

CARBON LIMITS

Sectors and subsectors for TNA and their analysis

Technology Needs Assessment and associated action plan for climate change mitigation and adaptation in Iraq's most vulnerable economic sectors

CTCN

June 2021



Contents:

Introduction	3
1. Existing national policies and development priorities in Iraq	4
2. Current situation	19
GHG emissions.....	19
Electricity and heat.....	21
Oil and gas industry	22
Vulnerability to climate change.....	24
Water Resources	25
Agriculture	25
Barriers and challenges.....	26
3. Selection of the sectors and sub-sectors for analysis	27
4. Description of methodology for technology prioritization	27
Annex: Outcomes of the stakeholder consultations during preparation of the GCF Readiness proposal.....	33

Disclaimer

This document is an output of the Technology Needs Assessment project in Iraq, funded by the Green Climate Fund (GCF) and implemented by the United Nations Industrial Development Organization (UNIDO) in collaboration with United Nations Environment Programme (UNEP). The present report is the output of a country-led process and the views and information contained herein are a product of the international TNA Implementation team, led by Carbon Limits and Iraqi Green Climate Organization (IGCO).

Introduction

This report is an output of the CTCN project “Technology Needs Assessment (TNA) and associated action plan for climate change mitigation and adaptation in Iraq’s most vulnerable economic sectors”. The aim of the study is to enable Iraq to implement its climate targets, including the commitments under the Paris Agreement, using the most appropriate technologies. The TNA and associated action plans will provide the necessary guidance to evolve prioritized technologies and help address country’s needs in climate change adaptation and mitigation.

The objective of this report is to review the relevant sectors that require priority attention from Iraqi government when it comes to climate adaptation and mitigation. The first review and prioritization of the sectors was carried out already at the preparation stage of the GCF Readiness Proposal and stakeholder engagement confirmed that four sectors require further analysis and technology needs assessment: energy, industry, water and agriculture. This is based on the Republic of Iraq’s Intended Nationally Determined Contribution (INDC) and its initial communication to UNFCCC, as well as associated sectoral plans and policies. As part of the sectoral review, an assessment of the Iraq’s sectoral plans and development priorities is conducted in this report.

A snapshot of the current situation with respect to greenhouse gas (GHG) emissions and the country’s vulnerability to climate change is another item within the report. The review of the current situation helps better understand the current status of implementation of climate technologies, key challenges and opportunities, as well as identify where the mitigation and adaptation efforts need to be focused within each of the sectors.

Finally, a brief description of the follow-up approach for technology identification and prioritization within each sector is described.

This report will serve as a basis for full Technology Needs Assessment reports for adaptation and mitigation of climate change in Iraq which are scheduled to be developed under this assignment.

1. Existing national policies and development priorities in Iraq

In 2003, the Ministry of Health Environment (MoHE) was established in Iraq to implement state policy that protects and improves the quality of the environment. The Ministry serves as a participant in international environmental agreements. Iraq became a member of the United Nations Framework Convention to Combat Desertification (UNCCD) in 2009. Iraq ratified the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol in 2009 as a Non-Annex I country, and the MoHE worked with UNDP, Global Environment Facility (GEF), and UN Environment Programme (UNEP) in the preparation and submission of its Initial National Communication (INC) to the UNFCCC. Iraq signed the Paris agreement on climate change in December 2016 but has yet to ratify the agreement.

Regulatory instruments related to climate change in Iraq, and their objectives in terms of mitigation and adaptation, are shown in this section.

Intended Nationally Determined Contributions (INDCs)

Despite the difficult challenges, the Government of Iraq has laid out an economy-wide plan to reduce GHGs emission by around 14% from the Business As Usual (BAU) scenario over the period 2020 until 2035. Iraq's NDC envisages a reduction of emissions by 1% below BAU by 2035, increasing to 13% with support from the international community. Emissions reduction from 2020 to 2035 have two scenarios:

- 1) Reduction by 1% of 2035 total emissions through implementing 15 projects, which falls within the national reduction capabilities in case security and peace are guaranteed; and
- 2) Reduction by 13% of 2035 total emissions through implementing 27 projects, which is conditional on security as well as on funding from UNFCCC and international partnerships.

Accordingly, Iraq intends to offer 14% of total business in clean and renewable energy and carbon management for investment between 2020 and 2035.

Furthermore, Iraq is determined to introduce clean and low-carbon technologies to different sectors, including electricity, industry, transport, waste management, housing, and oil and gas, through the utilization of most of the associated petroleum gas (APG) (currently burnt), to reduce dependency on heavy fuel in power generation and in other sectors, such as transport and industry.

Table 1: Projects considered in the NDC in energy, industry, water and agriculture sectors

Projects for the scenario of 1% reduction	Projects for the scenario of 13% reduction
<p><u>Energy</u></p> <ol style="list-style-type: none"> 1. Shift to combined cycle power plants; 2. Improve the performance of electricity system to maintain sustainability and stability with high reliability. 3. Utilize maximum levels of the associated petroleum gas (APG), currently burnt to reduce dependency on heavy fuel in power generation and in other sectors, such as transport and industry. 	<p><u>Energy</u></p> <ol style="list-style-type: none"> 1. Increase investment in combined cycle power plants; 2. Initiate energy conservation and efficiency programs; 3. Use clean, new and renewable energies; 4. Reduce the technical loss in power transmission and distribution; 5. Develop hydroelectric plants in Kurdistan Region, which will increase the hydroelectric power contribution to total generation to 3.3% by 2035, supposing that the Mosul Dam will have been rehabilitated 6. Improve the quality of oil products to match the international standards through the construction of advanced refineries and rehabilitation and development of existing ones; 7. Use LPG as vehicle fuel to reduce dependency on gasoline; and

	8. Utilize the APG in the national oil fields.
<u>Industry</u> 1. Heat recycling to produce electricity and use it for production purposes; 2. Develop manufacturing processes that reduce emissions, including in existing and planned industries such as the fertilizer industry; and 3. Replace some mechanical incineration systems in private brick factories with more efficient and environment-friendly systems.	<u>Industry</u> 1. Implement a strategic CCS project; 2. Develop manufacturing processes that reduce emissions, in all existing and planned industries, such as the fertilizer industry; 3. Replace mechanical incineration systems in private brick factories with more efficient and environment-friendly systems; and 4. Establish private and public industrial enterprises within the industrial zones envisaged by the Ministry of Industry and Minerals to encourage the manufacturing/ assembling of products including solar cells and other solar energy equipment such as heaters, lights, fridges, cars, pumps, stoves, etc.
<u>Water</u> 1. Rehabilitating the Mosul Dam to ensure its stability 2. Introduce automated irrigation modalities (sprinkler and drip) all over the country. 3. Expand the Tharthar regulating duct and the duct at the forefront of the Samara Barrage 4. Increase the number of water treatment plants so that by 2035 they can process 6.4 billion m ³ annually for the municipal sector assuming that consumption efficiency has been improved. 5. Improve and expand the water system, steadily reduce losses, and expand the use of meters. 6. Increase the number of wastewater treatment plants by 2035 7. Improve the water quality monitoring program already implemented in the Ministry of Water Resources 8. Rehabilitate major irrigation projects in Iraq and gradually link them to main drainage outfall areas or to evaporation basins to avoid returning them to rivers and freshwater streams. 9. In case a continuous water flow of no less than 50 m ³ /s from the Tigris along the Shatt al-Arab cannot be guaranteed, build a barrage on Shatt al-Arab at the entrance to the Al-Faw Port to prevent the expansion of the salty cape into the city of Basrah. 10. Conduct more studies about the feasibility of continuing the extraction of groundwater and about the aquifers to help replenish groundwater supplies and improve conditions for sustainable extraction 11. Construct dams in the Kurdistan Region to harvest rainwater 12. Reuse wastewater	
<u>Agriculture</u> 1. Development of a system to protect, maintain and increase natural forests	<u>Agriculture</u> 1. Land management 2. Improve rice farming technologies and natural fertilizer management to reduce CH ₄ emissions 3. Increase the use of Nitrogen fertilizers to reduce N ₂ O emissions 4. Improve the quality of crops

A number of specific technology barriers (including financial, regulatory/legal and market conditions) have been identified that effect the development and transfer of environmentally sound technologies. Iraq's NDC initiated a first step for action and a plan to aid the removal of potential barriers and create the enabling environment for technology options prioritized by Iraq.

National Development Plan 2018-2022

The National Development Plan (NDP) 2018-2022 aligns with Iraq's 2030 vision, which considers various dimensions of development from the economic, political, social, ecological and cultural perspectives. This plan establishes the actions planned in the short-term, to address the challenges that underlie the country, due to the current policies, the conflicts as well as the social problems that arise largely as a result of the demographic growth of recent years, which increased from 7.2 to 39.9 million people from the 1960s to the present.

The NDP is divided into four pillars, including private sector development as a vital anchor for progress and development and the reduction of multidimensional poverty in the provinces.

The NDP contains a section on sectoral and spatial development in which the planning for the economic and productive sectors of the country is established: Agriculture, Energy, Manufacturing Industries and Transport, in which the status and challenges of each sector are exposed, related to a series of objectives, means of achievement and indicators to face those challenges in the short term.

The key aspects of the sectors of interest according to the NDP are summarized below.

