- Finance sources are various. For example, US alone provides financial aid to Jordan, including from the following sources that are related directly and indirectly to climate action:

- Economic assistance from USAID (approximately USD 1 billion per year), focusing on Jordan's water infrastructure development.
- Millennium Challenge Account (approximately USD 275 million), which is assisting the development of Jordan's water efficiency and water treatment programs.
- Loan guarantees to assist small and medium enterprises (SMEs) in Jordan through various mechanisms including the Jordan Loan Fund Guarantee to de-risk business loans, which is also used by SMEs in the green economy sector.

- Specialized Climate Finance

Jordan receives financial assistance from various specialized green funds. For example, the Jordan Sustainable Finance Facility has been recently set up by EBRD, EIB, and KfW, and supported by EU NIF grants, with a pilot funding of €34.5million. It is worth mentioning that Jordan has not been as active as other developing nations in accessing the increasingly important climate funds that are being set up for green energy projects. A key example is the Global Climate Fund, for which as of yet, no Jordanian entity has been granted eligibility. Significant opportunities exist to access this nascent yet very large pool of funds for green growth projects.

- Commercial/private financing

Jordan has also been the recipient of direct financial investment and debt finance from the international commercial banking sector. Some of the recent renewables projects, including the Adenium Energy solar PV plants in Ma'an and the Falcon Ma'an for Solar Energy project obtained private financing as part of a consortium of investors. Nearly all renewable energy projects in Jordan have required some form of financing or underwriting from key international development banks or grants. Development assistance is provided primarily through concessional loans, co-financing, or equity investments into green growth projects. Furthermore, JREEEF has been set up to channel a range of funding, including international aid and development funds, to renewable and energy efficiency projects.

- Local funding sources

- Public sector funding: the public sector constitutes the major source of local funding for green projects in Jordan. The majority of projects are financed through national budgetary contributions, supported by development partners, including key national infrastructure projects.
- Local funding institutions such as the Agricultural Credit Corporation, a quasi-government lending facility, supports farmers operating under the umbrella of the Ministry of Agriculture.
- Other sources of funding that play a role in the financing of the green growth sector in Jordan include:
  - Jordan Loan Guarantee Corporation (JLGC): The JLGC is sponsored by the Overseas Private Investment Corporation and is operated by the Government Development Fund. It is a loan guarantee scheme focused on SME lending.
  - Jordan Enterprise Development Corporation (JEDCO) – grant funding.
  - Amman Chamber of Industry (ACI) – grant funding.
  - Central Bank of Jordan (CBJ) – loans and Governorates Development Fund (GDF).

Status at the national level

Jordan, like other developing countries, encounters a number of challenges in verifying the climate finance information on support provided by developed countries. The current status in Jordan suffers from the following challenges:

- Insufficient institutional arrangements: There are no sufficient institutional arrangements in Jordan that define clear roles and responsibilities of different ministries with regard to climate change.

  The Ministry of Environment is mandated to coordinate climate change-related activities. But it is the activities of other sectoral ministries that are affected by, or have the potential affect, climate change. Furthermore, MOPIC and the Ministry of Finance are in the driver's seat in defining national development priorities and formulating the national budget. The national budget does not include a specific allocation for climate change activities. In addition, MOPIC and the Ministry of Finance are the entities who engage with development partners and help maintain records of Official Development Assistance (ODA) flowing to various sectors.

  There also is no effective coordination and information sharing regarding climate finance or integrating climate change into development planning at national, sectoral, and subnational levels.

- Inconsistent definitions and criteria in defining climate finance and in distinguishing climate finance from other forms of finance is a challenge inherent in all climate finance monitoring efforts, whether by a contributor or a recipient. The key issue is how to distinguish climate finance from ODA and how to determine the proportion of climate finance that is additional to ODA.

- Inconsistent markers, indicators, and codes to characterize financial data may include:

  - Developing indicators for adaptation finance can be difficult.
  - Developing indicators for climate finance is especially challenging for projects that have multiple objectives.
  - Indicators are also challenging for cross sectoral projects that include climate-related benefits, but do not primarily focus on climate.

- Insufficient technical processes and systems to identify and record climate finance expenditures (such as reporting formats and software platforms for storing and sharing information) and mechanisms to integrate climate change into national systems for budgeting, monitoring, and reporting.

- Limitations on the availability of private financial data.

Having an effective monitoring, reporting, and verification system for climate finance that addresses the gaps and challenges discussed, including clear roles and responsibilities for different actors, can help countries determine where climate finance is flowing, whether it is being used in line with its intended purpose, and can facilitate accessing climate change support and financing.

4.3 Suggested Framework for MRV

The government of Jordan is committed to meeting the challenge of tackling climate change. Having a strong support and collaboration among all stakeholders will ensure a successful transition towards a green, lowcarbon, and sustainable economy.

The involvement of all entities in designing a robust multi-level MRV system that possesses the required flexibility and benefits all, will increase the chances of success and long-term sustainability.

Adopting a systems-based approach including a clear process design, responsibilities, data flows, and a supporting governance structure is important for the implementation of an effective MRV.

The MRV can be best thought of as a system, which includes various elements like process design, activity data flows, governance mechanisms, and information technology (IT) support systems.

It is suggested to have a legal arrangement in the form of by-laws, memorandums of understanding (MoUs), and agreements. The agreements or MoUs signed should enable the national focal point to directly access the data platforms to access the activity data at the Ministries in question. These agreements provide certainty about the type of data, the format, and timely access.

The IT support system should be designed in close collaboration with all stakeholders and should consider their specific needs. All stakeholders should be involved at early stages and consulted in determining the process design, and data flows, such as what data will be made available, when it will be collected, and in what form.

The overall purpose of the domestic institutional arrangements for MRV is to:

- Meet the reporting requirements of UNFCCC.
- Further build national capacities and ensure the sustainability of reporting processes.
- Inform national and international policymakers at different levels.
- Assist in institutionalizing activities related to reporting on climate change.

The following subsections describe a framework for a suggested domestic MRV system for climate action.

4.3.1 MRV- GHG inventory emissions

The ultimate objective of having an MRV system for emissions is fulfilling UNFCCC obligations to report on levels of GHG emissions by sources and removals by sinks.

The MRV system for emissions addresses gathering data for the estimation of GHG emissions by sources and removals by sinks to generate a national GHG Inventory, which is reported and verified in national communications and biennial update reports. Data collection, emission factor assessment and development, and emissions calculations are of importance. Adopting a systems approach will ensure MRV sustainability and will improve transparency, accuracy, comparability, completeness, and consistency. Planned activities, procedures, methodologies, and responsible entities are outlined in Table 4.1.

Since the national GHG Inventory addresses different sectors, the activity data need to be collected from various entities and organizations, or data providers. A systems approach that is governed by solid institutional arrangement would allow well-defined flows of data from data providers to four main sectoral units, which will in turn feed the data into the central registry unit at the Ministry of Environment, as illustrated in Figure 4.1.

The data are made available to the registry unit at the MoEnv from the sectoral central units on a biannual basis. The national GHG Inventory compiler will use the data to estimate and report the national GHG Inventory annually, according to UNFCCC guidelines and the IPCC software.

The GHG Inventory is then subjected to multiple reviews by national and international accredited bodies, such as the UNEP-UNDP Global Support program (GSP), academic institutions, or local research entities. The inventory is then submitted to UNFCCC Secretariat for final verification and approval as part of the NCs and BURs, as illustrated in Figure 4.2.

Table 4.1: Suggested design for MRV of GHG inventory emissions

MRV for GHG Inventory Emissions	The ultimate objective of having an MRV system for emissions is fulfilling UNFCCC obligations to report on levels of GHG emissions by sources and removals by sinks. The MRV system for emissions deals with gathering data for the measurement of GHG emissions by sources and removals by sinks to generate a national GHG Inventory, which is reported and verified in national communications and biennial update reports.
Lead institution	Ministry of Environment
Institutions involved in process	Line ministries, GAM, and data providers
Procedure	Measurement - collection of activity data Ministry of Environment has MoUs with: MEMR, Chamber of Industry, and DOS to provide data on a biannual basis. - MEMR has MOUs with energy sector data providers. - DOS has MOUs with AFOLU and waste sector data providers. - Chamber of Industry has MOUs with IPPU data providers. Reporting - GHG inventory estimation - Using the IPCC Guidelines for the estimation of GHG emissions from various sectors. - Compilation of the overall national GHG Inventory by the Ministry of Environment. Verification - Local technical review. - International review by an accredited/referenced entity, e.g., UNDP-UNEP Global Support Programme (GSP).
Methodology for estimation	The methodologies for measurement are not defined by the Convention. In undertaking measurement, Parties to the agreement including Jordan, rely on methodologies developed by the Intergovernmental Panel on Climate Change (IPCC), namely, IPCC 1996/2006.
Resources, capacities, staff, and tools	The resources needed at MoEnv, MEMR, DOS, and the Chamber of Industry are: ■ Technical staff that have the capacity and knowledge to handle large sets of data. ■ Templates for estimation, measurements, reporting, and verification. ■ Templates for activity data requests in IPCC format. ■ If available, supporting IT tools and database platforms for data storage and reporting.
Timeframe	Biannual effort to generate an annual GHG Inventory.

Figure 4.1: Suggested activity data flows from data providers

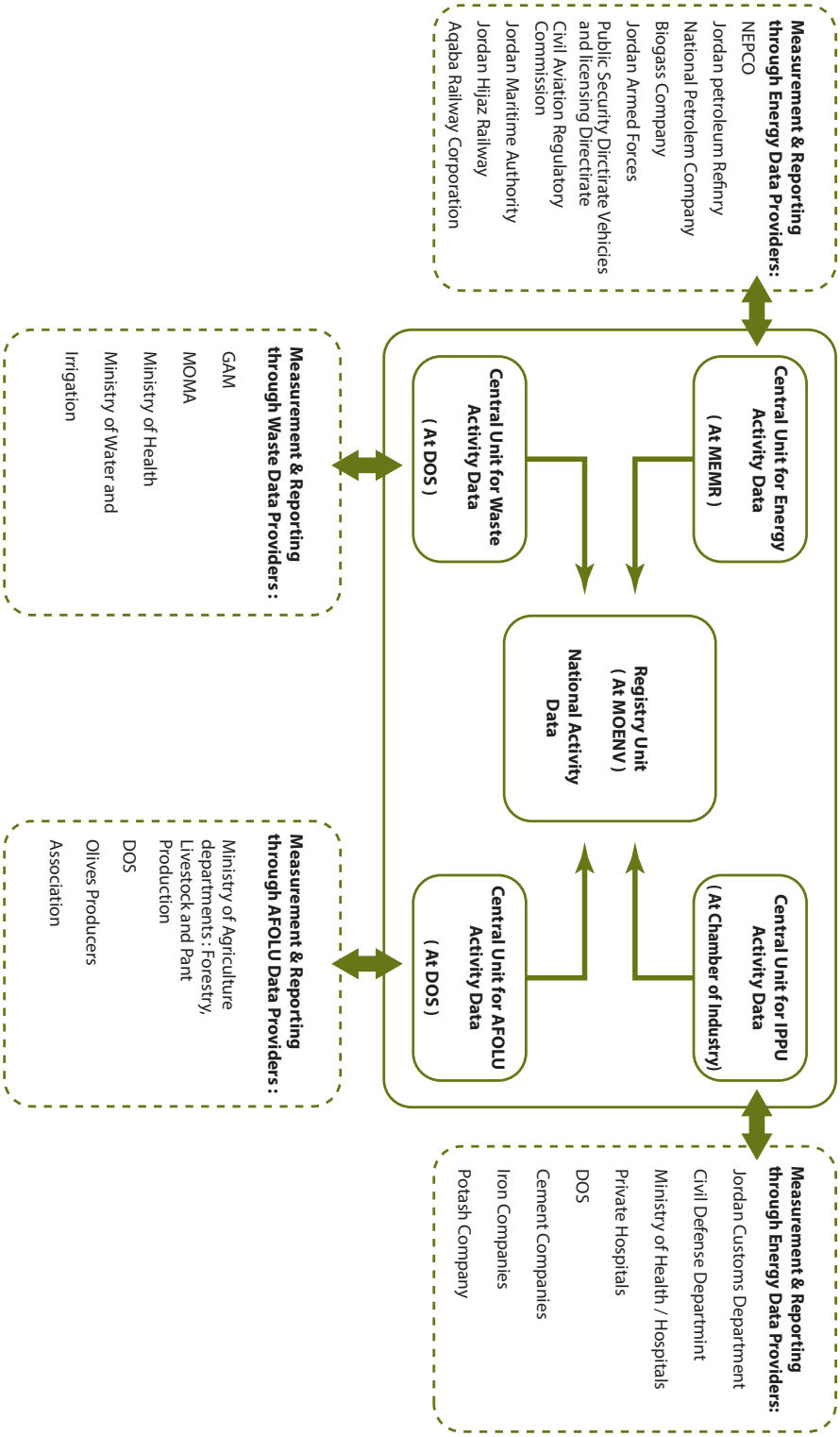
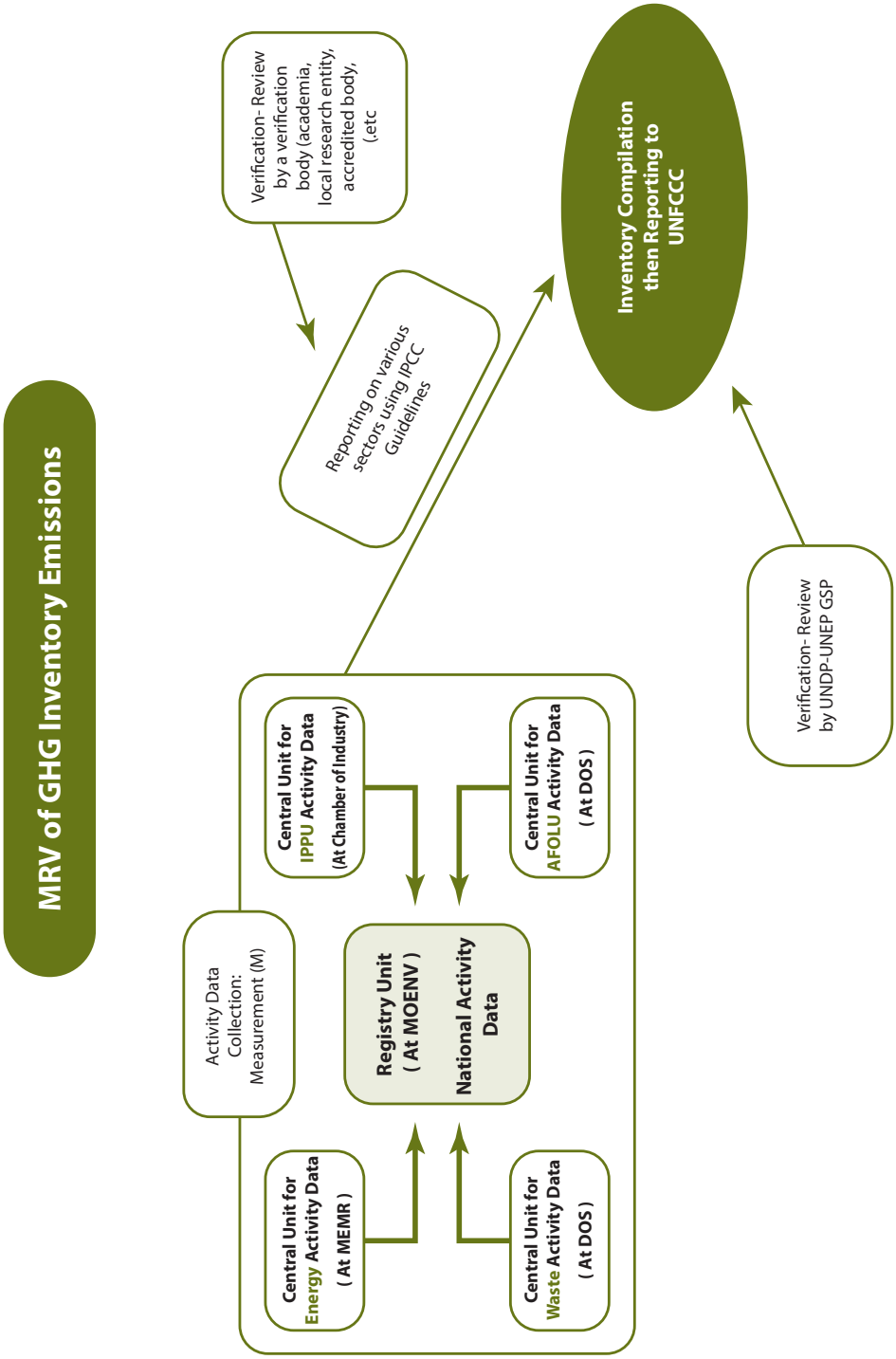


Figure 4.2: Suggested MRV system for GHG inventory emissions



4.3.2 MRV - mitigation measures

The objective of the MRV system for mitigation measures is to track the progress made in planning, managing, and implementing mitigation actions and to analyze their effectiveness.

A GHG mitigation analysis is performed and baseline and mitigation scenarios are constructed and assessed as follows:

- The baseline scenario reflects a future in which there are no policies or programs designed to encourage or require actions that reduce GHG emissions or enhance carbon sinks. Defining a reasonable baseline scenario is considered a critical element in the abatement assessment since the benefits and incremental costs of mitigation options are directly linked to a sound definition of the baseline scenario.
- The mitigation scenario is structured according to a set of criteria reflecting country-specific conditions such as the potential for a large change on GHG emissions, direct and indirect economic impacts, consistency with national development goals, potential effectiveness of implementation policies, sustainability of an option, data availability for evaluation, and other sector-specific criteria.

The methodologies for measurement are not defined by the Convention. In undertaking emissions management, Parties could rely on methodologies developed by the Intergovernmental Panel on Climate Change (IPCC) (e.g., IPCC 1996/2006) or GHG Protocol calculation tools and standards.