Table 2: National Development Plan for 2018-2022 and sectoral objectives

Sector	Current situation	Objectives
Oil and gas sector	<p>Available storage capacity will not be sufficient in the future due to the increase in targeted export capacities.</p> <p>Decline in locally refined oil.</p> <p>Six refineries were taken out of service due to military operations, reducing total design capacity by 51%.</p> <p>Flaring of large quantities of gas due to failure to implement required processing and gathering infrastructure, which limited the separation of gas to high value components.</p> <p>Large deficit in crude oil refining capacity.</p> <p>Obsolescence of crude oil pipeline network with no connection between the north and the south.</p>	<p>Increase the production capacity of crude oil to 6.5 million bpd.</p> <p>Increase the export capacity of crude oil to 5.25 million bpd.</p> <p>Raise the natural gas production to 3500 MMscf/d.</p> <p>Enhance confirmed gas reserves.</p> <p>Achieve self-sufficiency and derivatives export by increasing refining capacity to 900000 bpd.</p> <p>Enhance storage capacity of petroleum products to secure storage of 2267 m3.</p> <p>Protect the environment from contamination, address environmental problems resulting from existing oil and gas facilities, and reduce CO₂ emissions.</p>
Electricity	<p>High production deficit after many power plants were out of service (damaged during conflicts or outdated due to age).</p> <p>High load growth and increased demand for electricity.</p> <p>Total produced energy was 10.5 GW in 2016 (including imported energy of 1.4 GW).</p> <p>Reduction in existing plants efficiency due to poor provision of adequate fuel.</p>	<p>Increase the total electricity production capacity to 20.9 GW.</p> <p>Improve the electricity system efficiency.</p> <p>Improve quality of consumer services.</p> <p>Rationalise electricity consumption in different uses and reduce it by 7% annually (through energy efficiency</p>

	<p>Decreased water levels and their negative impact on the operation of steam plants.</p> <p>Weak community culture about consumption rationalisation, and absence of belief that the citizen is responsible for covering the costs of provided services as national obligations.</p> <p>Obsolescence of the electricity system equipment over time, and the urgent need for maintenance and rehabilitation programmes for keeping them in operation.</p> <p>Inability of transmission and distribution grids to accommodate added energy.</p>	<p>measures, in particular in the public sector)</p> <p>Improve the environmental impact of electricity activity by reducing CO2 emissions.</p>
Manufacturing and (non-oil) extractive industries sector	<p>Difficulties in competing with imported products due to high production costs.</p> <p>Limited private sector capabilities with little opportunities to expand and develop.</p> <p>Weak provision of infrastructure services to this sector (electricity, fuel, raw materials, etc.).</p> <p>Need of a sectoral interrelation to complete the economic cycle through using agricultural resources and livestock in the operations of many industries and vice versa. These industries include, for example, mechanical industries, food, textile, leather, petrochemicals, fertilizers and others.</p>	<p>Support strategic industries, especially in the liberated areas that have minerals and natural gas as key component for these industries.</p> <p>Establish interrelations between manufacturing and other sectors and involve the private sector to benefit from its potential</p> <p>Advance geological surveys to develop an integrated map of Iraq's mineral resources to render them into investment opportunities.</p>
Agriculture and water resources	<p>There is a clear decline in incoming water resources whether from Tigris and Euphrates rivers outside Iraqi borders, or from feeding rivers inside Iraq, whose water resources, in turn, have declined due to drought conditions.</p> <p>Many vital facilities, such as Ramadi and Fallujah Barrages, Warwar and Taqsim regulatory dams, and some other important secondary facilities, were destroyed or damaged.</p>	<p>Achieve sustainable food security</p> <p>Secure the annual demand for sustainable water uses in (agricultural, industrial, municipal) fields and achieve water balance with the possibility to reduce annual demand by 500 million m3.</p> <p>Provide sustainable water resources.</p>

As can be seen, the main interest of Iraq's NDP is to boost the growth of the sectors from an economic perspective. It is identified that not all sectors address challenges related to the protection of the environment and the fight against climate change. However, within the objectives, there is a component in these matters, aimed at reducing emissions from the energy sector, except for the industrial sector.

In addition, the NDP contains a chapter on environmental sustainability, which highlights the following issues:

- Iraq is exposed to many climate phenomena, especially as related to climate change and global warming.

- The latter have started to exert noticeable impact on Iraq and the entire region, linked to decreasing water resources including rainfall and increase in temperatures, humidity, evaporation and sandstorms.
- Loss of rainfall water in Iraq is due to groundwater infiltration (5%), surface water runoff (20%), and – notably evaporation from rising temperatures (75%).
- Iraq suffers from an environmental deficit; the biological capacity of the entire land footprint is lower than the international rates, but the ecological footprint is continuously increasing.

The plan identifies the renewable and clean energy sources, particularly solar energy as a key to reduce demand on oil and gas sources, and thereby limit resource depletion.

Added to the above, the plan puts on the spot the scarce of freshwater resources due to climate change and factors in the neighboring countries and the financial crisis that made extremely challenging to tackle environmental issues in Iraq.

Among the proposed measures to address environmental challenges are:

- Establish new environment-friendly refineries based on international standards (EURO-5);
- Take measures to transform Iraq to the dry canal (railroad);
- Rehabilitate closed landfills;
- Ensure treatment of by-products and waste;
- Establish and equip laboratories to conduct environmental tests at all power stations;
- Introduce the combined cycle system which contributes to reducing the emissions of power projects;
- Install fogging systems;
- Implement project for green belts in the electricity sector;
- Increase the number of factories which utilize clean production mechanisms;
- Reduce sulphur content in diesel fuel (gasoil);
- Ensure disposal of gas waste resultant from industrial activities and services that meets environmental requirements;
- Reduce carbon dioxide emissions;
- Utilize associated gas;
- Reduce the production of unleaded gasoline;
- Upgrade fuel and liquid gas stations.

The agricultural sector faces a number of problems and challenges. Successive years of drought, fluctuation in rainfall, environmental changes, and various risks. This has led to losses in agricultural production from harvesting to consumers and the lack of professional agricultural companies and associations specialized in agricultural mechanization, marketing, and transport, etc.

In the other side, water resources in Iraq suffered various environmental problems¹ that have exacerbated in the present time. At the same time, these problems also represent the environmental obstacles and challenges that hinder integrated water resources management. In brief, Iraq faces two main challenges in securing its water needs: decline in water flows and climate and geological changes.

Table 3: Adaptation related goals from NDP 2018-2022

Sector	Goals	Means of achievement
Agriculture	Increase the GDP contribution of the agricultural sector (for non-oil activities) from 4.5% in 2015 to 5.2% in 2022, and	1. Increase agricultural land and promote production and productivity by focusing on the following:

¹ The National Environmental Strategy and Action Plan for Iraq summarized below further elaborates on the environmental issues faced by the Water sector of Iraq.

	achieve a sector growth rate of 8.4% in the target year	<ul style="list-style-type: none"> • Expand cultivation of on-farm crops, used directly in human food, and industrial crops, used as raw materials in many industries; • Manufacture machinery and agricultural equipment to meet the growing domestic demand associated with the expansion of agricultural production (*regarding table page 133) • Establish a factory for agricultural supplies (such as plastic covers to cover plantings, and supplies of modern irrigation such as sprinkling and drip irrigation); • Integrated reclamation of agricultural land. <ol style="list-style-type: none"> 2. Combat desertification; 3. Perpetuate developmental and research programmes and agricultural extension; 4. Support domestic private sector and foreign investment; 5. Develop the infrastructure of agricultural sector; 6. Use modern technologies in irrigation and agriculture methods; 7. Control and monitor border outlets to prevent entry of agricultural products when local production is available.
Water resources	Secure the annual demand for sustainable water uses in (agricultural, industrial, municipal) fields and achieve water balance with the possibility to reduce annual demand by 500 million m ³ .	<ol style="list-style-type: none"> 1. Competent management of water resources; 2. Improve on-farm irrigation efficiency through integrated water resource management; 3. Reduce waste and losses in water uses; 4. Increase water reservoir volume.
	Provide sustainable water resources	<ol style="list-style-type: none"> 1. Reach an agreement with upstream and riparian states to ensure fair distribution and sustainable water rights; 2. Recover and develop marshes; 3. Invest renewable groundwater; 4. Rehabilitate and reconstruct water resources infrastructure damaged by the military operations (Haditha Dam, Adhaim Dam, Fallujah Barrage, Unified Canal Regulator, Ramadi Barrage, and Warrar Regulator).
	Minimise water loss by at least 10% of the baseline year	<ol style="list-style-type: none"> 1. Provide modern standards for all participants to control waste and reduce the losses of pure water and ensure the optimal use of water through special awareness programmes. 2. Expand the production and distribution of raw water to all districts of Baghdad and provincial centres to replace the clean water in watering gardens. 3. Enforce provisions, laws and legislation on those who violate public networks.

		4. Use modern technologies (photovoltaic cells and others) in water structures and others to reduce losses of pure water.
--	--	---

The National Environmental Strategy and Action Plan for Iraq (2013 – 2017)

Considering the several challenges, particularly in preserving and improving the environment and harmonizing it with national, regional and international requirements, the Iraq's Ministry of Health and Environment has developed the National Environmental Strategy and Action Plan for the 2013-2017 period. The strategy hasn't been updated, but it serves to the purposes of this project as provides the context of specific problems related to environment, and establish specific lines of action to face them.

It is important to mention that according to this strategy, MoE seeks to adopt SD concepts; follow the approach of integrated environmental management; and combat poverty, poor environmental awareness, low income and environmental deterioration. MoE also encourages the use of clean energy and Environment-Friendly Technologies (EFTs), while optimally utilizing natural resources, establishing the principle of reusing and recycling, and promoting community-level environmental awareness.