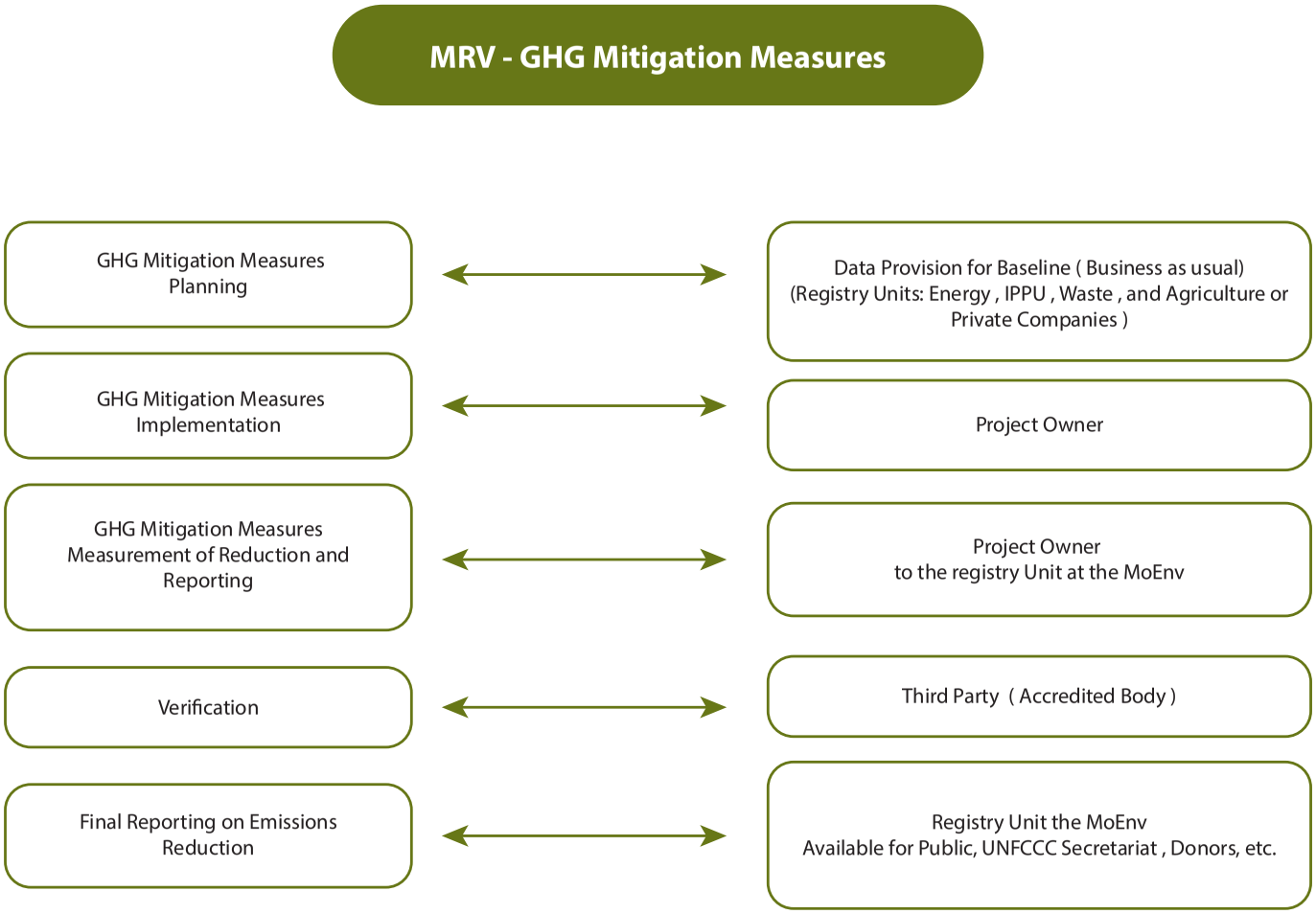
The GHG mitigation measures are planned and implemented by the project owner with external technical support, if needed. Baseline, mitigation, and feasibility analysis must be performed and reported to and with the support of the registry (activity data unit at the MoEnv). Planned activities, procedures, methodologies, and responsible entities are outlined in Table 4.2.

The implementation of planned activities is monitored by the Ministry of Environment. Analysis is performed to estimate emissions reduction and the cost of reduction measures, as reported by project owners. Verification of emissions reduction is conducted by a third, accredited party, such as research institutions, private consultants, local companies, and/or universities, etc.). A diagram outlining the needed tasks and the entities responsible for them is illustrated in Figure 4.3.

Table 4.2: Suggested design for an MRV system for GHG mitigation measures

MRV for Mitigation Measures	The objective of the MRV system for mitigation measures is to track the progress made in planning, managing, and implementing mitigation actions and analyze their effectiveness.	
Lead institution	Ministry of Environment	
Institutions involved in process	Line Ministries, GAM, project owners, and data providers	
Procedure	**Needed Tasks**	**Responsibility**
	- Oversees implementation of measures - Performs baseline, mitigation, and feasibility analysis - Implements measures - Verifies actual reduction	- Ministry of Environment - Project owner, private companies, and universities - Project owner, private companies, and universities - Third, accredited party (e.g., research institutions, private consultants, local companies, universities, etc.)
Methodology for estimation	The methodologies for measurement are not defined by the Convention. In undertaking emissions measurement, Parties could rely on methodologies developed by the Intergovernmental Panel on Climate Change (IPCC) (e.g., IPCC 1996/2006) or GHG Protocol calculation tools and standards.	
Resources, capacities, staff, and tools	The resources needed at the Ministry of Environment (MoEnv), MEMR, DOS, and Chamber of Industry are: ■ Technical staff that have the capacity and knowledge to handle large data sets and perform mitigation analysis. ■ Templates for measurement, reporting, and verification. ■ IT tools and database platforms for data storage and reporting.	
Timeframe	Biannual reporting (data on status readily available on an annual basis).	

Figure 4.3: Suggested MRV system for GHG mitigation measures



4.3.3 MRV - support

The suggested MRV for support is recommended to a have registry unit (green economy unit at the MoEnv) that receives data from various central units/data providers. It is recommended to collect the data as follows:

- Measurement and reporting data on international support for the public sector through MoPIC. Public sector organizations include:

- Ministries such as MWI, MEMR, MOA, MOH, MOE, MOT, MOMA, and MOIT.

- GAM and other municipalities.

- Measurement and reporting data on international support for universities through the Ministry of Higher Education.
- Measurement and reporting data on international support for NGOs through the Ministry of Social Development.
- Measurement and reporting data on loans from banks for green projects through the Central Bank of Jordan (CBJ).
- Measurement and reporting data on commercial/private financing, direct financial investment, and debt finance through the public-private partnership (PPP) unit at the Ministry of Finance.

The task of verification of received support is suggested to be the responsibility of MoPIC.

Planned activities, procedures, methodologies, and responsible entities are outlined in Table 4.3. A diagram illustrating a suggested MRV System for Received Support is shown in Figure 4.4.

The above framework system for support is in line with the recommendation of the Green Economy Strategy of having a standalone, independent unit or team (such as the Green Economy Unit at the MoEnv) to provide technical assistance with regard to green finance to the government under patronage of the Ministerial Council.

The mandate of this unit as suggested by the Green Economy Strategy is to:

- Advise on and support progress on all finance matters for green growth projects in Jordan.
- Build capacity of key government and regulatory stakeholders through training and awareness raising.
- Act as facilitators in project development, offering expert advice and support as a public service to loan or grant applicants. A number of promising green projects never make it to a "bankable" project, as stakeholders lack experience. Providing this expertise can be a value-added service to the Jordanian market.
- Act as technical advisors to fund providers who want to act as lenders, equity investors, or loan guarantors.
- Develop and execute an engagement and awareness "roadshow" for private sector stakeholders in and outside of Jordan to attract interest in financing green growth projects in Jordan.

In addition to the finance technical assistance mandate, it is suggested to add tracking and reporting mandate for climate finance. It is needed to work towards increased transparency and clear definitions for climate finance spanning both the type of flows to be included (public and private) and the types of activities that are eligible to be tracked (e.g., mitigation, adaptation, enabling activities, reporting). Thus, the unit that oversees the MRV for support (Green Economy Unit) needs to elaborate on how the unit plans to achieve a practical efficient MRV tracking system for climate finance, which may include:

- Creating definitions and criteria to define climate finance (distinguishing climate finance from other forms of finance). This can be coordinated with MoEnv, climate change directorate team.
- The need to decide on the level of detail for a classification system, as follows:

- A broad classification system may consider only

whether an activity is identified as being an adaption or a mitigation project.

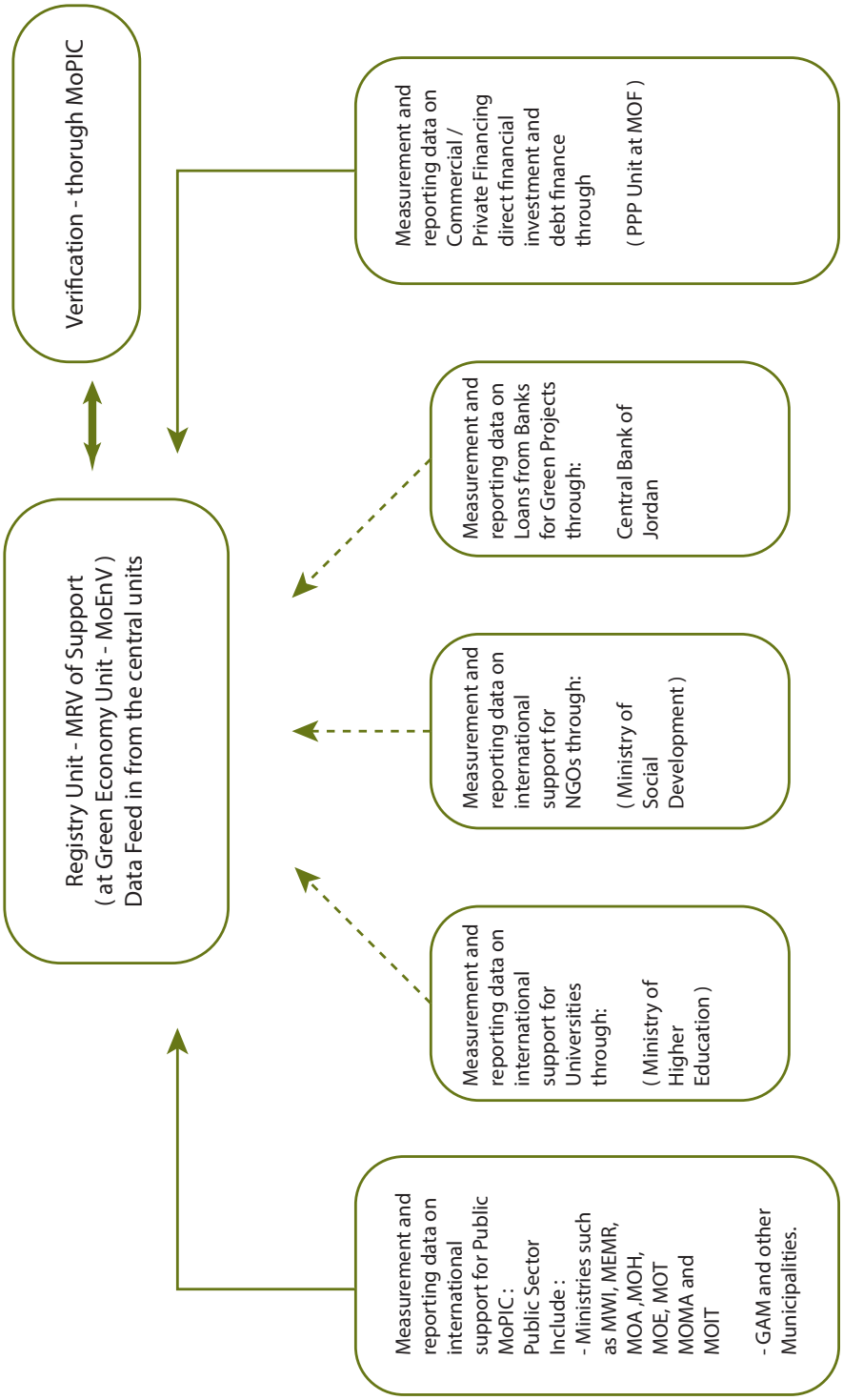
- A second level of detail could consider mitigation activities by sector - for example, energy, forestry, transportation, or manufacturing.
- A further layer of detail may look at subsectors. For example, energy-sector activities may be subdivided by technology: wind, solar, geothermal, nuclear, and so on. Jordan will have to determine a level of detail that is practical, and which meets its internal policy needs. Moreover, Jordan will need to consider how to identify climate adaptation projects, with respect to national development plans and programs and development assistance projects.

- Defining clear and well-defined roles and responsibilities for the preparation of GHG inventory estimates (both internally and externally), a quality assurance/quality control plan, a working archive system, and a description of the process for collecting data and developing GHG inventory estimates.

Table 4.3: Suggested design of an MRV system for received support

MRV for Support	The objective of the MRV system for support (namely, climate finance, technology transfer, and capacity building) is to track provision and receipt of climate support and monitor the results achieved, and assess their impact.
Lead institution	Ministry of Environment
Institutions involved in process	MoPIC, Line Ministries, GAM, project owners and data providers
Procedure	Preparation of a national regulation that provides guidance on measuring, tracking, and reporting of climate change received support.
Methodology for estimation	The methodologies for measurement are not defined by the Convention. Parties are free to create their own methodologies that suits their national circumstances. Measurement- collection of activity data - Ministry of Environment prepare MoUs with data providers
Resources, capacities, staff, and tools	■ Dedicated staff for data collection at each central unit. ■ Templates for measurements, reporting, and verification. ■ IT tools and database platforms for data storage and reporting.
Timeframe	Biannual effort to generate an annual report.

Figure 4.4: Suggested MRV system for received support



4.3.4 Suggested overall domestic MRV system

The overall MRV system will be under the lead of the Ministry of Environment, where all information should feed in to the Climate Change Directorate and green economy unit. With regard to institutional arrangements, commitment from senior management and decision makers at the level of the Ministerial Council–including formal agreements among ministries and other stakeholders concerning data collection and sharing processes, where necessary– is essential to ensure that all relevant government institutions are dedicated and have clear responsibilities for overseeing compilation and management of information. Improved coordination is an important step to ensure better tracking of climate finance flows (technical assistance, capacity building, and technology).

In 2016, Jordan has submitted its Market Readiness Proposal (MRP) to the Partnership for Market Readiness (PMR) initiative. The Jordan MRP outlines a plan for the implementation of necessary market readiness components to support the development of appropriate market based instruments.

A multi-tiered integrated MRV system for Jordan is being developed based on the proposal submitted by the Government of Jordan and the World Bank. The MRV system design is being developed in consultation with different national stakeholders and it is anticipated to be completed soon.

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- Handbook on Measurement, Reporting, and Verification for Developing Country Parties: https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf, accessed in February 2017.
- https://www.thepmr.org/system/files/documents/PMR%20Jordan_Market%20Readiness%20Proposal_Final_2April2016.pdf, accessed in February 2017.

UPDATED GAPS AND CONSTRAINTS, AND RELATED NEEDS

5.1 Introduction

According to decision 2/CP.17, non-Annex I Parties should provide updated information on constraints and gaps, and related financial, technical, and capacity-building needs.

Also, non-Annex I Parties should provide updated information on financial resources, technology transfer, capacity building, and technical support received from the Global Environment Facility. With regard to the development and transfer of technology, non-Annex I Parties should provide information on technology needs, which must be nationally determined, and on technology support received.

Accordingly, this chapter seeks to provide a brief description of the constraints and gaps identified in previous national climate change communications. It will also identify newly arising constraints and gaps, and needed actions and resources required to overcome them.

5.2 Institutional Constraints and Gaps and Policy Mainstreaming

Jordan is continuously striving to improve national GHG estimation and reporting to the UNFCCC. To achieve continuous improvement in national reporting, constraints, gaps, and related financial, technical, and capacity building, needs should be identified, and appropriate measures taken and implemented to address them.

In order to fulfil the obligations arising from the Cancun and Durban Conference of Parties (COP) decisions related to the submission of national communications and biennial update reports, further support is needed to continue to develop and consolidate existing technical and institutional capacities and to continue the efforts of integrating climate change into national policies, plans, and programs.

In 2013, a milestone was achieved in Jordan with the launch and adoption of the first National Climate Change Policy (NCCP) in the country and in the region. The policy was drafted to accommodate all national climate change priorities for action and to provide a highly flexible policy reference point, upon which further strategies and sectoral policies can be based. The implementation of NCCP relies on the framework of the laws, agendas, and strategies developed by the related ministries and authorities to provide an enabling environment.

In August 2014, the Ministry of Environment has created the Directorate of Climate Change (CCD). The Directorate acts as the institutional hub for coordinating and developing all climate change activities in Jordan in relation to the UNFCCC and the global climate change governance system and initiatives. According to the recently approved institutional framework, the overall objective of the Climate Change Directorate is to follow-up on and strengthen the implementation of provisions of UNFCCC and any related legal instruments that the COP may adopt and which Jordan ratifies. The creation of the CCD has been a milestone in improving the institutional structure of climate change in Jordan. However, the Directorate should be strengthened by adding more staff and enhancing their capacities.

Furthermore, a representative National Committee on Climate Change (NCCC) has been established in April 2001 by a decision by the Prime Minister. NCCC membership includes a number of stakeholders directly associated with climate change related sectors in Jordan. Current NCCC members represent line ministries, public institutions, research and academic organizations, and NGOs. The NCCC is a platform for the integration of multi-stakeholder dialogue and planning on climate change. Currently, the terms of reference and mandate of the NCCC are under review by MoEnv to enhance its role and mandate and facilitate the exchange of data and information among committee members.

Public policy in Jordan has not adopted a national GHG emissions target. The Intended Nationally Determined Contribution (INDCs), submitted in 2015, proposes to reduce Jordan's GHG emissions by 14% by 2030, driven by sectoral policies. Jordan tends to promote mitigation measures that are

justified by objectives other than climate change stabilization, such as cost-effectiveness, energy security, economic competitiveness, reducing energy expenses, and improving access to energy services.