Among other reasons, this planning instrument was developed to establish short- and long-term strategic solutions for global environmental variables (climate change) and their reflections on the local and regional level, strengthen the supervisory and inspection role of MoE bodies and build the necessary capacities in the field of advanced ecological monitoring systems.

What is important to highlight from this strategy is that it identifies as the main reasons of environmental deterioration, the population increase, the urbanization, the desertification and land degradation, the lack of environmental monitoring systems, the wars and political situation, all the above with high level impacts reflected in scarcity and pollution of water resources, air pollution, deterioration of biodiversity and pollution of marine waters that causes high costs to society and environment, accounted as damages to health and quality of life that reached 3.7% of GDP (56% of total losses) and damages to natural resources of 2.9% of GDP (44% of total losses), in 2013.

Based on the information of 2008 cited along the strategy, it was estimated the cost of environmental degradation in Iraq at 4.9-8.0% of GDP (an average of 6.4% or US\$ 5.5 billion a year). According to this, main reasons of those estimates were:

- Diseases resulting from drinking water of poor quality;
- Increased respiratory diseases due to polluted air;
- Neglected and pressured agricultural lands, which has led to losses in crops;
- Unsustainable management of and non-recycled wastes;
- Insufficiently protected coastal resources; and
- Inefficient production and use of energy and non-use of renewable energies.

Clean energy

Clean fuel must be used in fixed and mobile energy sources to reduce polluting emissions by designing proper mechanisms to dispose of leaded gasoline and reduce sulphur in diesel oil to protect public health and environment.

Industrial and service facilities in Iraq use obsolete and Non Environment-Friendly Technologies (NEFTs) causing significant resource consumption and high or medium concentrations of air pollutants. This requires encouraging the EFTs use, especially in industrial and service sectors by adopting cleaner production techniques to reduce emissions of air-polluting gases resulting from fossil fuel; providing proper economic incentives to industrial activities which use EFTs and rationalize resources; and building the technical capacities of these activities.

Excessive production and consumption of traditional energy sources cause a steady increase in emissions from power stations and other energy utilities. This requires using renewable energy like solar, wind, hydroelectric and biomass energy to reduce emissions.

Programs and projects considered in this planning instrument are shown in Table 4.

Table 4: Projects related to energy and industry sectors considered in the strategy

Components	Programs	Projects
Component I: Air pollution from natural sources	1.2 Assessment of the impacts of climate change and adaptation to it	1-2-1 Overall assessment of climate change for priority sectors
		1.2.2 Development of a national strategy to adapt to climate change
		1-2-3 Implementation of adaptation activities in the most fragile sectors, regions and ecosystems in partnership with civil society
		1.2.4 Establishment of the national center for climate change.
Component II: Air pollution from fixed (point) industrial sources	1.4 Control, enforcement and compliance to reduce air pollution	1.4.3 The private sector partnerships in controlling the emissions
		1.5 Rehabilitation of facilities not meeting environmental requirements
		1.5.1 Rehabilitation of MoIM companies 1.5.2 Rehabilitation of oil sector companies 1.5.4 Establishment of new refineries according to international specifications 1.5.5 Rehabilitation of power plants
	1.6 Promotion the use of renewable energies	1.6.1 Preparation of wind and solar energy Atlas for Iraq
		1.6.2 Using solar and wind energy to generate electricity and link to the national network
		1.6.3 Using solar and wind energy to generate electricity in public buildings and facilities
		1.6.4 Development of local technological industries of solar and wind energy technology
	1.7 Improvement of energy efficiency	1.7.1 National Project for energy efficiency in different sectors
		1.7.2 Modernizing the technology used in electric power production
		1.7.3 Cleaner fuel and its necessary specifications and legislations
	1.9 Development of craft industries in Iraq	1.9.2 Promoting the use of clean energies in craft industries
Component VI: Clean energy	1.14 Use of clean fuel	1.14.1 Using CNG, LNG, LPG in means of transport
		1.14.2 Establishing stations to fill cars with LPG and CNG
	1.15 Use of renewable energies	1.15.1 Using solar energy to support the electricity system 1.15.2 Promoting the use of solar energy in public buildings and facilities 1.15.3 Using wind energy for electric power generation in agricultural and desert areas

1.16 Energy production from waste	1.16.1 Using biogas for domestic use 1.16.2 Electric power production from waste for residential use
-----------------------------------	---

Water resources

Iraq suffers from water scarcity and pollution. This can be mainly attributed to population increase, economic growth climate change, and low water inputs from upstream countries. Consequently, it has become necessary to identify the annual water needs to satisfy the requirements without damaging or depleting water resources. Agricultural needs are estimated at 51 billion m³ to irrigate 11,300 km². Population needs to keep pace with the social and health developments are estimated at around 10 billion m³ annually. Needs of the industrial, oil electricity generation are estimated at 5 billion m³ annually. The increased water loss due to evaporation from rivers, dams and tanks estimated at 8 billion m³ in addition to water needs to recover the Marshlands shall also be taken into consideration.

Water pollution results from the lack of industrial and wastewater treatment plants, which affects the quality of water discharged into rivers without proper treatment. Other contaminating factors that increase environmental deterioration include random unlicensed industries in houses and shops which produce and discharge untreated water directly into rivers, animal and veterinary activities, popular electroplating plants, car washes, etc. Furthermore, there is a poor control over such industrial activities, poor enforcement of applicable laws that aim to alleviate the negative impact of discharged untreated water, and inadequate implementation of closed cycle and water reuse policies.

Programs and projects considered in this planning instrument are shown in Table 5.

Table 5: Projects related to water resources sector considered in the strategy

Components	Programs	Projects
Protect and improve water quality – Component Regional dimension of water resources scarcity in Iraq and quantity	2.1 Cooperation with neighbouring countries to ensure water quality and quantity	2.1.1 Establishing a national database to monitor water quantity and quality in shared rivers 2.1.2 Drafting quality agreement with riparian countries
	2.3 Study on the impacts of climate change on water demands	2.3.1 Studying the effects of drought and higher temperature on water quotas
	2.4 Water quality improvement	2.4.1 Developing a program for monitoring and control of different water resources and sources of pollution 2.4.2 Rehabilitation of WWTPs 2.4.3 Rehabilitating rivers banks 2.4.4 Remote sensing project (investment) to monitor the water quality of the Euphrates, Habbaniyah Lake and discharges flown into them (Anbar Environment Directorate) 2.4.5 Operational project to implement quality systems in Baghdad Directorate 2.4.6 Development of environmental monitoring and early warning systems 2.4.7 Improvement of quality of water resources in northern governorates through developing monitoring and install remote sensing systems

2.5 R&D and capacity building	2.5.1 Using mathematical models for SMWR 2.5.2 Establishing a water resources information bank 2.5.3 Development of national environmental database and atlases
2.6 Demand management planning	2.6.1 Mapping future water needs of different sectors 2.6.2 Water use rationalization in different sectors
2.7 Reduction of the Marshlands water scarcity and deterioration	2.7.1 National plan to handle cases of the Marshlands water scarcity 2.7.2 Using remote sensing techniques and GIS for the Marshlands M&E 2.7.3 Construction of dams and regulation of the Marshlands water channels with monitoring and control system for water quality
2.8 Restoration of the Marshlands and mobilization of international and regional support	2.8.1 National plan for rehabilitation and development of the Marshlands' villages (economic development - supply villages with electricity) 2.8.2 Taking advantage of recycling water and materials in the Marshlands communities 2.8.3 Including the Marshlands in the international and regional agreements}
2.9 Sewage and agricultural wastewater treatment	2.9.1 WWTPs Rehabilitation and using modern technologies (impermeable membrane technology) 2.9.2 Re-using sludge resulted from WWTPs for agriculture purpose 2.9.3 Establishing a program to monitor and locate sewage disposal in rivers (to be included within the sewage systems development plan) 2.9.4 Rehabilitating sewage networks 2.9.5 Issuance of instructions on the use of treated wastewater for the purposes of irrigation
2.10 Industrial wastewater treatment	2.10.1 Rehabilitation of IWTPs within MoIM companies 2.10.2 Rehabilitation of IWTPs within MoO companies 2.10.3 Rehabilitation of IWTPs 2.10.4 Establishment of new IWTPs in large refineries 2.10.5 Establishment of WWTPs for the residential areas affiliated with the oil sector 2.10.6 Rehabilitation of IWTPs within MoElc companies 2.10.7 Using magnetic systems and techniques for industrial wastewater treatment for preserving the environment 2.10.8 Encouragement of programs of cleaner production and recycling in plants and facilities to stop discharging wastes
2.11 Monitor water quality in the downstream estuary	2.11.1 Monitoring and control of water quality in the downstream estuary

MOE Plan and Renewable energy Plan

This plan was published by the Ministry of Electricity of Iraq and contains the Plan for investment in PV Solar Energy from 2017 to 2020. In summary, what was planned for this period is summarized below:

- Capacity of 475 MW in 2020;
- Capacity of 2,695 MW between 2017-2020;
- 13 potential solar PV projects are identified.

Generation Plan began in 2015 for the encourage investment from IPPs (9GW of power), including:

- Target for conversion of Simple Cycle Plant to Combined Cycle (5GW);
- Encourage generation from renewable energy (Solar);
- Sustaining Current Plant Production through initiatives (such as the Power Up Plan Program by General Electric (GE) and other initiatives by other multinationals e.g. Siemens);
- Plans for rehabilitation and reconstruction of Power Plants in the liberated areas

MOE's Transmission Plan, includes:

- Strengthening the transmission network throughout Iraq from South to Mid-Euphrates and Central areas of Iraq (JBIC, JICA, Siemens, GE, ABB).
- Plans for rehabilitation of substations, and transmission network in the liberated areas in north and west of Iraq to be reconnected with the rest of Iraq.