5.3 Technical and Capacity Building Needs

5.3.1 GHG inventory

5.3.1.1 Gaps and constraints identified during the previous national communications and recommendation to address them

a) Gaps, constraints, and capacity building needs identified during the previous National Communications (NCs):

- Previously, GHG inventories were estimated only as part of the NCs preparation project , and thus lacked continuity and sustainability. Data were collected by sending paper letters requesting data from potential data providers, a process that was both time consuming and tedious. This arrangement does not serve national efforts to prepare periodical inventories for NCs and BURs to the UNFCCC.
- There was a lack of institutional arrangement to support collection of data needed for estimating the national GHG inventory, particularly from the private and industrial sector.
- Data quality, completeness, and accuracy were a primary concern. In addition, most data were available in a format not suitable for GHG inventory estimation. The lack of disaggregate data was a barrier to improving the bottom up estimation.
- All stakeholders experienced shortage in technical staff proficient in converting raw primary data to a form that can readily be used by the GHG inventory software.

b) Suggested actions and recommendations to address the gaps and needs:

As part of the FBUR project, a framework for a domestic MRV system for GHG Emissions Inventory has been suggested to address most of the above gaps, constrains, and needs, as follows:

- A dedicated entity is suggested to be created to oversee collection and processing of data for GHG estimation by setting up institutional arrangements and clear responsibilities and mandates.
- The institutional arrangements shall ensure the continuous and sustainable flow of data from all governmental and private data providers to be used for periodical BURs, NCs, and GHG inventory estimation as well as for any other purposes.
- The suggested MRV system for GHG emissions will ensure verification of data to ensure quality, accuracy, and completeness.
- A national effort is ongoing supported by the Partnership for Market Readiness to design and implement a detailed multi-level MRV system.

5.3.1.2 Additional gaps and constraints newly identified during the current bur and recommendations to address them

a) Additional gaps and constraints newly identified during the current BUR:

- There is a need to build capacity in the use of the 2006 IPCC Guidelines and Software.
- The National GHG Inventories of 2010 and 2012 did not provide emission estimates for indirect GHGs such as carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), and other gases not controlled by the Montreal Protocol, such as sulphur oxides (SOx) because the 2006 IPCC Software does not support the estimation of those gases.

- The National GHG Inventories of 2010 and 2012 have been estimated using the 2006 IPCC Guidelines, which have structural and methodological differences with the Revised 1996 IPCC Guidelines used in estimating GHG emissions inventories for earlier national communications (NCs), which made it difficult to provide a consistent time series.
- In preparing all GHG inventories so far, default emission factors (EFs) were used since there are no available studies to develop national emission factors. The use of national EFs is highly vital, particularly for key categories within the inventory.

b) Suggested actions and recommendations to address the gaps and needs:

- It is recommended to conduct training and capacity building workshops on the preparation of GHG inventories, including detailed use of the 2006 IPCC Guidelines and data sheets and calculations. This will widen the base of national experts. As part of the current BUR effort, capacity building activities have been held for use of the 2006 IPCC Guidelines and Software. However, further capacity building for use of these guidelines is still needed, given that the Guidelines have been used for the first time in preparing the FBUR.
- As per Decision 17/CP.8, non-Annex I Parties are encouraged, as appropriate, to report on anthropogenic emissions of indirect GHGs and other gases not controlled by the Montreal Protocol, at the discretion of the Parties. To fulfill this decision requirement and to improve the completeness of the inventory, it is recommended to estimate the emissions of these gases using EMEP/EEA air pollutant emission inventory guidebook.
- In Decision 2 CP.17, each non-Annex I Party is encouraged to provide a consistent time series back to the years reported in the previous NCs. Therefore, it is recommended to use the 2006 IPCC Software to re-report the previous national communications' inventories.
- A key category analysis has been performed as part of this BUR. It is recommended that Jordan search for alternatives to gradually apply in future inventory submissions, to the extent possible and based on software readiness and national circumstances, Tier 2 methods in the categories identified as key. Thus, research should be directed to develop national emission factors to be able to use higher tiers for key categories.

5.3.2 GHG mitigation measures

5.3.2.1 Gaps and constraints identified during the previous national communications and recommendations to address them

a) Gaps, constraints, and capacity building needs identified during the previous NCs:

- Stakeholders had limited expertise in and knowledge capacity for conducting mitigation analysis for the transportation, IPPU, AFOLU, and waste sectors.
- The complex nature of mitigation actions and initiatives that are being developed and implemented within the UNFCCC had been a challenge. The various potentials and features of CDM, NAMAs, LEDs, INDCs, and other mitigation tools make it difficult for a holistic planning perspective in climate change mitigation.
- Data quality, completeness, and accuracy are of a primary concern when it comes to establishing the baseline and mitigation analysis. Data are not up to date, nor are they readily available in one place.

b) Suggested actions and recommendations to address the gaps and needs:

- It is recommended to expand the expertise base and the knowledge capacity for conducting mitigation analysis through an extensive training program.

- It is recommended to raise awareness on international mitigation mechanisms and initiatives among all decision makers and stakeholders to benefit from those mechanisms. It is also recommended that the MoEnv continue to provide support for technical capacity building related to accessing those mechanisms.
- It is recommended to conduct continuous and up to date surveys to provide quality and accurate data to be used for analysis.
- As part of the FBUR project, a framework for a domestic MRV system for GHG Mitigation has been suggested that addresses most of the above gaps, constrains, and needs, as follows:

➢ A dedicated entity is suggested to be created to oversee collection and processing of data for GHG estimation by setting up institutional arrangements and clear responsibilities and mandates.

➢ The suggested MRV system for GHG emissions will ensure verification of data to ensure quality, accuracy, and completeness.

➢ A national effort is ongoing supported by the Partnership for Market Readiness to design and implement a detailed multi-level MRV system.

5.3.2.2 Additional gaps and constraints newly identified during the current BUR and recommendations to address them

a) Additional gaps and constraints newly identified during the current BUR:

- There is limited experience in Jordan in mitigation model analysis. The LEAP software, which replaced the more familiar ENPEP model, has just been newly introduced to Jordan for use in climate change energy mitigation analysis.
- The Jordanian case built in this current FBUR using the LEAP model has been developed as project-based rather than as a program-based scenario.
- In this FBUR, no mitigation projects have been identified for the transportation sector, although it is a major GHG emitter. Addressing the transportation sector has proved to be difficult because of the lack of expertise in mitigation analysis and of clarity in responsibilities and mandates among different institutions working within the sector.
- In preparing this FBUR, the energy data used in the mitigation analysis for residential buildings, transportation, agriculture, and off-road vehicles were obtained from relatively old surveys and there were gaps in the availability of some data.
- There is a need to have a dependable mitigation tracking system for planning, implementation, and verification of emissions reduction. Having such a system in place will facilitate access to international and national funds and grants.

b) Suggested actions and recommendations to address the gaps and needs:

- As part of current BUR capacity building activities, two training workshops have been held on the use of LEAP, but further training in using the LEAP model use is needed.
- The Jordanian case built in this current FBUR using the LEAP model should be adopted and further developed in upcoming national communications and BURs. It is also recommended to start using LEAP to generate program based scenarios rather than project based scenarios to improve coverage and generate more impact.
- The transportation sector is a major GHG emitter and therefore, there is a need to suggest mitigation projects and programs. Capacity building among all institutions working within the sector should be developed to perform mitigation analysis.
- It is recommended to have up to date surveys that provide current data on a continuous basis.

5.4 Technology Needs Assessment and Technology Transfer

The Ministry of Environment, with GEF-UNDP support, has earlier published a technology needs assessment (TNA) and technology transfer report for 2004-2005. More recently, the Ministry has completed a climate change technology needs assessment for Jordan for the period 2015-2017. The project is being implemented through a partnership between the United Nations Environment Program (UNEP) and the Technical University of Denmark (DTU), and is known as UNEP-DTU Partnership. Three reports have been published by this project. The first report is for the selection of priority mitigation and adaptation sectors for TNA activities in Jordan. The second report presented a list of the main barriers and an enabling framework, while the third report, which was published in August 2017, offered a technology action plan for two priority mitigation sectors (energy and transport) and two priority adaptation sectors (water and agriculture). The following TNA analysis is extracted from the three published reports.

Results revealed the following top three technologies, prioritized, out of a long initial roster of assessed technologies in each targeted sector.

The top three mitigation technologies for the energy sector were:

(1) Solar thermal,

(2) PV for electrification, and

(3) PV for water pumping.

The three top-ranked priority mitigation technologies for the transportation sector were:

(1) Bus Rapid Transit,

(2) Improving pedestrian infrastructure, and

(3) Ticketing systems to improve the quality and the attractiveness of public transport services.

The final results for the water sector's top three priority adaptation technologies were:

(1) Roof-top rainwater harvesting,

(2) Augmenting and expansion of Water Users Association (WUAs), and

(3) Desalination and brackish water treatment and re-use.

The results for the agricultural sector's top three priority adaptation technologies were:

(1) Water saving technologies, such as drip or subsurface irrigation,

(2) Farm-level water harvesting, and

(3) Plant varieties resistant to climate change.

The report has also provided a combined technology action plan (TAP) for the three priority technologies for each sector and key projects have been suggested to turn ideas into action.

Energy Sector

The main actions proposed are:

- Removal of financial and economic barriers;
- Enforcement of standards;
- Focused training programs; and
- Effective awareness programs.

The following three main project ideas have been suggested:

- Designing financial support mechanisms and subsidizes for solar powered systems;
- Developing a complete PV process industry; from silicon to module;
- Developing a high-tech comprehensive solar thermal industry; flat, evacuated tube, and parabolic trough technologies.

Transportation Sector

The main actions proposed are:

- Introducing regulations that incentivize users and potential users of public transportation;
- Planning strategic rehabilitation of the main streets that will contain BRT lanes;

- Institutionalizing the roles of stakeholders;
- Organizing capacity building programs for drivers and operators; and
- Organizing a broad awareness campaign to incentivize users and the potential users of public transportation.

The following three main project ideas have been suggested:

- Establishing a new sustainable transportation graduate course of study (Master degree program) at Jordanian universities to train practitioners in this understaffed field;
- Planning a public transportation project between Amman and Irbid;
- Modernizing public transportation vehicles.

Water Sector

The three technologies prioritized in the water sector have distinctive characteristics and independent applied aspects in terms of resources, management modalities, beneficiary groups, and stakeholders involved as well as unique technical and governance barriers. Thus, the three technologies were addressed and assessed separately. Moreover, each technology has its unique scale and context of deployment as follows:

Roof-top rain water harvesting (RWH) technology:

Among the actions proposed for this technology are:

- Conducting a technical assessment and screening study to identify the most appropriate modality of RWH technology for different types of building settings in Jordan;
- Revising or developing a new water efficiency code/by-law for buildings to regulate water efficiency measures including RWH. The proposed code would address regulatory incentives such as tax cuts and fees deduction to encourage compliance by housing construction companies with RWH directives (building codes) and enhance feasibility and payback period;
- Developing awareness and information dissemination programs targeting relevant bodies (Ministry of Water and Irrigation, Jordan Engineers Association, Contractors Association).

Some actions inspired new project ideas. For example, the TAP for RWH inspired a proposal to establish a Regional Green Building Engineering Training Center in Jordan, which will be a fully-fledged demonstration green building with installed RWH technology among other sustainable building-oriented technologies (such as greywater, insulation, RE & EE technologies).

Empowerment and Expansion of WUAs Technology

Among the actions proposed for this technology are:

- Having a suitable law governing WUAs to empower its operations in Jordan;
- Strengthening WUAs to enable them to perform the mandated tasks (irrigation management transfer);
- Attaining effective means of financial sustainability for WUAs and building their capacity to develop income-generating activities and projects;
- Establishing a program for continuous training and capacity building and developing effective coordination and communication platforms for WUAs in the Jordan Valley;
- Developing capacity building programs to empower WUAs in marketing the concept of WUA as an innovation in participatory irrigation management, and improving the skills of WUAs in marketing their products;

It is expected that the above actions will become components of one mega program seeking to accelerate full irrigation management transfer to the WUAs throughout the Jordan Valley. This will contribute to removing the barriers for WUAs and facilitate its expansion in other parts of the country, such as southern Jordan.

Desalination and Brackish Water Treatment and Re-use

Because investment in these technologies requires a high capital cost, the scale for potential diffusion of this technology will be confined to a pilot site of promising readiness and preference for the authorities in charge (Water Authority of Jordan).

Among the actions proposed for this technology are:

- Promoting reasonable system prices for capital and operating costs through cost-effective desalination units integrated with energy solutions (such as solar energy);
- Promoting and providing incentives to locally-produced and assembled desalination units; and
- Promoting technologies of less environmental impact.

A well identified project idea for this technology is the installation of a PV-powered desalination plant with a capacity 3-3.5 MCM/year to be utilized for drinking water supply to Amman and the local area. A suggested site is the Al Husban Well Field (a set of 4 groundwater wells on the Dead Sea Groundwater Basin).

Agriculture Sector

The three technologies prioritized in the agricultural sector have distinctive characteristics and independent applied aspects in terms of resources, management modalities, beneficiary groups, and stakeholders involved, as well as unique technical and governance barriers.

Thus, the three technologies were addressed and assessed separately as well.

Application of Water Saving Technologies, such as Drip or Subsurface Irrigation Technology

The ambition for said technologies was set as a target: "Increase the irrigated areas in the Jordan Valley and Highlands using water saving technologies to 60,000 hectares by 2030". The ambition also extends to expanding water harvesting activities to the catchments of dry areas and the Badia region to deliver socio-economic and environmental benefits in the arable areas. To that end, the following actions are proposed for this technology:

- Improving agricultural extension services significantly to provide necessary advisory services and capacity building activities on the advantages of the technology;
- Developing capacity building campaigns targeting farmers;
- Providing economic incentives and subsidized tariffs for water saving irrigation practices in order to increase efficient use by land-owners and farmers;

Farm-level Water Harvesting

The scale and ambition for this technology is centered in local catchments in dry areas and the Badia region. Thus, among the actions proposed for this technology are:

- Implementation of pilot projects to demonstrate the advantages of the technology;
- Enabling provision of long-term and low-interest loans or grants through state funds, private sources (different banks), and international funds (WB, IFAD, GEF, GCF, Adaptation Fund); and
- Supporting the creation of a stakeholder network for the development and transfer of the technology through a network of technical experts.

Introduction (or Promotion) of Plant Varieties Resistant (Adaptive) to Climate Change

The scale of application for this technology will be restricted to rain-fed agricultural areas, where cereal-legume cropping systems are predominant. Therefore, the following actions are proposed for this technology:

- Establishing modern breeding programs to produce climate change resilient varieties in collaboration with multinational and international organizations;

- Developing specific subsidy mechanisms and incentives to the farmers to promote the utilization and dissemination of the climate change resilient crop varieties;
- Strengthening institutional capacity; and
- Promoting knowledge transfer and increasing public awareness regarding the benefits of improved varieties.

5.5 Financial Resources Needs

According to the National Environmental and Economic Development Study for Climate Change (NEEDS) study published in Jordan in 2010, both mitigation and adaptation measures in Jordan will require substantial financial resources. The study estimates that USD 3.5 billion will be needed for mitigation until 2020. With only 0.5% of the public budget allocated to projects in the environmental sector (apart from infrastructure investments in water and energy), considerable fundraising targets are required.

The Government of Jordan has proposed sectoral mitigation policies and programs to achieve a 14% reduction in GHG emissions by 2030 compared to the baseline scenario. The 14% reduction of GHG emissions is divided into two parts. The first part seeks to achieve a 1.5% reduction in GHG emissions through unilateral actions, while the remaining 12.5% reduction is contingent and conditional on receiving international financial support. In its INDCs, Jordan put the estimate of reducing GHG emissions by 14% at USD 5.7 billion. To finance mitigation measures in the energy sector, Jordan will require USD 5,158 million to meet its conditional mitigation targets. While a significant proportion of this is likely to come from international sources of finance, one of the key sectoral actions for the energy sector is attracting private sector finance and reducing administrative obstacles in order to enable JREEEF to support investments at early stages.

The key challenges in financing climate change projects, particularly EE and RE

- Banks in Jordan, in general, are interested in providing finance to RE and EE projects. Banks prefer financing RE projects, particularly those which are of a larger size and linked to their existing client base. EE and smaller sized projects are less preferred.
- To minimize risks, financiers need access to an independent, credible reference body for the accreditation of climate change projects, particularly RE and EE projects. However, technical verifiers are unavailable, and financiers lack technical capacity.
- There is a lack of appropriate financial products.
- Project developers lack technical capacity.

The work of public financing institutions, such as JREEEF and JEF, although small scale, could play a crucial role in promoting early stage investments, particularly for public private partnership (PPP) projects, and for projects with co-financing. The Jordan Environment Fund (JEF) lacked the needed financial and administrate autonomy to be able to carry out its mandate effectively and efficiently. JREEEF is now active and has full and adequate institutional, technical, and financial capacity to manage the fund, buttressed by a management committee, supportive legislation (JREEEF By-Law), a transparent and effective governance structure, a strategic business plan, and financial support windows. For JEF to fund mitigation activities will require a widening of its current role to include a specific focus on mitigation activity, and the development of project selection criteria including an assessment of projects' impact on GHG emissions. In addition, JEF currently lacks adequate human, technical, and financial capability to perform its current role, let alone an expanded role.

The majority of financial resources pumped into environmental sectors in Jordan come from donor countries through bilateral agreements that focus on fiscal and developmental challenges in the country. Framework agreements and strategies with major donors like UNDP, USAID,

EU, GIZ, JICA, and other agencies have been developed and address a variety of sustainable development objectives. The donor community is supportive of a public registry of projects which would allow transparency and coordination of ongoing activities, as well as the assessment of their cost effectiveness. In addition, these donors are particularly supportive of developing strong GHG MRV frameworks, believed to be key to demonstrating the effectiveness climate financing. Financial institutions and banks are interested in entering this new sector. Several green loans and programs are being established and green suppliers and manufacturers are growing in number. However, the market lacks proactive marketing and public outreach.

Currently, there is 112 million JD available for RE and EE financing in Jordan. Of this amount, 76 million JD is available through the four commercial banks using the Central Bank of Jordan's window for RE and EE, and 36 million JD is available through the Agence Français de Development (AFD) facility. Key challenges in disbursing these funds include the lack of credible market references and a short credit history. This is particularly a relatively new field and while some banks have already established designated credit lines, other banks are still on the fence. A particular challenge for them is the lack of sufficient knowledge to verify project assumptions, technologies, or risks. They need access to an independent, credible reference body for the accreditation of RE and EE projects.

The following are suggested actions and recommendations to address those gaps and needs:

- As part of the FBUR project, a framework for a domestic MRV system for Received Support was suggested that addresses most of the above gaps, constrains, and needs by:
  - Establishing a dedicated entity to oversee collecting and verifying received support information related to climate change.
  - Designing and implementing a national multi-level MRV system, supported by the Partnership for Market Readiness.
- It is recommended top raise the capacities of stakeholders to produce bankable viable projects.
- It is recommended to raise the awareness of bankers of technical projects evaluation and assessment.

5.6 Financial and Technical Support Provided by GEF Related to Climate Change

The Global Environment Facility (GEF) supported Jordan financially in executing the following climate change activities:

- Preparation of the Initial National Communication (INC), prepared by the General Corporation for Environment Protection (GCEP) (which later became the Ministry of Environment), 1996-1997.
- Vulnerability and adaptation to climate change, prepared by MoEnv in 2000 to complete the INC.
- Establishing a pilot biogas facility at Russifa domestic landfill site, implemented by the Greater Amman Municipality and commissioned in 2000.
- Technology needs assessment (TNA) and technology transfer (TT), prepared by MoEnv, 2004-2005.
- National Capacity Self-Assessment for Global Environmental Management (NCSA), implemented by MoEnv in 2005 to assess the capacity constraints and potentials for implementing the three international environmental conventions on biodiversity, climate change, and desertification.
- Enabling Activities for the Preparation of Jordan's Second National Communication to the UNFCCC, implemented by MoEnv, 2006-2009.

- National Environmental, Economic, and Development Study (NEEDS) for Climate Change, prepared by the Ministry of Environment, 2010.
- Developing Policy-relevant Capacities for the Implementation of Global Environmental Conventions, implemented by the Ministry of Environment in cooperation with UNDP and with support from GEF, 2010.
- Enabling Activities for the Preparation of Jordan's Third National Communication to the UNFCCC, implemented by MoEnv, 2012-2015.
- Jordan Climate Change Policy, supported by UNDP/GEF, 2013.
- Enabling Activities for the Preparation of Jordan's First Biennial Update Report to the UNFCCC, implemented by MoEnv, 2015-2017.
- Mainstreaming Rio Convention into National Sectoral Polices in Jordan Project, 2015-2018.

The above projects have been implemented with UNDP support, and with technical support from other United Nations organizations including UNEP and UNFCCC. In addition, UNEP/UNDP National Communication Support Programme and the UNDP/UNEP Global Support Programme (GSP) have provided technical support for the preparation of Jordan's National Communications and the FBUR on climate change through training workshops, provision of guidelines and guidance materials, review of studies and reports and provision of online support and tele-conference calls.

References

- Jordan's Third National Communication (TNC) to UNFCCC, 2014.
- Roadmap for a national MRV system for GHG inventory, GIZ, 2015.
- Market Readiness Proposal (MRP) of Jordan to World Banks' Partnership for Market Readiness' PA, 2015.
- National Environmental and Economic Development Study for Climate Change (NEEDS) Submitted to the United Nation Framework Convention on Climate Change, 2010.
- Jordan's Intended Nationally Determined Contribution (INDCs) to UNFCCC, 2015.
- Access to Finance: Survey for energy efficiency and renewable energy projects, USAID, 2015.
- Developing an Action Plan (2015-2018) for Climate Change Directorate in the Ministry of Environment, GIZ, 2015.
- Climate change technology needs assessment for Jordan (2015-2017). United Nations Environment Programme (UNEP) / UNEP-DTU Partnership.

INFORMATION ON SUPPORT RECEIVED

During the preparation of this FBUR, requests for data on financial inflows were made through official letters sent from the Ministry of Environment to MOPIC & MEMR. It was found out that no well-established systems were available at these organizations. The data received were incomplete. Data for example (but not limited to) related to the BRT bus developed in GAM, Al-ghabawi landfill, etc. are information present only in the responsible entity and can't be tracked from other sources.

At present, data collection systems for climate finance do not provide specific information on climate finance flows. Tracking progress will therefore entail compiling information on climate finance from a mix of individual private entities, public sector actors, and international organizations rather than one focal point (e.g., MOPIC). Table 6.1 provides information on the support received from national, bilateral, and multilateral sources since 2013-2019, including funding, technology transfer, capacity building, and technical assistance.

- Table 6.1 includes resources on grants, general budget, or concessional basis received for sustainable development purposes and for national strategies, and not specifically for climate action, in line with the principle of additionality of climate finance, as per article 4.3 of the UNFCCC.
- Due to the lack of precise guidelines for the MRV system for support and a consequential lack of available information, resources directed to the private sector were not included.

Table 6.1: Mapping financial flows of climate change from national and international sources

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2015-2019	Increasing the resilience of poor and vulnerable communities to climate change impacts in Jordan through implementing innovative projects in water and agriculture in support of adaptation to CC	Donor: Adaptation fund Implementing agency: MOPIC	Grant (USD 9,226,000)	X	X	The program seeks through its 1st component to support climate change adaptation in the agricultural and water sectors through technology transfer (the use of non-conventional water resources, rain water harvesting, and permaculture). The 2nd component seeks to strengthen climate change adaptation capacities at the national and local community levels, respectively, knowledge dissemination, and policy and legislation mainstreaming.
2014-2018	Irrigation technology pilot project to adapt to climate change in Jordan	Donor: GEF Implementing agency: IFAD in cooperation with National Center for Agricultural Research and Extension (NCARE)	Grant (USD 2 million)	X	X	Reducing the vulnerability of the agricultural system to climate change in Jordan particularly from impacts on water resources by testing innovative and efficient water-use technologies.
2009-2015	Mainstreaming sustainable land and water management practices in Jordan	Donor: GEF Implementing agency: IFAD in cooperation with Ministry of Agriculture	Grant (USD 6.44 million)	X	X	Reducing land degradation, promoting the integration of an ecosystem based approach into public supported development activities, Designing and implementing community activities to improve the economic productivity of land and support the adoption of sustainable land management concept and the concept of integrated management of water resources at local levels.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2015-2018	Mainstreaming RIO Convention provisions into national sectorial policies	Donor: GEF Badia restoration program Implementing agency: UNDP in cooperation with Ministry of Environment	Grant GEF (USD 1 million) (USD 777 thousand) additional grant	X		RIO Convention mainstreaming in targeted strategies by developing roadmaps for each strategy and improving awareness and understanding of RIO Convention contribution to local sustainable development.
2015-2017	Preparation of first biennial update report (FBUR)	Donor: GEF Implementing agency: UNDP in cooperation with Ministry of Environment and RSS	Grant (USD 352 thousand)	X	X	Assisting Jordan in mainstreaming and integrating climate change consideration into national and sectoral development policies, assisting in the preparation and submission of Jordan's First Biennial Update Report to UNFCCC.
	ICE	Donor: GIZ Implementing agency: Ministry of Environment	Grant (650 thousand Euro)	X	X	Increasing the cooperation between the respective ministries as well as between the public and private sectors, while agreeing on achievable and constructive targets to reduce the country's GHG emissions, combating climate change efficiently and in a participatory way.
	Partnership for Market Readiness (PMR) (phase 1)	Donor: World Bank Implementing agency: Ministry of Environment	Grant (USD 350 thousand)		X	Preparing the organizational framework for Jordan.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
	Partnership for Market Readiness (PMR) (phase 2)	Donor: World Bank Implementing agency: Ministry of Environment	Grant (USD 3 million)	X	X	The Jordan Market Readiness Proposal (MRP) outlines a plan for the implementation of necessary market readiness components to support the development of appropriate market based instruments. There are two phases. In the 1st phase, the objectives are: Developing a robust and transparent MRV framework that builds on and utilizes the existing information management systems managed by different ministries and funds, and Developing the pipeline of GHG mitigation activities through engagement, technical assistance, and capacity building of the private sector, increasing market participation through web-based registry for climate projects and financing sources.
	REIII	Donor: European union (EU) Implementing agency: Ministry of Energy	Grant (90 million Euro)	X	X	Replacing diesel-operated water pumps with 300 solar units, 200 in the Jordan Valley and 100 in the highlands.
	SNAP	Donor: CCAC Coalition Implementing agency: UNEP in cooperation with Ministry of Environment	Grant (USD 120 thousand)	X	X	Training and support of GHG emissions inventories (including BC), and mainstreaming short lived climate pollutants (SLCPs) in national plans.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
	INDCs	Donor: GIZ Implementing agency: Ministry of Environment			X	Jordan has nationally determined to reduce its greenhouse gas emissions by 14% by 2030. This contribution of GHG emissions reduction will be unconditionally fulfilled at, maximally, 1.5% by the country's own means compared to a business as usual scenario. However, Jordan, conditionally and subject to availability of international financial aid and support to means of implementation, commits to reduce its GHG emissions by at least 12.5% by 2030.
	Climate South Project	Donor: EU	Only Technical Assessment		X	Technical assistance task for Middle East developing countries.
2011-2019	Badia Rehabilitation Program: Monitoring and evaluation	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with University of Jordan	Grant (716 thousand JD)			Monitoring and evaluation of progress made in the project.
2014-2016	Ecosystems and livelihoods project in the Jordanian desert	Donor: Global Environment Facility (GEF) Implementing agency: Ministry of Environment in cooperation with the Royal Society for the Conservation of Nature	Grant (1,056 thousand JD)			Developing an eco-tourism program in the Eastern Badia region – Ruwaished.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2013-2017	Badia Rehabilitation Program: Training, guidance, and awareness raising for livestock breeders and the local community	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with Jordan Cooperative Corporation	Grant (737 thousand JD)	x		Publications, lectures, training, and awareness-raising courses.
2011-2019	Badia Rehabilitation Program: Implementation of rainwater harvesting in the small level of waterfalls (lines and semi-contour circles)	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with National Center for Agricultural Research and Extension	Grant (1,839 thousand JD)	X		Establishment of water harvesting techniques on 105 thousand acres of land using Valerian.
2011-2019	Badia Rehabilitation Program: Water diffusion and soil conservation technologies	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with National Center for Agricultural Research and Extension	Grant (140 thousand JD)	X		Implementation of 10 thousand meters of water diffusion technologies.
2011-2016	Badia Rehabilitation Program: Rehabilitation of artesian wells in Badia and improving water quality	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with the Water Authority of Jordan	Grant (2,866 thousand JD)	X	X	Rehabilitation of one well.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2011-2019	Badia Rehabilitation Program: Water harvesting technologies at a large level of waterfalls	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with the Jordan Valley Authority	Grant (11,936 thousand JD)			Digging a total of 26 holes/ wells
2013-2019	Badia Rehabilitation Program: Sustainable production of irrigated feed Through rising height of AlWaleh Dam	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Environment in cooperation with the Jordan Valley Authority	Grant (27,878 thousand JD)			Cultivation of 16,000 dunum of barley using the Al Waleh dam water.
2016-2019	Completion of the national network of protected areas	Implementing agency: Ministrzy of Environment	General budget (55 thousand JD)			Increasing the size of protected areas to become 4% of the kingdom's area by 2025. Completing the addition of 9 new protected areas in addition to existing ones.
2013-2016	Development of a comprehensive database about the state of the environment in Zarqa River basin	Implementing agency: Ministry of Environment	General budget (30 thousand JD)			Developing and setting up a database about the state of the environment in the Zarqa River basin.
2013-2016	Development of the evaporative unit in Al-Hamra landfill for Zibar water treatment	Implementing agency: Ministry of Environment	General budget (260 thousand JD)			Treatment of Zibar produced from olive presses in Al Balqa'a.
2016-2019	Studying air pollutants concentrations from industries	Implementing agency: Ministry of Environment	General budget (1,156 thousand JD)			Monitoring the concentration of air pollutants in industrial areas.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2013- 2018	Replacement of ozone depleting substances in the cooling and air conditioning maintenance sector	Donor: Montreal Fund Implementing agency: Ministry of Environment	Grant (3,540 thousand JD)	X		Reducing ozone depleting substances by 2025 by 40%.
2012-2016	Solar air conditioning and cooling project	Donor: Government of Germany Implementing agency: Ministry of Environment	Grant (2,720 thousand JD)	X		Installation of solar air conditioning and cooling systems
2016-2019	Central station for industrial wastewater treatment	Implementing agency: Ministry of Environment	General budget (75,000 thousand JD)			Establishing a central station for industrial wastewater treatment
2015-2016	Preparing the National Green Growth Plan	Donor: GGGI	Grant (797 thousand JD)		X	Preparing the National Green Growth Plan.
2016-2019	Setting up a solid waste recycling unit and waste-to-energy production unit	Implementing agency: Ministry of Environment	Private sector (15,000 thousand JD)			Setting up a solid waste recycling unit and waste-to-energy production unit
2013-2019	Badia Rehabilitation Program: Environmental education for students in Al- Badia	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Education	Grant (1,416 thousand JD)	X		Reaching out to 300 schools in the Al-Badia.
2011-2019	Badia Rehabilitation Program: Cultivation of pastoral shrubs with water harvesting technologies	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Agriculture	Grant (3,909 thousand JD)	X		Cultivation of 5,250,000 plants.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2011-2019	Badia Rehabilitation Program: Protection of grassland and grazing and the application of the pastoral cycle	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Agriculture	Grant (3,093 thousand JD)	X		Protection of pasture.
2011-2019	Badia Rehabilitation Program: Raising the productivity of livestock in Badia and improving the income of targeted groups	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Agriculture	Grant (4,119 thousand JD)	X		Improving the productivity of livestock.
2015-2017	Badia Rehabilitation Program: Studies and surveys on land use in areas under rehabilitation	Donor: Governing Council of the Badia Rehabilitation Program in the United Nations Implementing agency: Ministry of Agriculture	Grant (60 thousand JD)		X	Reporting on the progress made in the project currently being implemented by the compensation program for Al-Badia.
2016-2018	Public-private partnership with 500,000 EUR funded by EIB to conduct feasibility studies and tender documents.	Implementing agency: Ministry of Environment	Private sector (26,500 thousand JD)			Construction of an industrial wastewater treatment plant in Halabat area
2016-2019	Development of Al-Ekeder landfill and construction of a Zibar landfill	Implementing agency: Ministry of Environment	General budget (2,004 thousand JD)			Treatment of Zibar produced from olive presses in northern Governorates.
2016-2020	Construction of a single landfill at the site of the Khirbet Al Samra wastewater treatment plant	Donor: WAJ and KFW	Grant and general budget			Construction of a single landfill at the site of the Khirbet Al Samra in order to bury the sludge in the landfill and to collect biogas according to international technical and environmental standards.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2016-2020	Treatment and management of sludge at the Central Irbid treatment plant and Wadi Al Arab plant	Donor: WAJ and KFW	Grant and general budget			Sludge treatment and management in Central Irbid treatment plant and Wadi Al Arab plant, according to international standards.
2015	Wind energy - Tafila, 117 MW	Jordan Wind project Company (JWPC)	Private sector (USD 290 million)			Diversification of energy sources. Generating clean energy. Reducing carbon emission. Raising awareness about energy rationalization, conservation of energy resources, and protection of environment.
2015	Solar energy - Mafraq, 10 MW	Philadelphia Company for Solar Energy	Private sector (USD 22.5 million)			Same as above.
2015	Solar energy – Azraq, 2.17 MW	Atersa	Spanish grant (USD 5 million)			Same as above.
2015	Solar energy – Azraq, 3 MW	Ennera	Spanish loan (USD 6 million)			Same as above.
2016-2017	Solar energy - round I, 200 MW	International and local companies	Private sector (USD 400 million)			Same as above.
2017	Wind energy – Ma'an, 80 MW	Elecnor	Private sector (USD 150 million)			Same as above.
2017	Solar energy - Zaatari	Belectric Gulf Ltd.	Kreditan-stalt Fuer Wiederauf-bau (KfW) (15 million Euro)			Same as above.
2017	Solar energy - Mafraq, 50 MW	Fotowatio Renewable Ventures	Private sector (USD 86 million)			Same as above.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2017	Solar energy - Mafraq, 50 MW	Hareon Swiss Holding	Private sector (USD 79 million)			Same as above.
2017	Solar energy - Mafraq, 50 MW	Sun Rise PV Systems	Private sector (USD 80 million)			Same as above.
2017	Solar energy - Alsafawi, 50 MW	Saudi Oger	Private sector (USD 80 million)			Same as above.
2018	Solar energy - Quwera, 103 MW	TSK and Environmena	Grant - Abu Dhabi Fund (USD 150 million)			Same as above.
2019	Wind energy - Rajef, Ma'an, 82 MW	Green Watts Renewable Energy LLC	Private sector (USD 183 million)			Same as above.
2019	Wind energy - Fujij, Showbak, 90 MW	KEPCO	Private sector (USD 182 million)			Same as above.
2019	Wind energy -Tafila, 50 MW	Abour Energy Company (Xenel)	Private sector (USD 113 million)			Same as above.
2019	Wind energy - Tafila, 50 MW	KOSPO	Private sector (USD 113 million)			Same as above.
2019	Wind energy - Tafila, 100 MW	Mass Energy	Private sector (USD 201 million)			Same as above.
2019	Wind energy - Irbid, 45 MW	Hecate Energy	Private sector (USD 100 million)			Same as above.