Strategy for the reduction of poverty, 2018 – 2022

The time of preparation and implementation of the Poverty Reduction Strategy coincides with the government aspiration to achieve Sustainable Development Goals, through the Iraq Vision 2030 and the new National Development Plan (NDP) for 2018-22. The main target of this strategy is to reduce poverty by at least 25 percent, by 2022.

One of the biggest concerns in terms of housing and the environment is the problem of slums, the provision of affordable housing for the poor and puts in the focus the facilitation of the use of solar energy, as one of the ways to combat poverty, in the neighbourhoods.

Investment Map of Iraq, 2019

Lead by the National Investment Commission, in 2019 the Investment Map of Iraq was published to identify and make a plan to address investment opportunities found in Iraq. This map provides a detailed overview about the country, and an outline about each governorate including certain information on each sector. In addition, the document provides a list of investment opportunities that was classified as per the available investment opportunities in each economic sector and governorate. This map includes several investment opportunities that were presented by the concerned Ministries.

The investment opportunities mapping is given by province and sectors where local information of the circumstances is provided. A brief summary of goals by sector is summarized below:

Electricity

Goal 1: to increase the production capacity in the electrical system to reach (20869) megawatts.

Goal 2: increase the per capita electricity supply to reach (4041) kWh.

Goal 3: Improve the efficiency of the electrical system.

Goal 4: Improve the quality of services provided to consumers according to categories (household, government, industrial, agricultural, commercial).

Goal 5: To rationalize the consumption of electricity for different uses and reduce it by 7% annually.

Goal 6: Improve the environmental impact of electricity activity by reducing CO₂ emissions.

Goal 7: Enhancing the role of the private sector in managing the production and distribution sectors.

Goal 8: Promote governance of the electricity sector and its institutions.

Solar stations are considered (additional capacity of 355 MW)

Oil & Gas sector

Goal 1: increase the production capacity of crude oil to reach (6.5) million bpd.

Goal 2: increase the export capacity of crude oil to (5.25) million bpd.

Goal 3: raising the crude oil capacity of the crude oil in export warehouses.

Goal 4: raising natural gas production to reach (3500) mf³ per day.

Goal 5: Strengthen proven gas reserves.

Goal 6: To achieve self-sufficiency and export of petroleum products by increasing the refining capacity to reach (900) thousand bpd.

Goal 7: To strengthen the reservoir energy of petroleum products to secure storage of 2267 m³.

Goal 8: Protect the environment from pollution and address the environmental problems caused by the oil and gas activity of existing facilities and reduce CO2 emissions.

Plan to increase oil production and exports in the following years by expansion of refineries.

Manufacturing and Extraction Industries (excluding Oil)

Goal 1: Increase the contribution of non-oil manufacturing and extractive industries to GDP by 40% from the base year.

Goal 2: work on finding other sources of funding for public sector projects and limiting the financing of the investment budget for strategic projects only.

Goal 3: activate the strategies related to this sector and modernize them according to the industrial strategic developments in Iraq up to 2030 and the implementation mechanisms.

Goal 4: support important strategic industries, especially in the liberated areas, because they contain minerals and natural gas, which is a major incentive to encourage these industries.

Goal 5: achieve a sectoral interlinkage between the manufacturing sector and other sectors and the involvement of the private sector within this threading by using the potential available to the private sector.

Goal 6: Revitalize geological surveys in order to develop an integrated map of the country's mineral resources in order to turn them into investment opportunities.

Considered measures to address this sector are:

- Product and maintain electrical and solar heaters;
- Production of power stations working with solar cell energy;
- Production and maintenance of water purification and sterilization plants of various capacities and solar water sterilization systems;
- Production, design, assembling and connecting of Solar energy system to supply electricity for labs devices and internal lightning;
- Irrigation systems using solar energy;
- Production, design, implementation of Solar energy system to heat waters for all industrial and services sites;

Agriculture and Water resources

- Goal 1: Increase the contribution of the agricultural sector in the gross domestic product (non-oil activities) from 4.5% in 2015 to 5.2% in 2022. Achieving growth in the agricultural sector in the target year reaches 8.4%.
- Goal 2: Achieving sustainable food security.

- Goal 3: Secure the annual demand for water for sustainable uses in the fields of agriculture, industrial and municipal, and achieve water balance with the possibility of reducing the annual demand for water to 500 million m³ annually.
- Goal 4: Work towards sustainable water resources.
- The Investment Plan provides a list of predisposing land for Agricultural Investment in different provinces (214 opportunities in Iraqi provinces for 2019).

Water and sanitation

- Goal 1: ensure the supply of potable water according to international standards and access to the share of per capita consumption of clean water to fit the population growth and at least 250 liters / day per person in Baghdad and provincial centers and 200 liters / day in the districts and villages.
- Goal 2: Improve the quality of potable water.
- Goal 3: Reduce the lost by at least 10% of the base year.

Iraq, Reconstruction and Investment (2018)

The document is structured around five key pillars to face a country after a stage of conflicts: 1) Governance; 2) Reconciliation and Peacebuilding; 3) Social and Human Development; 4) Infrastructure; and 5) Economic Development. For each pillar, the framework suggests concrete reform priorities sequenced over the short-, medium- and long-term.

The framework provided by this document, identifies Iraq's main structural challenges and the conflict's impact on the liberated areas; formulates a reconstruction and development plan that identifies key recovery needs, local investment opportunities as well as national program and reform priorities. Likewise, it presents the envisioned institutional and implementation arrangements, covering timing and geographic scope of the Framework, implementation arrangements, accountability mechanisms and strategic communication. At the end, it addresses the envisioned financing strategy.

According to this document, key challenges within the environment and natural resources sector include: (i) Conflict pollution, related to widespread contamination of land by military wastes, land mines and hazardous chemicals; (ii) Oil pollution due to obsolete infrastructure occasioned by neglect due to multiple conflicts, a weak regulatory system, and weak capacity within the industry regarding hazardous chemical management; (iii) Management of natural resource scarcity including illegal and/or uncontrolled use of natural resources and poor farming practices resulting in widespread ecosystem degradation; and (iv) Climate change and desertification which exacerbates the ecological impacts of an already harsh climate characterised by low rainfall and high summer temperatures, with differentiated impacts on men and women, internally displaced persons, and vulnerable populations.

Regarding the energy sector, the following priorities for the reconstruction pathway are summarized.

Short-term priorities (up to Year 1):

- Rehabilitate electricity infrastructure to increase supply availability and quality after clearance of explosive hazards.
- Add new on-grid and off-grid generation capacity, also through renewable energy sources.

Medium-term priorities (up to Year 3):

- Reinforce the electricity network by expanding and upgrading the generation, transmission and distribution infrastructure, and by increasing power system efficiency.
- Improve supply reliability and reduce losses, and mobilize policy incentives and standards for increased investments in renewable energy

Long-term priorities (up to Year 5 and beyond):

- Operationalize the new electricity law and undertake sector reforms.
- Develop a strategy for international power exchange to promote regional power grid integration.

According to this document, in Iraq there are the next 7 solar PV stations at planning stage, to be structured over 15 years:

Solar PV station	Capacity (MW)
Al-hay	25
Diyala University	15
Abu Gharib	30
Haditha	40
Heet	125
Al-Fallujah	125
Jissan	50

Water resources

Today, Iraq faces numerous technical challenges regarding water management and control due to an increase in climatic variability as well as water scarcity, partly resulting from reduced water flows from neighbouring countries. This situation is exacerbated by recent events, which include the destruction of barrages and dams and deferred maintenance in the areas now liberated from ISIS, and the earthquake of November 12, 2017, which raised concerns about the safety and management of Darbandikhan and Dokan dams.

The Water Resources sector has several developmental challenges: (i) the sector's legal and institutional framework is complex with overlapping responsibilities; (ii) Iraq's groundwater governance is still perceived as an individual property and is exploited without consideration to its sustainability, leading to its overexploitation; (iii) access to irrigation water services and drainage is under pressure. Past trends suggest that even though absolute agricultural water withdrawals are high and increasing, the share of agricultural water withdrawals in total water withdrawals is declining; and (iv) salinity is a major threat. The water in the Tigris and Euphrates is becoming increasingly saline. Along with waterlogging, salinity is currently impacting agricultural production.

Agriculture

About 30 percent of Iraqis live in rural areas, providing abundant labor supply for the agricultural sector. Almost a third of the country's total area is arable land, half of which is used for rain fed agriculture. The sector is one of the largest non-oil sectors of Iraq's economy (with 5% of total GDP) and the largest source of employment (approximately 30%), including for the poor segments of the population and for women. The agriculture sector has been a leader in terms of the private sector, as Iraqi farms are mostly privately owned.

According to this document, cereal production—wheat, barely, rice, and corn— is the most important activity, in terms of both meeting local consumption needs and the size of cultivated land. Vegetable crops such as tomatoes, potatoes, and dates come second in their contribution to the GDP of Iraq. The key challenges of the agricultural sector include:

- Decades of conflict, isolation and destruction. Not only do such conflicts damage production and production capacity, they also increase perceived risks to investment in the sector;
- Limited rural financing for private sector development;
- Weak research and extension capacity and weak links to centers of excellence for food and agriculture;
- Poor agricultural technology due partly to Iraq's prolonged isolation from the developed world; and
- Climate change related reduction in water inflows and increased salinity.