Support Received						
Year	Project	Donor/ Implementing Agency	Type of Support			Project Objectives
			Financial Resources	Capacity Building	Technical Support	
2018	Solar energy - Muwaqer, 200 MW	Masdar	Private sector (USD 200 million)			Same as above.
2020	Solar energy - Round III, 200 MW	International and local companies	Private sector (USD 250 million)			Same as above.
2021	Wing energy - Round III, 100 MW	International and local companies	Private sector (USD 150 million)			Same as above.
2019	Solar energy - Risha, 50 MW	ACWA Power	Private sector			Same as above.
2019	Solar energy - East of Amman, 50 MW	AES/Mitsui	Private sector			Same as above.

APPENDICES

APPENDIX A

Mitigation Analysis Data

- Baseline Scenario: A.1- A.16
- GHG Emissions in the Baseline Scenario: A.17-A.21
- Mitigation Projects Tabular Updates: A.22- A.27
- GHG Mitigation Scenario: A.28

BASELINE SCENARIO

(1) Energy Sector:

Table A.1: Primary energy requirements (million ton of oil equivalent)

Year	Primary Energy	Year	Primary Energy
2013	8.30	2028	12.87
2014	8.68	2029	13.31
2015	9.24	2030	13.68
2016	9.69	2031	13.92
2017	9.93	2032	14.30
2018	10.11	2033	14.66
2019	9.97	2034	15.01
2020	10.30	2035	15.31
2021	10.36	2036	15.53
2022	10.77	2037	15.80
2023	10.92	2038	15.96
2024	11.35	2039	16.12
2025	11.53	2040	16.33
2026	11.98		
2027	12.43		

Table A.2: Final energy demand by sector (thousand TOE)

Sectors	Industrial	Residential	Services	Transport	Other	Total
2013	924	1,109	328	2,734	289	5,384
2014	1,064	1,152	338	2,398	379	5,331
2015	991	1,272	367	2,810	387	5,828
2016	1,048	1,308	388	2,880	409	6,032
2017	1,107	1,343	410	2,948	432	6,239
2018	1,170	1,377	433	3,013	457	6,450
2019	1,236	1,411	458	3,071	482	6,658
2020	1,307	1,443	484	3,133	510	6,876
2021	1,381	1,475	511	3,192	539	7,098
2022	1,459	1,506	540	3,248	569	7,323
2023	1,542	1,536	571	3,302	602	7,552
2024	1,629	1,564	603	3,353	636	7,786
2025	1,722	1,592	637	3,401	672	8,024
2026	1,816	1,618	672	3,455	708	8,268
2027	1,910	1,642	707	3,506	745	8,510
2028	2,004	1,665	742	3,554	782	8,747
2029	2,098	1,687	776	3,598	819	8,978
2030	2,192	1,706	811	3,639	855	9,203
2031	2,284	1,724	845	3,676	891	9,420
2032	2,374	1,740	879	3,709	927	9,629
2033	2,462	1,755	911	3,738	961	9,827
2034	2,548	1,767	943	3,763	994	10,015
2035	2,630	1,778	973	3,784	1,026	10,191
2036	2,709	1,786	1,002	3,800	1,057	10,354
2037	2,783	1,793	1,030	3,812	1,086	10,503
2038	2,852	1,797	1,055	3,820	1,113	10,637
2039	2,916	1,799	1,079	3,823	1,138	10,756
2040	2,974	1,800	1,101	3,822	1,161	10,857

Table A.3: Projected energy balance in 2020

Jordan Energy Balance, 2020								
	Solid Fuels	Natural Gas	Crude Oil	Hydropower	Renewables	Electricity	Oil Products	Total
Production								
Imports	230.3	3,262.9	2,535.8	2.5	568.1	106.4	3,608.1	10,314.1
Exports						-12.5	0.0	-12.5
Total Primary Supply	230.3	3,262.9	2,535.8	2.5	568.1	93.9	3,608.1	10,301.7
Oil Production								
Oil Refining			-2,535.8				2,430.6	-105.2
Gas Production		0.0						0.0
Gas Transmission		-						
Electricity Generation		-3,262.9		-2.5	-367.7	1,990.7	-1,138.9	-2,781.4
Own Use						-64.8		-64.8
Transmission and Distribution						-306.1		-306.1
Distributed Generation					-13.2	13.2		
Total Transformation	-	-3,262.9	-2,535.8	-2.5	-380.9	1,632.9	1,291.8	-3,257.5
Industrial	230.3					454.8	621.5	1,306.6
Residential					144.1	676.9	622.4	1,443.4
Services					43.1	278.8	161.6	483.5
Transport						3.2	3,129.4	3,132.6
Other						313.1	196.8	509.9
Non-Energy Sector							68.2	168.2
Total Demand	230.3	-	-	-	187.2	1,726.8	4,899.9	7,044.1
Unmet Requirements (Waste)					0.0	0.0	0.0	

Table A.4: Projected energy balance in 2025

Jordan Energy Balance, 2025									
	Solid Fuels	Natural Gas	Crude Oil	Hydropower	Renewables	Nuclear	Electricity	Oil Products	Total
Production									
Imports	303.5	1,067.3	3,002.3	2.5	622.2	3,012.9	106.4	3,421.6	11,538.7
Exports	-	-	-	-	-	-	-12.5	0.0	-12.5
Total Primary Supply	303.5	1,067.3	3,002.3	2.5	622.2	3,012.9	93.9	3,421.6	11,526.2
Oil Production									
Oil Refining			-3,002.3					2,877.8	-124.5
Gas Production		0.0							0.0
Gas Transmission									
Electricity Generation		-1,067.3		-2.5	-393.4	-3,012.9	2,484.9	-706.4	-2,697.5
Own Use							-80.2		-80.2
Transmission and Distribution							-378.7		-378.7
Distributed Generation					-13.2	-	13.2		
Total Transformation	-	-1,067.3	-3,002.3	-2.5	-406.5	-3,012.9	2,039.2	2,171.4	-3,280.9
Industrial	303.5						599.4	819.1	1,722.0
Residential					158.9		746.4	686.4	1,591.8
Services					56.8		367.5	213.0	637.3
Transport							7.2	3,393.4	3,400.6
Other							412.6	259.3	672.0
Non-Energy Sector								221.6	221.6
Total Demand	303.5	-	-	-	215.7	-	2,133.1	5,593.0	8,245.3
Unmet Requirements (Waste)	-	0.0					0.0	0.0	0.0

Table A.5: Projected energy balance in 2030

Jordan Energy Balance, 2030									
	Solid Fuels	Natural Gas	Crude Oil	Hydropower	Renewables	Nuclear	Electricity	Oil Products	Total
Production									
Imports	386.2	2,537.5	3,580.4	2.5	649.1	3,012.9	106.4	3,412.8	13,687.9
Exports							-12.5		-12.5
Total Primary Supply	386.2	2,537.5	3,580.4	2.5	649.1	3,012.9	93.9	3,412.8	13,675.4
Oil Production									
Oil Refining			-3,580.4					3,431.9	-148.5
Gas Production									
Gas Transmission									
Electricity Generation		-2,537.5		-2.5	-393.4	-3,012.9	3,009.0	-552.4	-3,489.6
Own Use							-96.5		-96.5
Transmission and Distribution							-455.7		-455.7
Distributed Generation					-13.2		13.2		
Total Transformation	-	-2,537.5	-3,580.4	-2.5	-406.5	-3,012.9	2,470.0	2,879.6	-4,190.3
Industrial	386.2						762.8	1,042.5	2,191.6
Residential					170.3		800.2	735.8	1,706.3
Services					72.3		467.7	271.1	811.1
Transport							8.1	3,630.8	3,638.8
Other							525.2	330.1	855.2
Non-Energy Sector							-	282.1	282.1
Total Demand	386.2	-	-	-	242.6	-	2,563.9	6,292.4	9,485.1
Unmet Requirements (Waste)	-	0.0	0.0	-	0.0	-	0.0	0.0	0.0

Table A.6: Projected energy balance in 2040

Jordan Energy Balance, 2040									
	Solid Fuels	Natural Gas	Crude Oil	Hydropower	Renewables	Nuclear	Electricity	Oil Products	Total
Production	-	-	-	-	-	-	-	-	-
Imports	1,844.7	2,836.4	3,580.4	2.5	769.8	3,007.9	106.4	4,199.2	16,347.4
Exports	-	-	-	-	-	-	-12.5	-	-12.5
Total Primary Supply	1,844.7	2,836.4	3,580.4	2.5	769.8	3,007.9	93.9	4,199.2	16,334.9
Oil Production	-	-	-	-	-	-	-	-	-
Oil Refining	-	-	-3,580.4	-	-	-	-	3,431.9	-148.5
Gas Production	-	-	-	-	-	-	-	-	-
Gas Transmission	-	-	-	-	-	-	-	-	-
Electricity Generation	-1,320.6	-2,836.4	-	-2.5	-478.8	-3,007.9	3,826.5	-428.9	-4,248.6
Own Use	-	-	-	-	-	-	-122.0	-	-122.0
Transmission and Distribution	-	-	-	-	-	-	-575.8	-	-575.8
Distributed Generation	-	-	-	-	-13.2	-	13.2	-	-
Total Transformation	-1,320.6	-2,836.4	-3,580.4	-2.5	-492.0	-3,007.9	3,142.0	3,003.1	-5,094.8
Industrial	524.2	-	-	-	-	-	1,035.3	1,414.8	2,974.2
Residential	-	-	-	-	179.6	-	843.9	776.1	1,799.6
Services	-	-	-	-	98.1	-	634.7	367.9	1,100.7
Transport	-	-	-	-	-	-	9.4	3,812.7	3,822.1
Other	-	-	-	-	-	-	712.7	447.9	1,160.7
Non-Energy Sector	-	-	-	-	-	-	-	382.8	382.8
Total Demand	524.2	-	-	-	277.7	-	3,235.9	7,202.3	11,240.1
Unmet Requirements (Waste)	-	0.0	0.0	-	-	-	0.0	0.0	0.0

(2) IPPU

Table A.7: Actual and estimated production/extraction/import of relevant products for (2014-2040)

Year	Clinker produced (ton)	Lime produced (ton)	Limestone extracted (ton)	Soda Ash imported (ton)	Nitric Acid produced (ton)
2014	4008856.8	10875.2	868875.6	6072.9	83740
2015	3973131.8	11315.6	904065.0	6566.7	88866
2016	4134043.6	11773.9	940679.6	6832.7	90000
2017	4301472.4	12250.8	978777.2	7109.4	90000
2018	4475682.0	12746.9	1018417.6	7397.3	90000
2019	4656947.1	13263.2	1059663.6	7696.9	90000
2020	4845553.5	13800.3	1102579.9	8008.6	96000
2021	5041798.4	14359.2	1147234.4	8333.0	96000
2022	5245991.2	14940.8	1193697.4	8670.5	96000
2023	5458453.9	15545.9	1242042.2	9021.6	96000
2024	5679521.2	16175.5	1292344.9	9387.0	96000
2025	5909541.9	16830.6	1344684.8	9767.2	102000
2026	6080918.6	17318.7	1383680.7	10050.4	102000
2027	6257265.2	17820.9	1423807.4	10341.9	102000
2028	6438725.9	18337.8	1465097.9	10641.8	102000
2029	6625448.9	18869.5	1507585.7	10950.4	102000
2030	6817587.0	19416.8	1551305.7	11268.0	108000
2031	7015297.0	19979.9	1596293.5	11594.7	108000
2032	7218740.6	20559.3	1642586.1	11931.0	108000
2033	7428084.1	21155.5	1690221.1	12277.0	108000
2034	7643498.5	21769.0	1739237.5	12633.0	108000
2035	7865160.0	22400.3	1789675.3	12999.4	108000
2036	8093249.6	23049.9	1841575.9	13376.3	108000
2037	8327953.9	23718.4	1894981.6	13764.3	110000
2038	8569464.5	24406.2	1949936.1	14163.4	110000
2039	8817979.0	25114.0	2006484.3	14574.2	110000
2040	9073700.4	25842.3	2064672.3	14996.8	110000

(3) AFOLU

Table A.8: Actual numbers of livestock in Jordan, 2010-2015

Livestock	Number of Animals (head)				
	2010	2012	2013	2014	2015
Dairy cows*	51269	51400	52942	54530	56166
Beef Cattle*	5448	4670	4810	4954	5103
Other Cattle *	12855	10000	10300	10609	10927
Total Cattle*	69572	66070	68052	70094	72196
Buffalo*	100	100	103	106	109
Sheep*	2316311	2405630	2477799	2552133	2628697
Goats*	850000	888236	914883	942330	970599
Camels**	12500	11050	11382	11723	12075
Horses**	2400	2400	2472	2546	2623
Mules & Asses**	10300	10200	10506	10821	11146
Broiler*	28122400	28139000	28983170	29852665	30748245
Layers*	7605379	6877555	7083882	7296398	7515290
Broiler Parents*	3676846	3857100	3972813	4091997	4214757
Layers Parents*	90000	70000	72100	74263	76491
Ducks**	5000	6000	6180	6365	6556
Turkeys**	3000	3000	3090	3183	3278

*Obtained from MOA, the Livestock Department, Annual reports

**Obtained from FAO statistic-online (http://www.fao.org/faostat/en/#data/QA)

Table A.9: Projected numbers of livestock in Jordan, 2016-2040

	Dairy Cows*	Beef Cattle*	Other Cattle *	Total Cattle*	Buffalo*	Sheep*	Goats*	Camels**	Horses**	Mules & Asses**
2016	57851	5256	11255	74362	113	2707558	999717	12437	2701	11480
2017	59587	5414	11593	76593	116	2788784	1029709	12810	2782	11825
2018	61374	5576	11941	78891	119	2872448	1060600	13194	2866	12179
2019	63216	5744	12299	81258	123	2958621	1092418	13590	2952	12545
2020	65112	5916	12668	83695	127	3047380	1125191	13998	3040	12921
2021	67065	6093	13048	86206	130	3138802	1158947	14418	3131	13309
2022	69077	6276	13439	88793	134	3232966	1193715	14850	3225	13708
2023	71150	6464	13842	91456	138	3329955	1229526	15296	3322	14119
2024	73284	6658	14258	94200	143	3429853	1266412	15755	3422	14543
2025	75483	6858	14685	97026	147	3532749	1304405	16227	3524	14979
2026	77747	7064	15126	99937	151	3638731	1343537	16714	3630	15428
2027	80080	7276	15580	102935	156	3747893	1383843	17216	3739	15891
2028	82482	7494	16047	106023	160	3860330	1425358	17732	3851	16368
2029	84956	7719	16528	109204	165	3976140	1468119	18264	3967	16859
2030	87505	7950	17024	112480	170	4095424	1512162	18812	4086	17365
2031	90130	8189	17535	115854	175	4218287	1557527	19376	4208	17886
2032	92834	8435	18061	119330	181	4344835	1604253	19958	4335	18422
2033	95619	8688	18603	122910	186	4475180	1652381	20556	4465	18975
2034	98488	8948	19161	126597	192	4609436	1701952	21173	4599	19544
2035	101442	9217	19736	130395	197	4747719	1753011	21808	4737	20131
2036	104486	9493	20328	134307	203	4890150	1805601	22462	4879	20734
2037	107620	9778	20938	138336	209	5036855	1859769	23136	5025	21357
2038	110849	10071	21566	142486	216	5187961	1915562	23830	5176	21997
2039	114174	10373	22213	146761	222	5343599	1973029	24545	5331	22657
2040	117599	10685	22879	151163	229	5503907	2032220	25282	5491	23337

	Broiler*	Layers*	Broiler Parents*	Layers Parents*	Ducks**	Turkeys**
2016	31670692	7740749	4341200	78786	6753	3377
2017	32620813	7972971	4471436	81149	6956	3478
2018	33599438	8212160	4605579	83584	7164	3582
2019	34607421	8458525	4743746	86091	7379	3690
2020	35645643	8712281	4886059	88674	7601	3800
2021	36715013	8973649	5032641	91334	7829	3914
2022	37816463	9242859	5183620	94074	8063	4032
2023	38950957	9520145	5339128	96896	8305	4153
2024	40119486	9805749	5499302	99803	8555	4277
2025	41323070	10099921	5664281	102797	8811	4406
2026	42562762	10402919	5834210	105881	9076	4538
2027	43839645	10715007	6009236	109058	9348	4674
2028	45154834	11036457	6189513	112329	9628	4814
2029	46509480	11367550	6375199	115699	9917	4959
2030	47904764	11708577	6566455	119170	10215	5107
2031	49341907	12059834	6763448	122745	10521	5261
2032	50822164	12421629	6966352	126428	10837	5418
2033	52346829	12794278	7175342	130221	11162	5581
2034	53917234	13178107	7390602	134127	11497	5748
2035	55534751	13573450	7612321	138151	11842	5921
2036	57200793	13980653	7840690	142296	12197	6098
2037	58916817	14400073	8075911	146564	12563	6281
2038	60684322	14832075	8318188	150961	12940	6470
2039	62504851	15277037	8567734	155490	13328	6664
2040	64379997	15735348	8824766	160155	13728	6864

Table A.10: Actual and projected areas of forest plantations, 2017-2040

	Natural Forest	Private	Plantations
	Area (1000 ha)		
2017 (actual)	36.5	10.7	50.3
2018	36.5	10.8	50.8
2019	36.5	10.9	51.3
2020	36.5	11.0	51.8
2021	36.5	11.1	52.3
2022	36.5	11.2	52.9
2023	36.5	11.4	53.4
2024	36.5	11.5	53.9
2025	36.5	11.6	54.5
2026	36.5	11.7	55.0
2027	36.5	11.8	55.6
2028	36.5	11.9	56.1
2029	36.5	12.1	56.7
2030	36.5	12.2	57.2
2031	36.5	12.3	57.8
2032	36.5	12.4	58.4
2033	36.5	12.5	59.0
2034	36.5	12.7	59.6
2035	36.5	12.8	60.2
2036	36.5	12.9	60.8
2037	36.5	13.1	61.4
2038	36.5	13.2	62.0
2039	36.5	13.3	62.6
2040	36.5	13.5	63.2