For the agricultural sector to recover and serve as a decent income sources of farmers in rural areas, the following measures need to be taken in different time frames:

Table 6: Identified priorities identified in the “Iraq, Reconstruction and Development Framework” report (2018)

Term	Priorities for agriculture	Priorities for water resources
Short term (up to 1 year):	<p>“Primacy of transfer”: This is specifically ensuring that communities and households to have access to the right inputs at the most appropriate time.</p> <p>Clearing appropriate infrastructure: Most of the clearance of mines, Unexploded ordnance (UXO) and booby traps will be focused on irrigation channels (and other conflict related assets).</p> <p>Reestablishing commercial value chains and markets, as well as basic agricultural technologies.</p> <p>Improving access to finance for farmers and for small and medium farm enterprises.</p>	<p>Rehabilitate the partially damaged water and sanitation facilities after clearance of explosive hazards. Provide key equipment for water and sewerage operation and maintenance.</p> <p>Prepare detailed assessment for complicated damages to facilities, including preparation of designs.</p>
Medium to long term (up to and beyond 5 years):	<p>Pull financing mechanisms to draw Private Sector engagement</p> <p>Reestablishing investment in public goods such as research extension.</p> <p>Developing a coordinated approach to rural investment, which integrates energy, communications, and road infrastructure</p>	<p>Up to year 3</p> <p>Complete rehabilitation works for damaged and destroyed facilities.</p> <p>Establish safe operating procedure for dams and water structures for saving lives and livelihoods of the vulnerable communities.</p>
Long-term priorities (up to Year 5 and beyond):	NA	<p>Prepare a governorate master plan for water and sewerage for the coming 15-20 years.</p> <p>Promote private sector participation in the water and sanitation sector.</p>

Other documents

There are other reports that might be relevant for the purposes of this TNA, due to the kind of analysis and proposed pathways to the near future of Iraq, reason why they are considered for this report. Key messages from these documents are mentioned below.

The document “Iraq’s Energy sector. A Roadmap to a Brighter Future” (2019), set the goal to double domestic generation, imports and neighborhood generation by 2030, for a total supply of over 250 TWh. It considers that one priority in the near and medium term is investment in large scale water treatment projects to supply water for reinjection in the oilfields in the South region.

The document highlights the need to expedite the development of projects that can deliver water to the southern fields for oil recovery, notably the Common Seawater Supply Project, while encouraging companies to enhance efforts on produced water reuse and recycling; push for full implementation of gas flaring reduction projects over the next years; clarify ownership of produced gas and responsibilities for its productive use; develop mechanisms to monetize ethane, and expedite full

restoration of the Baiji refinery, which would increase Iraq's operational refining capacity by 30% and reduce the USD 2-2.5 billion bill for annual oil product imports.

Likewise, the document "Iraq's Energy sector. A Roadmap to a Brighter Future, 2019" established a goal of Increase the share of solar photovoltaics (PV) – in particular – in the power mix and underline the goal of increase the share of renewables up to 30% of electricity supply by 2030. Accordingly, the most severe and immediate shortfalls in supply can be mitigated by: the rapid initiation of network maintenance, targeting a small number of high-impact upgrades; the rapid deployment of new mobile power units; the upgrading of some existing power plants; and the enforcement of tariff regulations for all neighborhood generators. It pointed out the need to cut network losses and more gas needs to be captured and put to use in efficient power plants.

Finally, it can be mentioned the "Iraq's Integrated National Energy Strategy: Summary And Key Recommendations, 2012-2030", which mention that by 2030 it is expected that renewable capacity will exceed 2 GW, approximately 4 percent of system installed capacity. The renewable capacity could increase to 8 percent of system installed capacity if KRG renewable penetration is considered.

2. Current situation

The Republic of Iraq is considered to be a country which is one of the most vulnerable to the impacts of climate change in the Middle East. In particular, a higher frequency and intensity of extreme weather events, such as drought, sand and dust storms are being experienced in recent years. These events are leading to rising environmental degradation throughout the country, threatening Iraq's progress towards sustainable development. Iraq is committed to reducing its vulnerability to the impacts of climate change. In 2009, Iraq ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol as a Non-Annex I country. Since then, Iraq has worked to establish the national entities and units necessary to facilitate the implementation of the provisions of the UNFCCC².

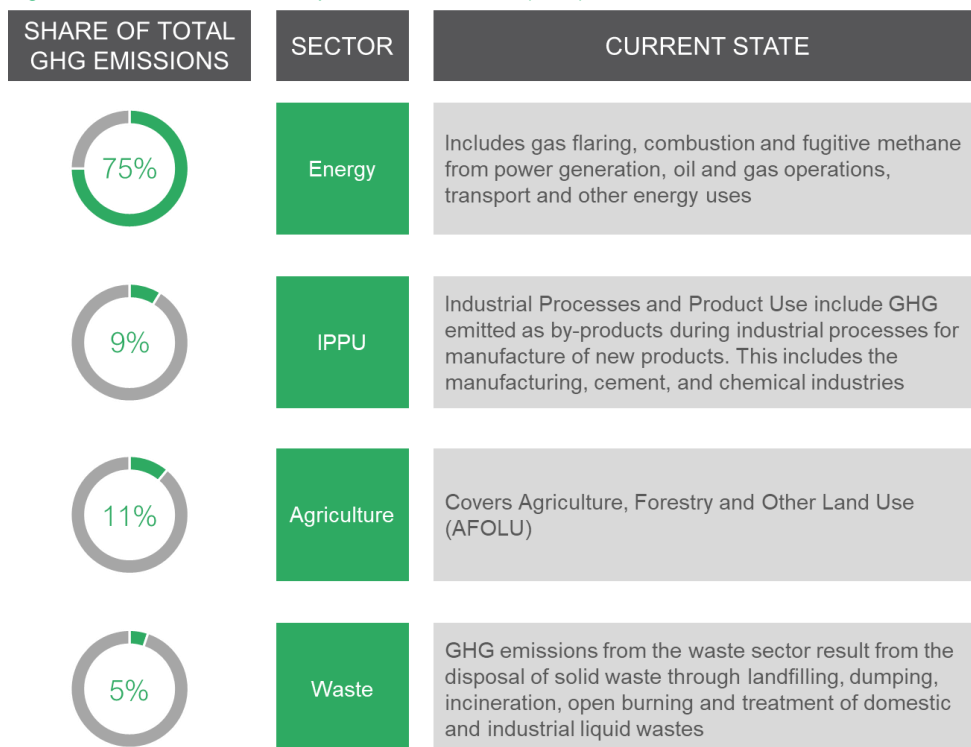
GHG emissions

According to the national GHG inventory of Iraq (submitted to UNFCCC in 2016 with emission estimates from 1997), the total GHG emissions in Iraq in 1997 were of about 73 million tonnes CO_{2e}. The energy sector was by far the main contributor to these emissions with 54.5 million tonnes CO_{2e}, covering 75% of total emissions. With 8 million tonnes CO_{2e} (11.1%), agriculture is the second largest contributor.³

² <https://www.greenclimate.fund/sites/default/files/document/readiness-proposals-iraq-unep-adaptation-planning.pdf>

³ Iraq's Initial National Communication to the UNFCCC (2016)

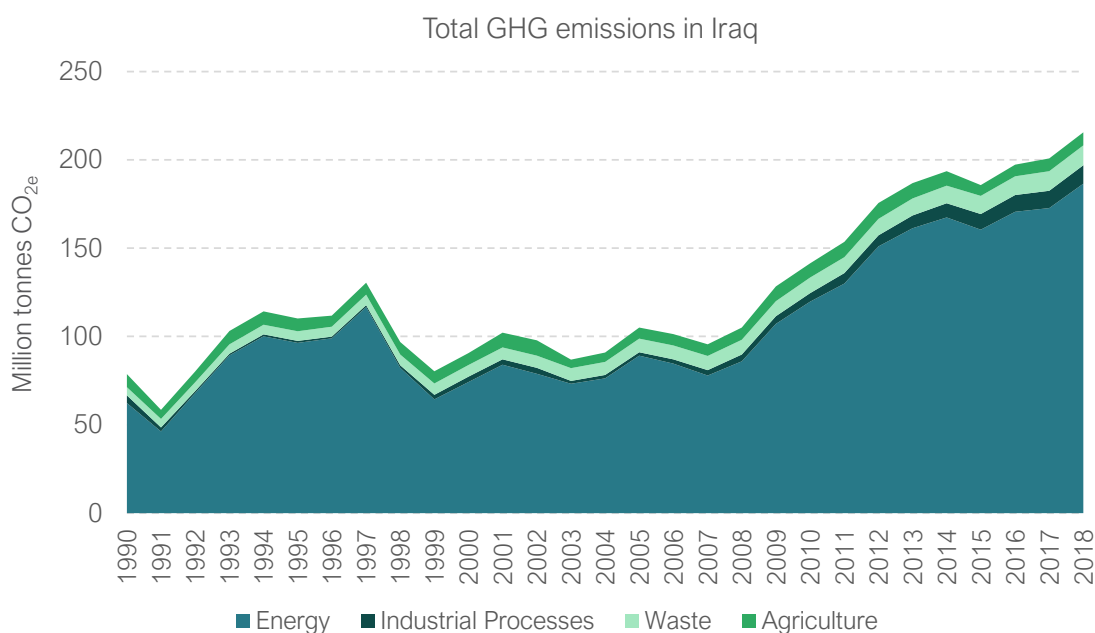
Figure 1: GHG Emissions in Iraq – national estimates (1997)



Source: based on Initial National Communication - NC 1 (2016)

Given that the national estimates of emissions date back more than 20 years, one needs to refer to international assessments of GHG emissions for Iraq for more recent data. It should be noted that international assessments are likely very uncertain, as organizations compiling the data have limited access to local data and need to often rely on international emissions factors and activity data. Figure 2 illustrates historical development of emissions in Iraq based on the World Resource Institute’s assessment. GHG emissions more than doubled in the last decade with emissions from the energy sector accounting for over 85% of the total national emissions in 2018.