Table A.11: Actual and projected areas of non-forest fruit trees (perennial crops), 2012-2040

	Almonds	Apples	Apricots	Bananas	Cherries	Dates	Figs	Fruit, citrus	Fruit, fresh	Grapefruit (incl. pomelos)	Grapes
2010	313	2291	898	1853	130	1708	200	7	1645	553	3199
2012	313	2381	904	2090	130	1840	209	7	1466	554	3952
2013	316	2405	913	2111	131	1858	211	7	1481	560	3992
2014	319	2429	922	2132	133	1877	213	7	1495	565	4031
2015	322	2453	931	2153	134	1896	215	7	1510	571	4072
2016	326	2478	941	2175	135	1915	217	7	1526	576	4112
2017	329	2502	950	2197	137	1934	220	7	1541	582	4154
2018	332	2527	960	2219	138	1953	222	7	1556	588	4195
2019	336	2553	969	2241	139	1973	224	8	1572	594	4237
2020	339	2578	979	2263	141	1992	226	8	1587	600	4279
2021	342	2604	989	2286	142	2012	229	8	1603	606	4322
2022	346	2630	999	2309	144	2033	231	8	1619	612	4365
2023	349	2656	1009	2332	145	2053	233	8	1636	618	4409
2024	353	2683	1019	2355	146	2073	236	8	1652	624	4453
2025	356	2710	1029	2379	148	2094	238	8	1668	631	4498
2026	360	2737	1039	2402	149	2115	240	8	1685	637	4543
2027	363	2764	1050	2426	151	2136	243	8	1702	643	4588
2028	367	2792	1060	2451	152	2158	245	8	1719	650	4634
2029	371	2820	1071	2475	154	2179	248	8	1736	656	4680
2030	374	2848	1081	2500	155	2201	250	8	1754	663	4727
2031	378	2877	1092	2525	157	2223	252	8	1771	669	4774
2032	382	2905	1103	2550	159	2245	255	9	1789	676	4822
2033	386	2934	1114	2576	160	2268	258	9	1807	683	4870
2034	390	2964	1125	2601	162	2290	260	9	1825	690	4919
2035	393	2993	1136	2627	163	2313	263	9	1843	696	4968
2036	397	3023	1148	2654	165	2336	265	9	1861	703	5018
2037	401	3053	1159	2680	167	2360	268	9	1880	710	5068
2038	405	3084	1171	2707	168	2383	271	9	1899	718	5119
2039	409	3115	1183	2734	170	2407	273	9	1918	725	5170
2040	414	3146	1194	2761	172	2431	276	9	1937	732	5222

	Lemons	Olives	Oranges	Peaches and nectarines	Pears	Pistachios	Plums	Tangerines, andarins, clementine, satsumas
2010	1742	60879	2609	2357	334	304	555	1949
2012	1755	62687	2623	2357	334	290	557	1950
2013	1773	63314	2649	2381	337	293	563	1970
2014	1790	63947	2676	2404	341	296	568	1989
2015	1808	64586	2702	2428	344	299	574	2009
2016	1826	65232	2730	2453	348	302	580	2029
2017	1845	65885	2757	2477	351	305	585	2049
2018	1863	66544	2784	2502	355	308	591	2070
2019	1882	67209	2812	2527	358	311	597	2091
2020	1900	67881	2840	2552	362	314	603	2112
2021	1919	68560	2869	2578	365	317	609	2133
2022	1939	69245	2897	2604	369	320	615	2154
2023	1958	69938	2926	2630	373	324	621	2176
2024	1978	70637	2956	2656	376	327	628	2197
2025	1997	71344	2985	2682	380	330	634	2219
2026	2017	72057	3015	2709	384	333	640	2241
2027	2038	72778	3045	2736	388	337	647	2264
2028	2058	73505	3076	2764	392	340	653	2287
2029	2078	74240	3106	2791	396	343	660	2309
2030	2099	74983	3137	2819	400	347	666	2332
2031	2120	75733	3169	2848	404	350	673	2356
2032	2141	76490	3201	2876	408	354	680	2379
2033	2163	77255	3233	2905	412	357	686	2403
2034	2184	78028	3265	2934	416	361	693	2427
2035	2206	78808	3298	2963	420	365	700	2451
2036	2228	79596	3331	2993	424	368	707	2476
2037	2251	80392	3364	3023	428	372	714	2501
2038	2273	81196	3397	3053	433	376	721	2526
2039	2296	82008	3431	3083	437	379	729	2551
2040	2319	82828	3466	3114	441	383	736	2577

Table A.12: Actual and projected areas of annual crops, 2012-2040

	Barley	Beans, green	Cabbages and other brassicas	Carrots and turnips	Cauliflowers and broccoli	Chick peas	Chilies and peppers, green	Cucumbers and gherkins	Eggplants (aubergines)	Garlic	Lentils	Lettuce and chicory	Maize	Melons
2012	36342	686	896	177	1183	1321	1630	2076	3488	67	186	1898	1361	875
2013	37432	707	923	182	1218	1361	1679	2138	3593	69	192	1955	1402	901
2014	38555	728	951	188	1255	1401	1729	2202	3700	71	197	2014	1444	928
2015	39712	750	979	193	1293	1443	1781	2269	3811	73	203	2074	1487	956
2016	40903	772	1008	199	1331	1487	1835	2337	3926	75	209	2136	1532	985
2017	42130	795	1039	205	1371	1531	1890	2407	4044	78	216	2200	1578	1014
2018	43394	819	1070	211	1413	1577	1946	2479	4165	80	222	2266	1625	1045
2019	44696	844	1102	218	1455	1625	2005	2553	4290	82	229	2334	1674	1076
2020	46037	869	1135	224	1499	1673	2065	2630	4418	85	236	2404	1724	1108
2021	47418	895	1169	231	1544	1724	2127	2709	4551	87	243	2476	1776	1142
2022	48841	922	1204	238	1590	1775	2191	2790	4688	90	250	2551	1829	1176
2023	50306	950	1240	245	1638	1829	2256	2874	4828	93	257	2627	1884	1211
2024	51815	978	1277	252	1687	1883	2324	2960	4973	96	265	2706	1940	1248
2025	53369	1007	1316	260	1737	1940	2394	3049	5122	98	273	2787	1999	1285
2026	54971	1038	1355	268	1789	1998	2466	3140	5276	101	281	2871	2059	1324
2027	56620	1069	1396	276	1843	2058	2539	3234	5434	104	290	2957	2120	1363
2028	58318	1101	1438	284	1898	2120	2616	3331	5597	108	298	3046	2184	1404
2029	60068	1134	1481	293	1955	2183	2694	3431	5765	111	307	3137	2250	1446
2030	61870	1168	1525	301	2014	2249	2775	3534	5938	114	317	3231	2317	1490
2031	63726	1203	1571	310	2074	2316	2858	3640	6116	117	326	3328	2387	1534
2032	65638	1239	1618	320	2137	2386	2944	3749	6300	121	336	3428	2458	1580
2033	67607	1276	1667	329	2201	2457	3032	3862	6489	125	346	3531	2532	1628
2034	69635	1314	1717	339	2267	2531	3123	3978	6683	128	356	3637	2608	1677
2035	71724	1354	1768	349	2335	2607	3217	4097	6884	132	367	3746	2686	1727
2036	73876	1394	1821	360	2405	2685	3313	4220	7090	136	378	3858	2767	1779
2037	76092	1436	1876	371	2477	2766	3413	4347	7303	140	389	3974	2850	1832
2038	78375	1479	1932	382	2551	2849	3515	4477	7522	144	401	4093	2935	1887
2039	80726	1524	1990	393	2628	2934	3621	4611	7748	149	413	4216	3023	1944
2040	83148	1570	2050	405	2707	3022	3729	4750	7980	153	426	4342	3114	2002

	Okra	Onions, dry	Onions, shallots, green	Peas, green	Potatoes	Pumpkins, squash and gourds	Sesame seed	Sorghum	Spinach	Strawberries
2012	1280	1030	87	484	6038	2951	3	783	44	107
2013	1318	1061	90	499	6219	3040	3	806	45	110
2014	1358	1093	92	513	6406	3131	3	831	47	114
2015	1399	1126	95	529	6598	3225	3	856	48	117
2016	1441	1159	98	545	6796	3321	3	881	50	120
2017	1484	1194	101	561	7000	3421	3	908	51	124
2018	1528	1230	104	578	7210	3524	4	935	53	128
2019	1574	1267	107	595	7426	3629	4	963	54	132
2020	1621	1305	110	613	7649	3738	4	992	56	136
2021	1670	1344	114	632	7878	3850	4	1022	57	140
2022	1720	1384	117	650	8115	3966	4	1052	59	144
2023	1772	1426	120	670	8358	4085	4	1084	61	148
2024	1825	1469	124	690	8609	4207	4	1116	63	153
2025	1880	1513	128	711	8867	4334	4	1150	65	157
2026	1936	1558	132	732	9133	4464	5	1184	67	162
2027	1994	1605	136	754	9407	4598	5	1220	69	167
2028	2054	1653	140	777	9689	4735	5	1256	71	172
2029	2116	1702	144	800	9980	4878	5	1294	73	177
2030	2179	1754	148	824	10279	5024	5	1333	75	182
2031	2244	1806	153	849	10588	5175	5	1373	77	188
2032	2312	1860	157	874	10905	5330	5	1414	79	193
2033	2381	1916	162	900	11232	5490	6	1457	82	199
2034	2453	1974	167	927	11569	5654	6	1500	84	205
2035	2526	2033	172	955	11917	5824	6	1545	87	211
2036	2602	2094	177	984	12274	5999	6	1592	89	218
2037	2680	2157	182	1013	12642	6179	6	1639	92	224
2038	2760	2221	188	1044	13021	6364	6	1689	95	231
2039	2843	2288	193	1075	13412	6555	7	1739	98	238
2040	2929	2357	199	1107	13815	6752	7	1791	101	245

	Tobacco	Tomatoes	Vegetables, fresh (NES)	Vegetables, leguminous (NES)	Vetches	Watermelons	Wheat
2012	2502	12345	3387	1375	900	2932	15499
2013	2577	12715	3489	1416	927	3020	15964
2014	2654	13097	3593	1459	955	3111	16443
2015	2734	13490	3701	1502	983	3204	16936
2016	2816	13894	3812	1548	1013	3300	17444
2017	2901	14311	3926	1594	1043	3399	17968
2018	2988	14741	4044	1642	1075	3501	18507
2019	3077	15183	4166	1691	1107	3606	19062
2020	3169	15638	4291	1742	1140	3714	19634
2021	3265	16107	4419	1794	1174	3826	20223
2022	3362	16591	4552	1848	1210	3940	20829
2023	3463	17088	4688	1903	1246	4059	21454
2024	3567	17601	4829	1960	1283	4180	22098
2025	3674	18129	4974	2019	1322	4306	22761
2026	3784	18673	5123	2080	1361	4435	23444
2027	3898	19233	5277	2142	1402	4568	24147
2028	4015	19810	5435	2206	1444	4705	24871
2029	4135	20404	5598	2273	1488	4846	25617
2030	4259	21017	5766	2341	1532	4992	26386
2031	4387	21647	5939	2411	1578	5141	27178
2032	4519	22296	6117	2483	1626	5296	27993
2033	4654	22965	6301	2558	1674	5454	28833
2034	4794	23654	6490	2635	1724	5618	29698
2035	4938	24364	6685	2714	1776	5787	30589
2036	5086	25095	6885	2795	1830	5960	31506
2037	5239	25848	7092	2879	1884	6139	32451
2038	5396	26623	7304	2965	1941	6323	33425
2039	5558	27422	7524	3054	1999	6513	34428
2040	5724	28244	7749	3146	2059	6708	35461

*NES=Not elsewhere specified

(4) Waste Sector

Table A.13: Domestic landfill sites in Jordan

No.	Site name	Operation date	Governorate	Site area (dunum)	Quantity (ton/day)
1	Al-Ekader	1980	Irbid	856	1300
2	Husaineat	1986	Mafraq	380	180
3	North Badia	2001	Mafraq	360	85
4	Al Humra	1989	Al Salt	267	500
5	Al-Ghabawi	2003	Amman	2000	3000
6	Maddaba	1973	Madaba	163	500
7	Al-Dhulil	1991	Zarqa	270	350
8	North Ghor	1989	Irbid	76	180
9	Middle Ghor/Dir alla	1998	Al-Balqa	364	290
10	Ghor Al-Mazra'a	1997	Karak	205	22
11	Lajoon	1996	Karak	485	800
12	Ghor Al-Safi	1996	Karak	153	25
13	Jurf Al Drawish	1985	Tafilah	450	100
14	Eyil Neimat	1983	Ma'an	274	42
15	Ma'an	1993	Ma'an	500	80
16	Al-Quaira	2000	Aqaba	380	47
17	Aqaba	2005	Aqaba	60	120

Source: Ministry of Municipal affairs, Municipal Solid Waste Strategy, 2014

Table A.14: Actual and predicted amounts of generated domestic solid waste for 2010-2040

Year	Population (capita)	MSW disposed to SWDS (Gg MSW)
2010	6113000	2008.12
2011	6249000	2052.80
2012	6388000	2098.46
2013	6530000	2145.11
2014	7930491	2605.17
2015	9559000	3140.13
2016	9769298	3209.21
2017	9,984,223	3279.82
2018	10,203,875	3351.97
2019	10,428,361	3425.72
2020	10,657,785	3501.08
2021	10,892,256	3578.11
2022	11,131,886	3656.82
2023	11,376,787	3737.27
2024	11,627,076	3819.49
2025	11,882,872	3903.52
2026	12,144,295	3989.40
2027	12,411,470	4077.17
2028	12,684,522	4166.87
2029	12,963,582	4258.54
2030	13,248,780	4352.22
2031	13,540,253	4447.97
2032	13,838,139	4545.83
2033	14,142,578	4645.84
2034	14,453,715	4748.05
2035	14,771,697	4852.50
2036	15,096,674	4959.26
2037	15,428,801	5068.36
2038	15,768,234	5179.86
2039	16,115,135	5293.82
2040	16,469,668	5410.29

Table A.15: Quantities of wastewater discharged to WWTPs, 2010-2015

Year	2010	2011	2012	2013	2014	2015
	M³/day	M³/day	M³/day	M³/day	M³/day	M³/day
Samra	20192	0	0	0	0	0
Samra Mech.	210414.1	226674.6	240925.5	249740	283740	294862.4
Aqaba Tertiary	9845.5	7980.2	8511.3	9955	10892	12475
Aqaba Natural	6730.6	7001	7220.1	6877	7447	6699
Irbid	8132.1	8635.1	8710.7	8104.1	7544.1	8142.9
Salt	5290.7	5327	6539.2	7487.6	8127.7	8082.1
Jerash	3680.8	4224.1	3333.2	0	0	0
Mafraq	2008.8	1915.2	1618.2	1710	4190	3556
Baqa'a	10208.6	10627.2	11713.3	13537	12363	11861.1
Karak	1753.4	1674.3	1852.2	1750	1398	1408
Abu Nuseir	2570.8	2631.9	2400.6	2724	3113.8	3200.7
Tafila	1380	1526.8	1575.4	990.2	1242	1450.4
Ramtha	3488.3	3857.5	4049.9	4477	4713	4743
Ma'an	3170.8	2517.7	2357.8	2530.3	2477.6	2288
Madaba	5172	5013.6	5259.6	5204	5859	6548.6
Kufranja	2763	2079.1	2637.6	2559.5	2601.7	2506
Wadi Al Seer	3623.8	3554.2	4052.8	4760.1	4748.6	5039.9
Fuhis	2221	2036.4	2304.7	2305	2380.3	2719
wadi Arab	10264	10136.6	10681.4	11289	12532	12880
Wadi Mousa	3028.9	2519.4	2536.4	2733.3	2816.5	2628
Wadi Hassan	1139.3	1131.8	1237.6	1277	1598	1594
Tall- Almantah	300	321	365	365	382	320
ALekader	3907.8	3232.4	2932.4	3316	2951	1918
AL- Lajjoun	853.1	738.4	734.7	738	678.4	595
AL -Jiza	703.9	569.1	623.9	739.2	769.6	772.8
Al- Maraad	0	853	2297.1	3601	4910	6268
Shobak	39	71.1	67.8	43.9	69.4	91.8
AL- Mansourah	0	15	12.1	N.A	N.A	N.A
Al - Shallalh	0	0	0	2307	4375	5656
Mu'ta	0	0	0	0	0	1228
North Shouna	0	00	0	0	0	827
Total m³/d	322882.3	316863.7	336550.5	346736.1	388940.3	410360.7
Total (MCM) M³/Yr	117.85	115.7	122.8	126.6	142.0	149.8

Source: MWI open files, 2016

Table A.16: Influent organic load to WWTPs, 2015

Plant	BOD5 (IN)mg/l
Jerash	0
Kufranja	678
Irbid	1214
Madaba	923
Baqa'a	542
Wadi Hassan	1285
Salt	680
Ramtha	1066
Fuhais	409
Samra	620
Karak	NA
Mafraq	N.A
Wadi Arab	803
Tafila	731
Wadi Mousa	327
Abu-Nusir	800
Ma'an	551
Wadi Al Seer	388
Aqaba Natural	370
Aqaba Tertiary	338
Tall - Almantah	913
AL - Lajjoun	1500*
Al- ekader	1500*
Al-Mirad	1204
Mu'ta	415
AL_ Jiza	1150

Source: MWI annual report, 2015

GHG EMISSIONS IN THE BASELINE

(1) Energy

Table A.17: GHG emissions (million ton of CO_2eq) from energy demand and supply in the baseline scenario for 2016-2040