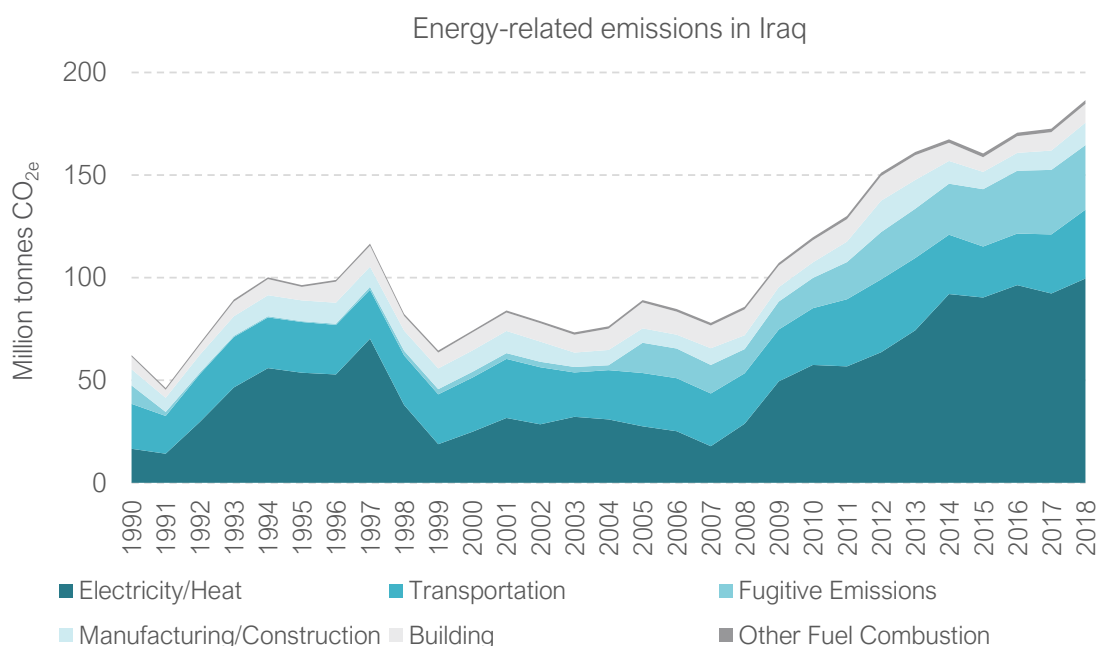
Figure 2: GHG emissions in Iraq – international assessment



Source: Climate Watch Historical GHG Emissions. 2021. Washington, DC: World Resources Institute. Available online at: <https://www.climatewatchdata.org/ghg-emissions>

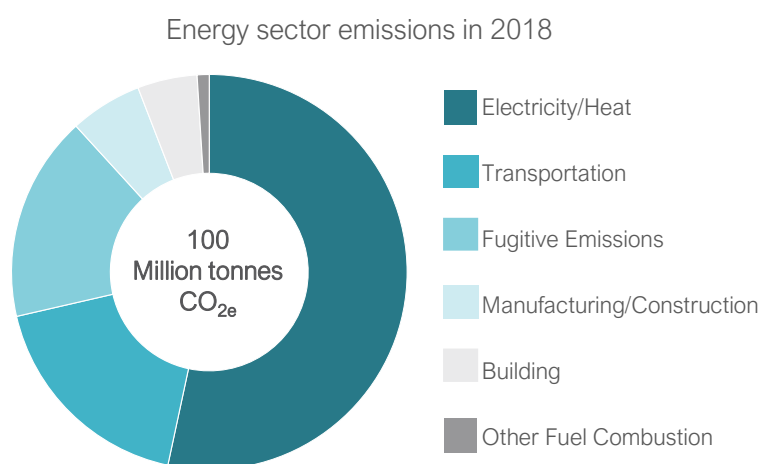
The energy sector emissions include mainly emissions from combustion of fossil fuels across the entire economy, as well as direct fugitive emissions in the oil and gas sector of Iraq (emitted mostly in the form of methane – a very potent greenhouse gas with strong climate impacts). Most of the growth of emissions from energy sector comes from emissions associated with electricity and heat generation, as well as fugitive emissions from the oil and gas sector. The sections below look into these two key emission categories within the energy sector emissions.

Figure 3: Energy-related emissions in Iraq – international assessment



Source: Climate Watch Historical GHG Emissions. 2021. Washington, DC: World Resources Institute. Available online at: <https://www.climatewatchdata.org/ghg-emissions>

Figure 4: Energy-related emissions in Iraq (2018) – international assessment



Source: Climate Watch Historical GHG Emissions. 2021. Washington, DC: World Resources Institute. Available online at: <https://www.climatewatchdata.org/ghg-emissions>

Electricity and heat

Iraq's net electricity generation grew on average by around 8% from 2008 to 2018 reaching approximately 80 TWh. Over 97% of the electricity is generation from oil and gas. The share of natural gas in power generation has increased from 30% in 2016 to approximately 50% in 2018, but mainly

due imports of gas from Iran and not own supplies of gas. About 23% of Iraq's electricity is produced from natural gas produced in Iran and about 5% is imported from Iran.⁴

The country's electricity consumption is very seasonal and reaches its peak during the hot summer months. In general, power generation plants operate at low utilization rates (with available production capacity much lower than installed capacity) due to poor transmission infrastructure, extremely high transmission losses (which amount on average to 52% of the total electricity supply⁵) and damaged or inefficient power plants. This results in frequent power shortages, especially in the summer.

Population groups with higher incomes often use local neighborhood generators to avoid the blackout issues, adding to the consumption of the liquid fossil fuels and associated emissions⁶.

Oil and gas industry

Oil and gas sector is the key pillar of the Iraq's economy – it is by far the largest industrial sector and contributes to over 90% of the total government revenues. The crude oil production has grown dramatically over the last years – from 300,000 barrels per day in 2013 to over 4.7 million barrels/day in 2019⁷.

GHG emissions from the oil and gas sector can be divided into two large categories: (1) emissions from energy combustion for productive purposes, and (2) emissions due to resource waste through flaring, venting and fugitive emissions of methane. While the first category of emissions might be significant due to high production volumes of the petroleum sector and its strategic importance to the country, they are not easily reduced (certain energy efficiency measures can be taken, but reduction in energy consumption will be minimal). The second category of emissions, including flaring of associated gas, venting and unintentional (fugitive) methane emissions through leaks, are important to mitigate. They represent a resource waste that can be used elsewhere in the Iraq's economy for productive purposes, for example, for power generation or in transport. Hence the focus of this section will be on this emission category.

Associated gas flaring

One of the most important sources of emissions, which can be not only be avoided but also lead to emission reduction in other sectors (namely power generation) is associated petroleum gas (APG) flaring which continues to be significant in Iraq. Around 17 billion m³ (bcm) of APG are being annually flared in Iraq. This amounts to an energy loss that alternatively could provide over 80 TWh of electricity, which is equivalent of the total current electricity production in Iraq (78 TWh in 2018⁸). The gas is flared primarily due to insufficient pipeline capacity and processing infrastructure to move and process the gas.

The figure below presents international satellite-based flare estimates based on the data collected by a Visible Infrared Imaging Radiometer Suite (VIIRS)⁹ and analysed by the US National Oceanic and Atmospheric Administration (NOAA)¹⁰. This data is an important source of information in trying to understand the scope and location of flaring in a particular country. However, it is important to state

⁴ Iraq country profile. US Energy Information Administration. 2021. Available online at: <https://www.eia.gov/international/overview/country/IRQ>

⁵ These are the result of damaged infrastructure, poor system design and high rates of electricity theft.

⁶ Iraq's Energy Sector: A Roadmap to a Brighter Future. 2019. International Energy Agency. Available online at: <https://www.iea.org/reports/iraqs-energy-sector-a-roadmap-to-a-brighter-future>

⁷ Iraq country profile. US Energy Information Administration. 2021. Available online at: <https://www.eia.gov/international/overview/country/IRQ>

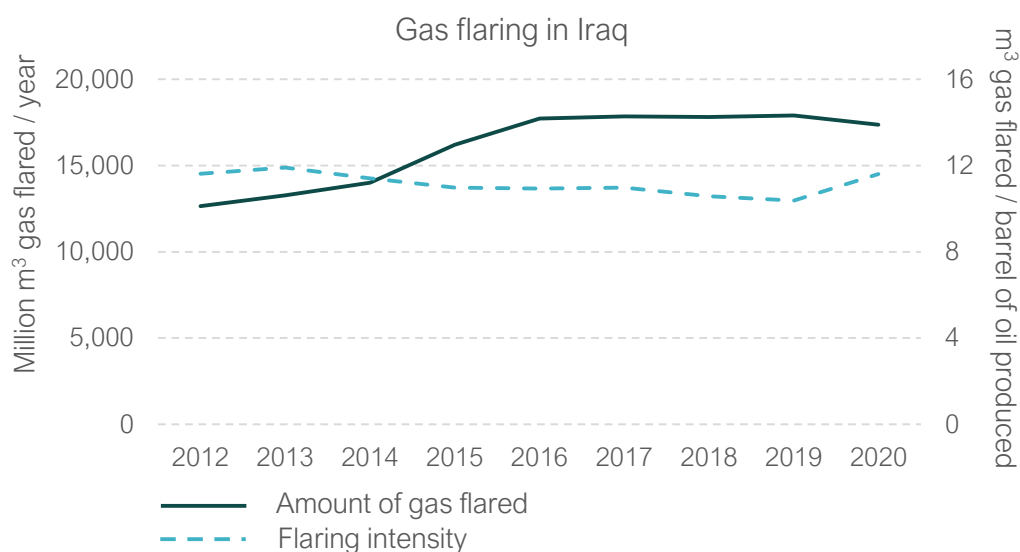
⁸ Iraq country profile. US Energy Information Administration. 2021. Available online at: <https://www.eia.gov/international/overview/country/IRQ>

⁹ VIIRS, a scanning radiometer that is used to measure cloud and aerosol properties, ocean color, sea and land surface temperature, ice motion and temperature, fires, and Earth's albedo. Climatologists use VIIRS data to improve our understanding of global climate change. <http://npp.gsfc.nasa.gov/viirs.html>

¹⁰ For detailed description of the analytical approach, refer to: <http://www.mdpi.com/1996-1073/9/1/14>

that this source of information has its limitations and an assigned degree of uncertainty (estimated to be at $\pm 9.5\%$).

Figure 5: Volumes of associated gas flaring and flaring intensity in Iraq – international assessment



Source: Global Gas Flaring Tracker Data. The World Bank. 2021. Available online at: <https://www.ggfrdata.org/>

As it can be seen from the chart, flare intensity (amount of gas flared per unit of oil produced) has been slightly decreasing in Iraq from 2013 to 2019, due to increasing number of gas utilization projects, but more efforts are needed to eliminate routine flaring. Iraq pushed back its target to eliminate natural gas flaring to 2025¹¹. Iraq is pursuing several projects to capture its associated natural gas and is negotiating agreements with several technology providers for natural gas capture and processing, power generation¹². In particular, the Basrah Gas Company has made recent progress and is now capturing and processing around 10 bcm of gas per year¹³.

Venting and fugitive emissions through leaks

Venting and fugitive emissions are different from combustion emissions – the main GHG that is emitted through direct releases of gas (without combustion) into the atmosphere is methane. Methane is a powerful greenhouse gas and stays in the atmosphere for only approximately 12 years. During this time, it contributes substantially more to climate warming than CO₂. The global warming potential of methane is over 25 times greater than CO₂ over a 100-year timeframe—and 86 times greater over a 20-year timeframe. As a result, methane emissions have contributed to over one-quarter of the warming we are experiencing today. Methane is emitted throughout the oil and gas supply chain, from unintentional leaks to intended/planned processes. The sector provides the greatest potential for emissions reduction – according to the International Energy Agency, over 70% of emissions can be abated with technology that exists today, and up to 40% - at no net cost (i.e. economic gains from deploying these technologies outweigh the costs)¹⁴.

Unfortunately, no reliable national estimates of direct methane emissions exist in Iraq as of today. However, there is a number of international studies that have looked into the issue and some of the results are presented in the charts below. There is consensus that methane emissions from Iraq’s oil and gas sector are substantial, but improved estimates of the magnitude, location and sources of methane emissions are needed in order to facilitate mitigation of these emissions.

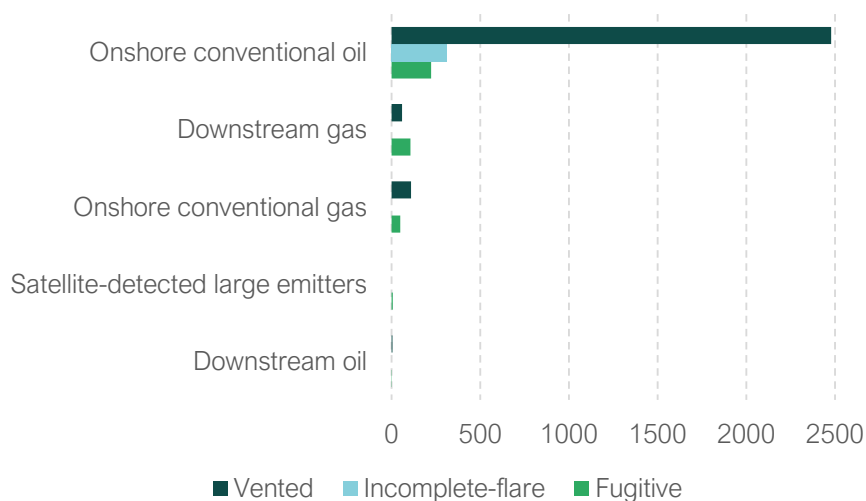
¹¹ Middle East Economic Survey, “Iraq Delays 100% Gas Capture Timeline to 2025,” August 28, 2020

¹² Iraq Oil Report, “Iraq Crude Production and Export Tracker,” August 2020

¹³ Iraq’s Energy Sector: A Roadmap to a Brighter Future. 2019. International Energy Agency. Available online at: <https://www.iea.org/reports/iraqs-energy-sector-a-roadmap-to-a-brighter-future>

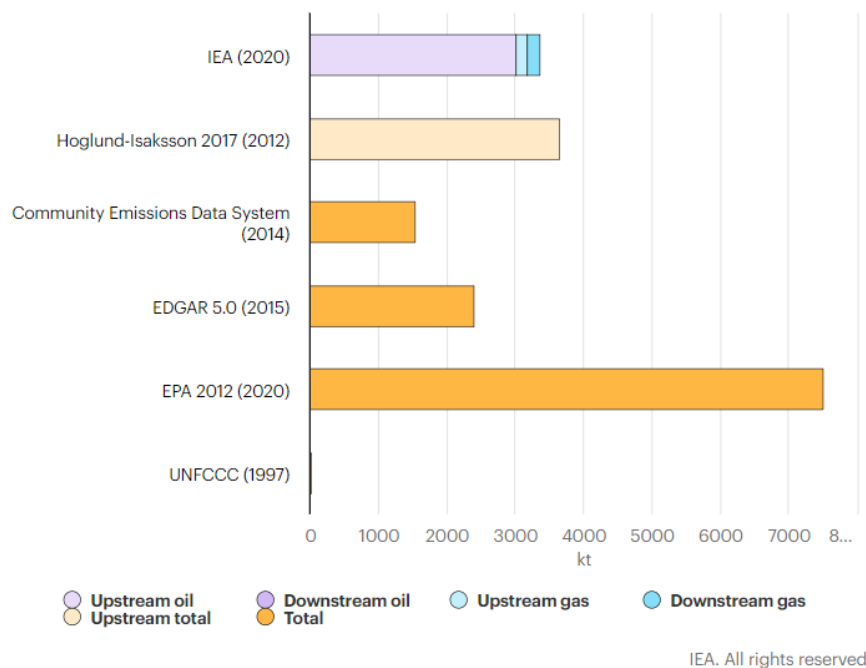
¹⁴ Methane tracker 2021. IEA. 2021. Available online at: <https://www.iea.org/reports/methane-tracker-2021>

Figure 6: Direct methane emissions in Iraq (2020) – international assessment



Source: Methane Tracker 2021. IEA. 2021. Available online at: <https://www.iea.org/reports/methane-tracker-2021>

Figure 7: Comparison of international estimates of direct methane emissions in Iraq



Source: Methane Tracker 2021. IEA. 2021. Available online at: <https://www.iea.org/reports/methane-tracker-2021>

Vulnerability to climate change

Iraq is considered to be one of the most vulnerable countries to climate change in the Middle East and is already experiencing significant adverse impacts of the global warming in the form of rising temperatures and declining precipitation. These will lead to decreased water and food availability, desertification, and associated impacts on the population's health, as well as the major industries, including the oil and gas and agriculture sectors which require significant water resources for their operations. The hydropower generation is also threatened by increasing temperatures – according to some scenarios the capacity of the plants can reduce from 1,846 MW to 400 MW¹⁵. Drought and low rainfall due to global climate changes have decreased water quantities feeding rivers. As a result, several

¹⁵ 2016. Iraq's initial national communication to the UNFCCC. Ministry of Health and Environment.

wells, springs and irrigation channels have dried out and a number of waterways has become shallow water pans affected by several pollution sources like industrial wastewater or water resulting from irrigation of agricultural lands, which carry contaminated organic materials or solid wastes. It is, therefore, important to increase multi-use water allotments to compensate natural water scarcity.

The country's vulnerability was affected further by the conflicts happening on Iraq's territory in the past decades – damage to water systems, irrigation facilities and disruption of value chains.