Branches	Demand	Transformation	Total
2016	13.73	12.45	26.19
2017	14.17	12.38	26.55
2018	14.61	12.14	26.75
2019	15.04	11.08	26.11
2020	15.48	11.42	26.90
2021	15.94	11.16	27.09
2022	16.39	11.79	28.18
2023	16.86	7.94	24.79
2024	17.32	8.62	25.94
2025	17.79	4.82	22.61
2026	18.29	5.53	23.81
2027	18.77	6.23	25.00
2028	19.25	6.93	26.18
2029	19.71	7.62	27.33
2030	20.15	7.81	27.96
2031	20.58	8.12	28.70
2032	20.99	8.74	29.73
2033	21.37	7.64	29.02
2034	21.74	8.23	29.97
2035	22.07	6.97	29.04
2036	22.38	7.09	29.47
2037	22.66	7.51	30.17
2038	22.91	7.60	30.51
2039	23.13	7.74	30.87
2040	23.31	8.11	31.42

(2) IPPU

Table A.18: GHG emissions (Gg of CO_2eq/year) from industrial processes in the baseline scenario for 2015-2040

Year	N_2O	CO_2	Total
2015	0.62	2474.8	2667.6
2016	0.63	2575.0	2770.3
2017	0.63	2679.3	2874.6
2018	0.63	2787.8	2983.1
2019	0.63	2900.7	3096.0
2020	0.67	3018.2	3226.5
2021	0.67	3140.4	3348.7
2022	0.67	3267.6	3475.9
2023	0.67	3399.9	3608.3
2024	0.67	3537.6	3746.0
2025	0.71	3680.9	3902.2
2026	0.71	3787.7	4009.0
2027	0.71	3897.5	4118.8
2028	0.71	4010.5	4231.9
2029	0.71	4126.8	4348.2
2030	0.76	4246.5	4480.9
2031	0.76	4369.7	4604.0
2032	0.76	4496.4	4730.7
2033	0.76	4626.8	4861.1
2034	0.76	4760.9	4995.3
2035	0.76	4899.0	5133.4
2036	0.76	5041.1	5275.4
2037	0.77	5187.3	5426.0
2038	0.77	5337.7	5576.4
2039	0.77	5492.5	5731.2
2040	0.77	5651.8	5890.5

(3) AFOLU

Table A.19: GHG emissions (Gg of CO_2eq/year) from the AFOLU sector in the baseline scenario for 2013-2040

Year	CH_4 Emissions from Livestock	N_2O Emissions from managed soils	Net CO_2 Emissions from Land	Total
	(Gg of CO_2eq/year)			
2013	24.363	0.017	-228.614	288.314
2014	26.068	0.018	-212.611	340.502
2015	27.893	0.020	-197.728	394.103
2016	29.845	0.021	-183.887	449.372
2017	31.935	0.022	-171.015	506.572
2018	34.170	0.024	-159.044	565.974
2019	36.562	0.026	-147.911	627.858
2020	39.121	0.028	-137.557	692.516
2021	41.860	0.029	-127.928	760.250
2022	44.790	0.031	-118.973	831.378
2023	47.925	0.034	-110.645	906.230
2024	51.280	0.036	-102.900	985.157
2025	54.870	0.039	-95.697	1068.524
2026	58.710	0.041	-88.998	1156.718
2027	62.820	0.044	-82.768	1250.148
2028	67.218	0.047	-76.974	1349.246
2029	71.923	0.051	-71.586	1454.469
2030	76.957	0.054	-66.575	1566.304
2031	82.344	0.058	-61.915	1685.266
2032	88.109	0.062	-57.581	1811.903
2033	94.276	0.066	-53.550	1946.797
2034	100.876	0.071	-49.802	2090.570
2035	107.937	0.076	-46.316	2243.882
2036	115.492	0.081	-43.073	2407.438
2037	123.577	0.087	-40.058	2581.989
2038	132.227	0.093	-37.254	2768.336
2039	141.483	0.099	-34.646	2967.336
2040	151.387	0.106	-32.221	3179.899

Table A.20 GHG emissions (Gg of CO_2eq/year) from the waste sector in the baseline scenario for 2015-2040

Year	Wastewater		Solid Waste	Total CO_2eq (Giga gram/year)
	CH_4	N_2O	CH_4	
2015	0.0197	0.6225	141.00	3154.39
2016	0.0205	0.6362	145.65	3256.27
2017	0.0212	0.6502	149.98	3351.52
2018	0.0220	0.6645	153.26	3425.00
2019	0.0228	0.6791	153.05	3425.05
2020	0.0237	0.6940	156.68	3505.86
2021	0.0245	0.7093	160.29	3586.45
2022	0.0254	0.7249	163.61	3661.13
2023	0.0264	0.7409	166.66	3730.14
2024	0.0274	0.7572	169.78	3800.77
2025	0.0284	0.7738	172.69	3866.97
2026	0.0294	0.7908	175.64	3934.19
2027	0.0305	0.8082	178.24	3994.24
2028	0.0316	0.8260	181.15	4060.95
2029	0.0328	0.8442	183.57	4117.38
2030	0.0340	0.8628	185.96	4173.33
2031	0.0353	0.8817	188.26	4227.59
2032	0.0366	0.9011	190.44	4279.45
2033	0.0379	0.9210	194.05	4361.35
2034	0.0393	0.9412	198.39	4458.80
2035	0.0408	0.9619	203.05	4563.12
2036	0.0423	0.9831	207.66	4666.58
2037	0.0439	1.0047	212.22	4769.05
2038	0.0455	1.0268	216.76	4871.29
2039	0.0472	1.0494	221.16	4970.64
2040	0.0489	1.0725	225.58	5070.65

Table A.21: GHG emissions (million ton of CO_2eq/year) in Jordan by sector in the baseline scenario for 2016-2040

2Year	IPPU	AFOLU	Wastewater	Solid Waste	Waste	Energy
2016	2.77	0.45	0.20	3.06	3.26	26.19
2017	2.87	0.51	0.20	3.15	3.35	26.55
2018	2.98	0.57	0.21	3.22	3.42	26.75
2019	3.10	0.63	0.21	3.21	3.43	26.11
2020	3.23	0.69	0.22	3.29	3.51	26.90
2021	3.35	0.76	0.22	3.37	3.59	27.09
2022	3.48	0.83	0.23	3.44	3.66	28.18
2023	3.61	0.91	0.23	3.50	3.73	24.79
2024	3.75	0.99	0.24	3.57	3.80	25.94
2025	3.90	1.07	0.24	3.63	3.87	22.61
2026	4.01	1.16	0.25	3.69	3.93	23.81
2027	4.12	1.25	0.25	3.74	3.99	25.00
2028	4.23	1.35	0.26	3.80	4.06	26.18
2029	4.35	1.45	0.26	3.85	4.12	27.33
2030	4.48	1.57	0.27	3.91	4.17	27.96
2031	4.61	1.69	0.27	3.95	4.23	28.70
2032	4.73	1.81	0.28	4.00	4.28	29.73
2033	4.86	1.95	0.29	4.08	4.36	29.02
2034	5.00	2.09	0.29	4.17	4.46	29.97
2035	5.13	2.24	0.30	4.26	4.56	29.04
2036	5.28	2.41	0.31	4.36	4.67	29.47
2037	5.43	2.58	0.31	4.46	4.77	30.17
2038	5.58	2.77	0.32	4.55	4.87	30.51
2039	5.73	2.97	0.33	4.64	4.97	30.87
2040	5.89	3.18	0.33	4.74	5.07	31.42

MITIGATION PROJECTS TABULAR UPDATES

Table A.22: Primary energy projects

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status	Main assumptions used in the mitigation analysis	Project Duration	Emission reductions during project duration (Gg of CO_2eq)
Electricity T&D Network Losses	Electricity (CO_2, N_2O, CH_4)	NEPCO and Distribution Companies	planned	Reduce the T&D losses to 12% in 2022 compare to 16% in 2015	2017-2022	8435
Adding a 100 MW Combined cycle in AsSamra Power Plant	Electricity (CO_2, N_2O, CH_4)	CEGCO	planned	Utilize the waste heat	2018-2019	3564
Natural Gas Distribution Network in Amman, Zarqa, Aqaba	Supply (CO_2, N_2O, CH_4)	MEMR and Private Sec.	planned	Replace the Oil products with NG in demand sectors	2020-2030	3442
Demand Side Management	Electricity (CO_2, N_2O, CH_4)	NEPCO and Distribution Companies	planned	Reduce the system peak load	2018-2022	2842

OBJECTIVE OF THE MITIGATION ACTION

The objective of these mitigation actions is to reduce emissions by:

- Reducing electricity consumption which will result in reduced quantity of fuels used for electricity generation.
- Replacing used fuel oil products with natural gas.

Table A.23: Renewable energy projects

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
1. 100 MW Concentrated Solar Power (CSP)	Renewable energy sub-sector (CO_2)	Ministry of Energy and Mineral Resources	Proposed idea	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Capacity factor for CSP technology is 27%. d. Discount rate is 8%.	2018-2040	3,158
2. 300 MW Concentrated solar power (CSP)	Renewable energy sub-sector (CO_2)	Ministry of Energy and Mineral Resources	Proposed idea	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Capacity factor for CSP technology is 27%. d. Discount rate is 8%.	2023	7,415 This is the yearly reduction needed to add the cumulative reduction over the life time of the project (reduced at 8%) Please confirm abatement cost of -25.57 JD / ton of CO_2eq
3. 150 MW Wind farm	Renewable energy sub-sector (CO_2)	MEMR	Baseline project (part of the committed projects as per the updated Energy strategy 2015-2025)	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Capacity factor for wind energy is 26%. c. Discount rate is 8%.	2018	4,562

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
4. Solar water heaters 1-30,000 houses	Renewable energy sub-sector Residential sector (CO_2)	JREEEF	Part of it is under implementation Baseline JREEEF is implementing a program to install 5000 SWH	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Annual energy production for one m2 of solar water heater is 740 KWh. c. Discount rate is 8%.		1,362
5. Solar water heaters 2-30,000 houses	Renewable energy sub-sector Residential sector (CO_2)	MEMR & JREEEF can initiate and lead the implementation of this action.	Considered as additional (mitigation measure)	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Annual energy production for one m^2 of solar water heater is 740 KWh. c. Discount rate is 8%.	2018-20140	1,362
6. Solar water heaters 3-30,000 houses	Renewable energy sub-sector Residential sector (CO_2)	MEMR & JREEEF can initiate and lead the implementation of this action.	Proposed idea, Additional (mitigation)	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Annual energy production for one m^2 of solar water heater is 740 KWh. c. Discount rate is 8%.	2020	1,362
7. Biogas power plant - 15 MW	Renewable energy sub-sector (CO_2)	This project is included in the MEMR plan to be implemented by the private sector in the northern part of Jordan at Al-Ekader waste dumping site.	Baseline (25 MW plant in Al Ekader is under implementation currently in the tendering stage)	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. annual average electricity production is 2,000 KWh/KW.	2018	

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
8. PV 1 - 200 MW	Renewable energy sub-sector (CO_2)	This proposed project will be implemented according to the direct proposals by MEMR until 2020.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.	2018	4,166
9. PV 2 - 200 MW	Renewable energy sub-sector (CO_2)	This proposed project will be implemented according to the direct proposals by MEMR until 2020.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.	2018	4,166
10. Wind - 230 MW	Renewable energy sub-sector (CO_2)	This project is included in planned renewable energy projects in Jordan's INDCs as direct proposal.	Part of it is included in the baseline with a capacity of 100 MW and it is not valid to include the remaining capacity as mitigation project	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Capacity factor for wind energy is 26%. c. Discount rate is 8%.	2018	6,995
11. PV 3 - 50 MW	Renewable energy sub-sector (CO_2)	This proposed project will be implemented according to the direct proposals by MEMR until 2020.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.		

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
12. PV 4 - 50 MW	Renewable energy sub-sector (CO_2)	This proposed project will be implemented according to the direct proposals by MEMR until 2020.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.		
13. PV 5 - 50 MW	Renewable energy sub-sector (CO_2)	This proposed project will be implemented according to the direct proposals by MEMR until 2020.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.		
14. PV 6 - 50 MW	Renewable energy sub-sector (CO_2)	This proposed project will be implemented according to the direct proposals by MEMR until 2020. It will be implemented in Azraq.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.		
15. PV7- 50 MW	Renewable Energy Sub-sector CO_2 Reduction	This proposed project will be implemented according to a bidding system by MEMR. It will be implemented in Quweirah.	Baseline	a. Annual average solar energy yield is 1520 KWhe/KWp. b. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). c. Discount rate is 8%.		

Table A.24: Energy efficiency projects

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
1. Replacing high thermal mass cars with low thermal mass ones in ceramic factories.	Energy efficiency sub-sector (CO_2)	Manufacturing plants in Jordan)	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	9.305
2. Returning Un-returned condensate to the feed water tanks in Food processing	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in food factories in Jordan. Jordan Chamber of Industry can lead/initiate the implementation of this action.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2019	16.177
3. Insulating un-insulated pipes, fittings, and tanks in food processing	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in food factories in Jordan. Jordan Chamber of Industry can lead/initiate the implementation of this action.	Not planned yet.	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	18.044

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
4. Replacing fluorescent lamp fixtures with LED lamp fixtures in commercial buildings	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in commercial buildings. Jordan Chamber of Commerce can initiate and lead the implementation of this measure.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	112.162
5. Insulating walls and roofs in 35,000 new houses	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in residential buildings. Ministry of Public Works and Housing can lead the implementation of this action in cooperation with municipalities.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2023	153.613
6. Replacing 125 W mercury lamps with 70 W high pressure sodium lamps.	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in street lighting. Municipalities/ local authorities in Jordan such as GAM, Irbid, and ASEZA can lead the implementation of this action.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	Considered in LEAP as a mitigation measure.

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
7. Using regenerative burners instead of conventional burners in steel reheating.	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in steel processing. Jordan Chamber of Industry can lead/initiate the implementation of this action.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	171.711
8. Using variable speed drives in pumps.	Energy efficiency sub-sector (CO_2)	This project represents the expected savings from using variable speed drives in pumps. Jordan Chamber of Industry can lead/initiate the implementation of this action.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	196.283
9. Replacing the E-27 incandescent lamp fixtures with LED lamp fixtures in residential buildings -1,000,000 LED lamp.	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in residential buildings. Ministry of Energy and Mineral Resources and electricity distribution companies can lead the implementation of this action.	Proposed idea Considered as mitigation after modification (150,000 lamps)	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018-2030	Considered in LEAP as a mitigation measure.

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Proposed idea, planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2016-2040)	Emissions reduction (Gg)
10. Energy efficiency in existing small and medium hotels.	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in hotels. Hotels Association can lead the implementation of this action.	Proposed idea	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018- 2040	Considered in LEAP as a mitigation measure.
11. Replacement of (4X18 watt) fluorescent tubes in public buildings with LED tubes - assume replacement of 35,000 Tubes.	Energy efficiency sub-sector (CO_2)	This project represents the expected savings in public buildings. Ministry of Energy and Mineral Resources and electricity distribution companies can lead the implementation of this action.	There is some implementation but there is room for more, so it is considered a mitigation measure.	a. Grid emission factor of 0.580548 kg CO_2/KWh (Jordan NAMA report). b. Discount rate is 8%. c. No escalation rate was considered. d. Fuel emission factors used are the ones received from the refinery.	2018	Newly suggested project (not part of TNC mitigation projects).

Table A.25: IPPU Projects

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2018-2040)	Emission reductions (Gg)
Option no. 1: Use of steel slag and/ or fly ash to substitute the raw materials needed to produce clinker at the selected Cement Plant	Industrial Processes	The selected Cement Plant	Idea – not implemented	To have a reasonable option; a substitution could be estimated to produce new type of cement CEM V (Composite Cement) at one of the cement industries. A 40% substitution of steel slag/fly ash and a 10% production of new CEM V/B is assumed at this company. Therefore; the selected Company annual CO_2 emissions from producing CEM II/B-P are multiplied by 4% to calculate the CO_2 emissions reduction because of implementing this option.	To have time for the experimental trials and having environmental clearance if needed, it is expected to start the implementation of such project in 2018. The project lifetime will be as the lifetime of the Cement Plant which expected to be more than 50 years.	226.9

OBJECTIVE OF THE MITIGATION ACTION

Reduction of CO_2 emissions.
Recycling solid waste (steel slag/fly ash) as raw materials in cement industry.
This option also could reduce the consumption of energy needed to produce the substituted clinker.

ACTIVITIES PLANNED UNDER THE MITIGATION ACTION

Steel slag can be fed directly into the kiln without grinding. In this case, the only equipment upgrades are a slag hopper with a regulated withdrawal system and conveyors to the feed point of the kiln.
Jordan has more than 5 steel melting and galvanizing factories, therefore; there is available stock of steel slag and fly ash to be used in cement industry. However; the implementation of such option needs an experimental investigation of the impact of using the steel slag and/ or fly ash on the properties of produced cement as well as the maximum percentage of raw materials that could be replaced by such additives.

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2017-2040)	Emission reductions (Gg)
Option No. 2: Increase the percentage of Pozzolana in CEM II	Industrial Processes	Cement Plants	Idea – not implemented	A reasonable 2% more substitution of Pozzolana could be assumed on average and so a reduction of CO_2 emissions by 2% could be assumed as well. This option is modified to include all cement companies without excluding one of them as per the assumption of TNC report.	To have time for the experimental trials, it is expected to start the implementation of such project in 2017. The project lifetime will be as the lifetime of Cement Plants which expected to be more than 50 years.	591.3

OBJECTIVE OF THE MITIGATION ACTION

Reduction of CO_2 emissions.
This option also could reduce the consumption of energy needed to produce the substituted clinker.

ACTIVITIES PLANNED UNDER THE MITIGATION ACTION

More than 90% of cement produced at the local cement companies is CEM II (Portland–Pozzolana Cement) with a percentage of Pozzolana ranges between 21-32%. Therefore; there is an area to increase the percentage of Pozzolana in CEM II by improving the reactivity of the produced clinker and the raw mix to produce CEM II/B-P to achieve the required strength of 42.5N that cause the use of Pozzolana of less than 32% (the 3% is substituted by gypsum).

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2020-2040)	Emission reductions (Gg)
Option No. 3: Produce new cement product CEM IV with 45% of Pozzolana	Industrial Processes	Cement Plants	Idea – not implemented	It is estimated that 10% of currently produced CEM II/B-P will be changed to CEM IV, strength 22.5X in which the Pozzolana substitution will reach 45% (more by at least 13% (=45-32)). Annual CO_2 emissions from producing CEM II/B-P are multiplied by 1.3% to calculate the CO_2 emissions reduction because of implementing this option.	To have time for the experimental trials, marketing the new product, set the legally binding regulations and enforcement measures to control its use, it is expected to start the implementation of such project in 2020. The project lifetime will be as the lifetime of Cement Plants which expected to be more than 50 years.	312.7

OBJECTIVE OF THE MITIGATION ACTION

Reduction of CO_2 emissions.
This option also could reduce the consumption of energy needed to produce the substituted clinker.

ACTIVITIES PLANNED UNDER THE MITIGATION ACTION

The implementation of such suggestion depends on many factors such as the uses of such products, clear instructions to prepare the concrete mix, strict regulations, strong enforcement and the users' awareness of needed instructions of application such as the needed setting time.

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2019-2040)	Emission reductions (Gg)
Option No. 4: Use of biomass (MSW or/ and Sewage Sludge) as alternative fuels	Industrial Processes	Cement Plants	Idea – not implemented	20% substitution is assumed regarding the effect of biomass on the produced cement characteristics. A reduction factor of 0.0231 ton CO_2/ ton cement is used to estimate the average use of MSW or dried sewage sludge as available. This value is multiplied by the clinker produced to conserve the estimations.	To have time for the experimental trials, studies of the maximum percentage of MSW and dried sewage sludge to be used, availability of stocks at market, testing the emissions, conduct EIA study and get the environmental clearance; it is expected to start the implementation of such project in 2019. The project lifetime will be as the lifetime of Cement Plants which expected to be more than 50 years.	1,427.6

OBJECTIVE OF THE MITIGATION ACTION

Reduction of CO_2 emissions.
This option also could reduce the consumption of energy needed to produce the substituted clinker.

ACTIVITIES PLANNED UNDER THE MITIGATION ACTION

Since most of local cement factories are licensed to burn coal, petcoke and alternative fuels such as waste tires, oil shale and used oil to replace the expensive heavy fuel oil, they are equipped with multi-purpose burners which reduce the investment costs for using biomass as alternative fuels. However, the required capital cost depends on the needed storage, segregation, handling, grinding and metering as well as environmental pollution control measures.

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (2019-2040)	Emission reductions (Gg)
Option No. 5: Catalytic Reduction of N_2O inside the Ammonia Burner of the Nitric Acid Plant	Industrial Processes	Cement Plants	Idea – not implemented	The selected N2O abatement technology depends on replacing some of Al2O3 balls that support the platinum-rhodium catalyst by base metal secondary catalyst, which is capable of reducing N_2O by at least 75%.	There are no economic benefits, enforcement regulations or pollution abatement benefits of implementing such project, it only aims at reducing the GHG emissions, therefore; its implementation strongly depends on having economic incentives such as of Clean Development Mechanism (CDM).. The lifetime of this project is estimated to be same as the lifetime of KEMAPCO plant which is estimated to be 25 years (till the year 2040).	1,433.3

OBJECTIVE OF THE MITIGATION ACTION

Reduction of N_2O emissions.

ACTIVITIES PLANNED UNDER THE MITIGATION ACTION

The project activity involves the installation of a new N2O abatement technology that is not commonly used in nitric acid plants. The abatement technology is a pelleted catalyst that will be installed inside the ammonia burner just underneath the precious metal gauzes. This technology is capable to reduce approximately 75% to 80% of the N2O formed at the precious metal gauzes inside the ammonia burner to atmospheric N_2 and O_2.

Table A.26: AFOLU Projects

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (20XX-20YY)	Emission reductions (Gg)
Restoration of Rangelands	Agriculture	Ministry of Agriculture	idea	• Annual rainfall within the targeted area is <100-150 mm • 50 shrubs per du will give productivity of 50 kg/du as average. • 50 shrub/du with soil organic carbon sequestration (SOC) rate of 2-4 g m2/year	15 productive years	7,112 Tonne of CO2.
OBJECTIVE OF THE MITIGATION ACTION						
The Project suggests planting an area of 60000 du - rangelands with perennial fodder shrubs Area: Badia (Al Jafr and Al Husseinieh) sub-districts within the Ma'an Governorate Kochia Scoparia sp & and the indigenous plant type Atriplex halimus						

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (20XX-20YY)	Emission reductions (Gg)
Protection of natural Rangelands (Area of 100000 du)	Agriculture	Ministry of Agriculture	idea	• Annual rainfall within the targeted area is <100-150 mm • The average annual dry matter production is 4 kg/du in normal years and when protected can be increased to 15 kg/du in the range reserves. • It is assumed to have an average of 35 average sized shrub/du and the sequestration rate is 4 g SOC/m^2/year.	15 productive years	11,853 Tonne of CO_2.
OBJECTIVE OF THE MITIGATION ACTION						
Despite its deterioration this region is known to be the main grazing land in Jordan. The project will achieve reductions through CO_2 emissions offset from natural soil carbon release caused by rangeland deterioration. The project aims at applying rain harvest techniques as well as soil erosion control techniques (erosion is caused from flash floods flow).						

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (20XX-20YY)	Emission reductions (Gg)
Reforestation project	Land use	Ministry of Agriculture-Department of forestry	idea	A medium growth coniferous tree, planted in an urban setting and allowed to grow for 10 years, sequesters 0.039 ton CO_2 per planted tree.	10 years	8,278.91 Tonne of CO_2.
OBJECTIVE OF THE MITIGATION ACTION						
The Project suggests planting 26 000 trees will be planted over five years 10 000 Jerash ➔ 2000 tree per year 16 000 Ajloun ➔ 4000 first year and then 3000 trees per year						

Table A.27: Waste Projects

Name and brief description of the mitigation action 9	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (20XX-20YY)	Emission reductions (Gg)
Capture of methane emissions from a selected landfills in Jordan (Aukider, Madaba, Dulail, Karak, Salt)	Solid waste GHG reduced include mainly methane and CO_2	Ministry of Municipal affairs	Planned	• 2014 was taken as base year • Density of methane = 0.717 kg/m^3. • working hours per year are 8000 hours. • electricity 0.06 JD/kWh. • The cost of 1 MW biogas 1500000 JD (According ARENA • The fixed annual cost is (10% of capital investment According to ARENA)	2019-2043	7,696,205 ton of CO_2
OBJECTIVE OF THE MITIGATION ACTION						
The objective of the mitigation action is to reduce methane emitted by anaerobic decomposition of waste at landfills and to use captured methane to produce electricity. This will directly subsidize part of the electricity already produced by combustion of fuel including natural gas and HFO						

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (20XX-20YY)	Emission reductions (Gg)
An aerobic digestion of sludge at selected wastewater treatment plant (Baq,a, Salt, Madaba,, Ramtha, Wadi Alarab	Solid waste GHG reduced include mainly methane and CO_2	Ministry of Water and Irrigation	Planned	• Total amount of organic generated is taken from the Baseline scenarios for Waste Sector Report • Density of methane = 0.717 kg/m^3. • Methane capture100% • working hours per year are 8000 hours. • electricity price 0.094 JD/kWh. • The cost of 1 MW biogas digester is 4000000 JD (from biogas Project)	2019-2043	1,286,716 ton of CO_2

OBJECTIVE OF THE MITIGATION ACTION

The objective of the mitigation action is to reduce methane emitted by anaerobic decomposition of waste at landfills and to use captured methane to produce electricity. This will directly subsidize part of the electricity already produced by combustion of fuel including natural gas and HFO

ACTIVITIES PLANNED UNDER THE MITIGATION ACTION

Currently Assamra plant and shallalah have an aerobic digester. MWI is planning to construct digester at other proposed plant

Table A.28: GHG Mitigation Scenario

Year	Baseline Scenario	Mitigation Scenario	Avoided	Cumulative Reduction
	million ton of CO2 Equivalent			
2016	32.66	32.19	0.47	0.47
2017	33.28	32.69	0.59	1.06
2018	33.72	32.71	1.02	1.61
2019	33.26	30.99	2.27	3.28
2020	34.33	31.65	2.68	4.95
2021	34.79	31.84	2.95	5.63
2022	36.15	32.84	3.31	6.26
2023	33.04	29.35	3.68	7.00
2024	34.47	30.63	3.85	7.53
2025	31.45	27.44	4.01	7.85
2026	32.91	28.64	4.27	8.28
2027	34.37	29.90	4.46	8.74
2028	35.82	30.99	4.83	9.29
2029	37.25	32.32	4.93	9.75
2030	38.18	33.64	4.53	9.46
2031	39.22	34.76	4.46	8.99
2032	40.55	36.00	4.55	9.01
2033	40.19	37.25	2.94	7.49
2034	41.51	38.47	3.04	5.99
2035	40.99	38.07	2.92	5.96
2036	41.83	37.20	4.62	7.54
2037	42.95	38.36	4.59	9.21
2038	43.73	39.14	4.58	9.17
2039	44.54	40.05	4.48	9.07
2040	45.56	40.73	4.83	9.32

APPENDIX B

Domestic MRV

- B.1: Needed Activity Data for GHG Inventory
- B.2: GHG Mitigation Measures Form
- B.3: Support Data Form

Table B.1: Needed Activity Data for GHG Inventory

Categories	Activity Data	Data Sources
1 - Energy		
1.A - Fuel Combustion Activities		
1.A.1 - Energy Industries	• Amount of primary fuels produced • Amount of primary and secondary fuels imported • Amount of primary and secondary fuels exported • Net increase or decrease in stocks of fuels • Amount of natural gas used for electricity generation • Ministry of Energy annual reports • Amount of fuel used in Jordan Petroleum Refinery operations • Jordan Petroleum Refinery Company annual reports • Fuel density for each fuel type • Net heat values for each fuel type • Net heat value for Al-Resha natural gas • Net heat value for Egyptian natural gas	• Ministry of Energy and Mineral Resources • Department of Statistics • Jordan Petroleum Refinery • Jordan Petroleum Company • Biogas Company
1.A.2 - Manufacturing Industries and Construction	• Total consumption figures in the industrial sector by fuel type • Total consumption figures in the agricultural sector by fuel type • Total consumption figures in the residential and commercial sector by fuel type • Country specific fuel density • Ministry of Energy annual reports • Fuel density for each fuel type • Net heat values for each fuel type • Net heat value for Al-Resha natural gas • Net heat value for Egyptian natural gas	• Ministry of Energy and Mineral Resources • Department of Statistics • Jordan Petroleum Refinery • Jordan Petroleum Company

Categories	Activity Data	Data Sources
1.A.3 - Transport	• Ministry of Energy annual reports • Amount of fuel used in international aviation bunkers • Amount of fuel used in local aviation between Amman and Aqaba • Estimation of the amount of fuel used for international aviation bunkers • Latest available survey of fuel use in different sectors: transport and agriculture • Fuel density for each fuel type • Net heat values for each fuel type	• Ministry of Energy and Mineral Resources • Ministry of Transport • Public Security Directorate/ Drivers and Vehicles License Department • Royal Jordanian • Jordanian Marine Authority • Jordanian Civil Aviation Authority • Department of Statistics • Jordan Petroleum Refinery • Jordan Petroleum Company • Hedjaz Jordan Railway • Aqaba Railway Corporation • Arab Bridge Maritime Company • Aqaba Port Marine services Company • Jordan Armed Forces
1.A.4 - Other Sectors (residential, industrial,...)	• Latest available survey of fuel use in different sectors: transport, agriculture, industrial, residential, and commercial • Total consumption figures for military uses by fuel type • Net increase or decrease in stocks of fuels • Net heat values for each fuel type • Fuel density for each fuel type • Net heat value for Al-Resha natural gas • Net heat value for Egyptian natural gas	• Ministry of Energy and Mineral Resources • Department of Statistics • Jordan Petroleum Refinery
1.B - Fugitive emissions from fuels		
1.B.1 - Solid Fuels 1.B.2 - Oil and Natural Gas 1.B.3 - Other emissions from Energy Production	• Amount of natural gas produced • Amount of natural gas used for electricity generation • Natural gas released to the atmosphere from flaring and venting • Natural gas released to the atmosphere from accidents or leaks • Net heat value for Al-Resha natural gas • Amount of primary fuels produced	• Ministry of Energy and Mineral Resources • Department of Statistics • Jordan Petroleum Refinery • Jordan Petroleum Company • Biogas Company
2 - Industrial Processes and Product Use		
2.A - Mineral Industry		
2.A.1 - Cement production	• Amounts and type of cement produced • clinker fraction for each type of cement produced • Amounts of clinker imported and exported	• Cement companies (annual reports) • Department of Statistics • Jordanian Customs Department

Categories	Activity Data	Data Sources
2.A.2 - Lime production	• Amount and type of lime produced	• Cement companies (annual reports) • Ministry of Energy and Mineral Resources • Department of Statistics
2.B - Chemical Industry		
2.B.2 - Nitric Acid Production	• Amount of nitric acid produced or the production capacity • Type of production processes • Results of NOx measurements	• Kemira Arab Potash Company ltd (KEMAPCO)
2.B.7 - Soda Ash Production	• Amount of soda ash exported and imported	• Department of Statistics • Jordanian Customs Department
2.C - Metal Industry		
2.C.1 - Iron and Steel Production	• Amount of iron produced	• Iron companies (annual reports) • Department of Statistics
2.D - Non-Energy Products from Fuels and Solvent Use		
2.D.1 - Lubricant Use 2.D.2 - Paraffin Wax Use 2.D.3 - Solvent Use	• Amount of production • Population and GDP	• Department of Statistics • Ministry of Environment, Second Report on the State of Environment, 2016 • Jordan Customs Department
2.F - Product Uses as Substitutes for Ozone Depleting Substances		
2.F.1 - Refrigeration and Air Conditioning	• Quantity of imported refrigerants in bulk • Quantity of imported refrigerators and air conditioning units • Quantity of exported refrigerators and air conditioning units	• Jordan Customs Department
2.F.3 - Fire Protection	• Quantity of imported fire suppression units	• Jordan Customs Department • Civil Defense Department (Prevention Department, Mechanics-Accreditation Section)

Categories	Activity Data	Data Sources
2.G - Other Product Manufacture and Use		
2.G.1 - Electrical Equipment 2.G.2 - SF6 and PFCs from Other Product Uses	• Amount of SF6 and PFCs in electrical equipment and in other products	• Jordan Chamber of Industry • Jordan Customs Department • Universities • Ministry of Environment • National Electric Power Company
2.G.3 - N2O from Product Uses	• Amount of N2O used in medical applications	• Ministry of Health • King Hussein Cancer Center • Private hospitals • Royal Medical Services Hospitals
2.H - Other		
2.H.1 - Pulp and Paper Industry 2.H.2 - Food and Beverages Industry	• Quantity produced of each type	• Department of Statistics • Jordan Customs Department • Jordan Chamber of Industry
3 - Agriculture, Forestry, and Other Land Use		
3.A - Livestock		
3.A.1 & 3.A.2 - Enteric Fermentation & Manure Management	• Number of livestock by type • Type of manure management • Amount of manure processed	• Ministry of Agriculture- • Livestock and Animal Production Department • Department of Statistics • FAO Stat (online tool) • Animal Production Department, University of Jordan
3.B - Land		
3.B.1 & 3.B.2 Forest land & Cropland	• Areas of forests and croplands based on land use (during the past 20 years)	• Ministry of Agriculture • Soil and Forestry Department • Department of Statistics • FAO Stat (online tool)

Categories	Activity Data	Data Sources
3.C - Aggregate sources and non-CO2 emissions sources on land		
3.C.1 - Emissions from biomass burning 3.C.3 - Urea application 3.C.4 - Direct N2O Emissions from managed soils 3.C.5 - Indirect N2O Emissions from managed soils 3.C.6 - Indirect N2O Emissions from manure management	• Amount of urea (produced, imported, and exported) • Areas burned • Type of burning	• Department of Statistics • FAO Stat (online tool)
4 - Waste		
Solid waste		
4.A - Solid Waste Disposal 4.B - Biological Treatment of Solid Waste 4.C - Incineration and Open Burning of Waste 4.E - Other (hazardous and medical)	• Quantity of waste and available landfills (year of establishment, capacity, type, available treatment methods) • Type of waste and composition of waste • Population and GDP	• Department of Statistics • Ministry of Municipal Affairs • Greater Amman Municipality • Ministry of Health • Ministry of Environment, Second Report on the State of Environment, 2016
Wastewater		
4.D - Wastewater Treatment and Discharge	• Annual reports of Wastewater Systems Operations unit at the Ministry of Water and Irrigation	• Ministry of Health • Ministry of Water and Irrigation • Ministry of Environment

* The numbering of categories is based on IPCC Guidelines and available sectors/subsectors in Jordan

Table B.2: GHG Mitigation Measures Form

Name and brief description of the mitigation action	Sector and subsector (and GHG reduced)	Implementing institution	Status [Planned, implemented, under implementation, cancelled/invalid]	Main assumptions used in the mitigation analysis	Duration (20XX-20YY)	Emission reductions (Gg)
OBJECTIVE OF THE MITIGATION ACTION						
e.g. The objective of the mitigation action is to reduce emissions by fostering self-supply renewable energy projects and contribute to the long-term development of the renewable energy industry in Chile. The mitigation action will achieve the objectives through a comprehensive programme of measures to remove barriers and incentivize SSRE investments with three components: a financial component, a technical support component, and an outreach component.						
ACTIVITIES PLANNED UNDER THE MITIGATION ACTION						

Table B.3: Support Data Form

SUPPORT RECEIVED								
Project	Date	Project Description	Donor/ Implementing Agency	Source of Support	Type of Support			
					Financial Resources	Capacity Building	Technical Support	Technology Transfer
Project Title	Project implementation period	Description of project main objectives	Donor name and the implementing agency name	International, Local, other (please specify)	Grant, loan, or own budget	Select if applicable	Select if applicable	Select if applicable