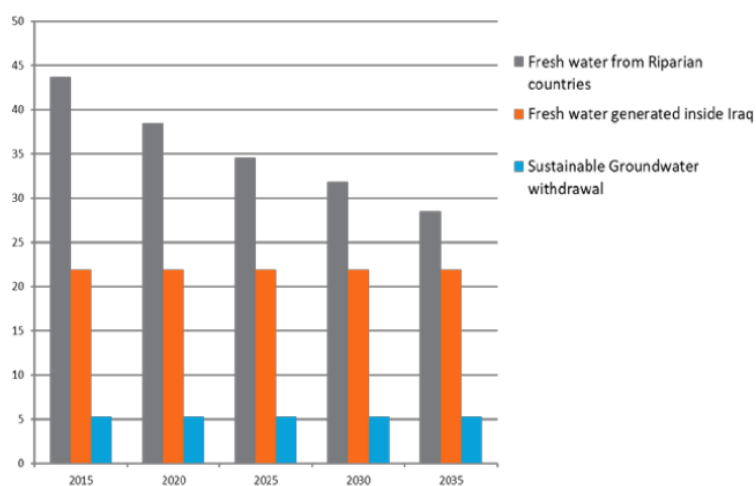
Water Resources

Water resources are particularly impacted by climate change, both through rainfall and increasing temperatures. The Tigris-Euphrates river basin provides up to 98% of Iraq's water. Both rivers are expected to decline by 50% and 25% respectively by 2025. They have already been in decline for decades and the dangerous trend is likely to continue. The Euphrates had a volume of 30.6 bcm in the middle of last century and the current volume is estimated at 18 bcm.

According to The National Environmental Strategy and Action Plan for Iraq (2013 – 2017), compared to 2002, salinity rates in rivers in 2006 increased by 50% as a result of high temperatures and drought, low rainfall to less than normal by 50%, and high evaporation rates which usually increase in summer. The impacts of climate change are accompanied by the fact that the highest percentage of water consumption (around 80%) is for agricultural purposes. To sustain water, methods of irrigations and cultivation should be developed to achieve the highest efficiency and the least rate of loss. Furthermore, there should be focus on using untraditional water, such as gray water, rainwater harvesting, industrial wastewater, wastewater, and treated water.

Both Iraq's population, oil and gas sector production and agricultural sector are expected to grow in the years to come, which will continue putting increasing pressure on the water demand in the country.

Figure 8: Expected water supply sources and quantities in Iraq until 2035



As Iraq's INDC indicates, there was a 16% shortage of renewable water resources compared to actual needs in the early 2000s. This percentage is expected to reach 37% during the period 2020-2030 and 51% over the period 2040-2050. This will lead to further issues in agriculture, impacting agricultural production, natural systems and biodiversity.

Agriculture

The agricultural sector is one of the key consumers of water resources in Iraq (over 85%) and its development will strongly depend on the water resource availability in the future¹⁶. Agriculture in the country is mostly practiced on small farming units and it is a low input-low output system. Crop yields

¹⁶ 2016. Iraq's initial national communication to the UNFCCC. Ministry of Health and Environment.

are rather low compared to other neighbouring countries as farmers aim to minimize costs related to land preparation, planting, weeding and harvesting. Most of the farming is related to crop production (over 75%), while the rest produce livestock or a mix of crops and livestock. Grains, primarily wheat and barley, are Iraq's main crops in the north and central rain-fed areas. In central and southern Iraq, where agriculture depends mainly on irrigation from the Tigris and Euphrates rivers, mixed farming systems are predominant¹⁷. The amount of water used for irrigation is increasing due to use of open and old irrigation canals, outdated irrigation techniques and traditional agricultural practices. This has led to high levels of groundwater, water logging and soil salinization.

Barriers and challenges

While the country seeks to achieve the target of the INDC through effective utilization of energy resource and transition to low carbon initiative gears toward decarbonizing the economy, the following still poses as barriers that will need to be surmounted if the country's targets are to be achieved. This barrier analysis will be further carried out through stakeholder consultations and technology prioritization process in order to identify barriers specific for each sector and measures that can be taken to overcome those.

Lack of awareness about climate change, its impacts and mitigation opportunities

Lack of awareness about climate change, its impacts and possibilities for mitigation exists on all levels and across different institutions, communities and organizations.

Limited integration of climate-related issues in key sectoral strategies and plans

Many sectors have started to understand the important of climate change adaptation and/or mitigation for their continued operations and for competitiveness in international markets (especially in the oil and gas sector, where companies are facing increasing pressure from the consumers to make their products more "sustainable"). However, there is still a limited number of sectoral strategies that incorporate specific targets and identify measurable actions for climate mitigation and adaptation.

Technological barriers

There is a limited number of technology providers operating in the country/region and lack of specific technologies on the market, as well as limited access and/or inadequate dissemination channels especially to final users of these technologies (e.g. small and medium enterprises, SMEs). Project developers are often faced with the need to conduct detailed market studies to identify and procure necessary equipment, for which they often do not have available resources and/or capacity (e.g. farmers might not have the time or know-how to procure state-of-the-art solar-based irrigation equipment).

Economic instability

The last decades of military conflicts has left Iraq facing increasing financial constraints despite it being a large oil- and gas-producing nation. At the moment, the majority of international financing is directed to humanitarian assistance and reconstruction of the country in the north. The lack of clear integration of climate change priorities in key national legislation and sectoral strategies prevents the country from receiving more funding for supporting climate mitigation and adaptation action.

Institutional capacity

Limited coordination and collective action regarding climate change mitigation and adaptation among relevant institutions, resulting in fragmented ownership of climate change portfolio and elusive responsibilities.

¹⁷ 2012. Iraq: Agriculture Sector Note. Food and Agriculture Organization (FAO) Investment Centre.

3. Selection of the sectors and sub-sectors for analysis

The basis for selection of the priority sectors for adaptation and mitigation analysis was the Intended Nationally Determined Contribution (INDC) of Iraq, as well as other policy documents. The INDC prioritises sectors with the highest potential for adaptation and mitigation respectively: agriculture and water, as well as energy and industry.

The Iraq's Integrated National Energy Strategy and National Environmental Strategy and Action Plan identified a number of important sectors that were grouped by a mitigation and adaptation focus:

Mitigation	Adaptation
Electricity	Water
Industry	Agriculture
Oil and Gas	Biodiversity
Transport	Health
Housing	Sea-level Rise
Waste	Tourism

All of the identified priorities were taken into account during preparation of the Readiness Proposal to GCF for this TNA work, and elaborated further through a series of stakeholder consultations. In discussion with the relevant ministries and agencies the priorities presented above were grouped into four sectors that formed the basis for selected key sectors:

Mitigation	Adaptation
Energy, including Electricity and Housing	Water
Industry, including Oil and Gas	Agriculture

Selection of the focus sub-sectors is based on similar principles: these are areas with highest possible impacts in the short- to medium-term, as there is a strong need for Iraq to act quickly in order to decrease its vulnerability to climate change. In addition, the future development of the sub-sectors was taken into account. Those sub-sectors that are planned to increase output and will thus demand more resources should be prioritized, as deployment of outdated, carbon-intensive technologies in these strategic sub-sectors will only further worsen Iraq's position and prevent from reaching its ambitions set forth in the INDC and other strategic documents. The following sub-sectors will be further reviewed when identifying and prioritizing technologies for mitigation and adaptation:

Mitigation	Adaptation
Energy: <ul style="list-style-type: none">- Power generation- Transmission and distribution	Water: <ul style="list-style-type: none">- Water management
Industry: <ul style="list-style-type: none">- Oil and gas sector- Energy efficiency in manufacturing industries	Agriculture: <ul style="list-style-type: none">- Irrigation systems- Farming systems and crop management

4. Description of methodology for technology prioritization

After the selection of the key sectors and subsectors is completed, the next steps in the Technology Needs Assessment will include the identification and prioritization of specific technologies that can help

Iraq mitigate and/or adapt to climate change impacts. Multi-criteria assessment is often used as a tool to perform such prioritization exercise, as it allows to combine different criteria and assess different technologies using a unified approach.

A solid knowledge base is built around TNA development and multi-criteria assessment applied to establish a prioritized list of technologies for climate adaptation and mitigation of a specific country. UNEP DTU has built a valuable resource database, including both methodological documents, as well as real national TNAs and associated action plans to implement selected technologies: <https://tech-action.unepdtu.org/>. The team will utilize existing methodologies and assessment processes that have proven to be effective, especially in the Middle East and North African countries. For example, a recent summary report on TNA process conducted since 2009 in 31 African countries, has identified similar patterns in their prioritization for adaptation and climate change. 94% of the countries in questions have chosen to focus on agriculture and water as their key adaptation sectors, and 97% selected energy sector as the priority for mitigation actions¹⁸.

The aim of this activity will be to validate and prioritize key technologies, aligned with Iraq's NDC within three key sectors identified (energy, industry, water and agriculture)¹⁹. A number of parameters are important when deciding which technologies should be utilized for climate adaptation and mitigation, including their costs and effectiveness (e.g. mitigation potential), market availability, natural resources, skills base, barriers for implementation and more. In order to formalize the approach and make sure that options are compared using a unified set of criteria, a multi-criteria assessment is typically used.

Adopting stringent climate mitigation and adaptation options can generate multiple positive non-climate benefits that have the potential to reduce the costs of achieving sustainable development. Research shows that aligning mitigation options with wider sustainable development goals will help ensure public acceptance, faster implementation and protect human rights²⁰. Some priorities will obviously be better fitted to address the economic/societal/environmental challenges that a country faces and there is a large number of studies that have evaluated such impacts (see

¹⁸ UNEP DTU, 2020. TNA: Regional technology brief – Africa, <https://unepdtu.org/wp-content/uploads/2020/04/regional-technology-brief-africa-final.pdf>

¹⁹ Unless analysis in Activity 2.1 confirms that another sector needs to be included in further analysis.

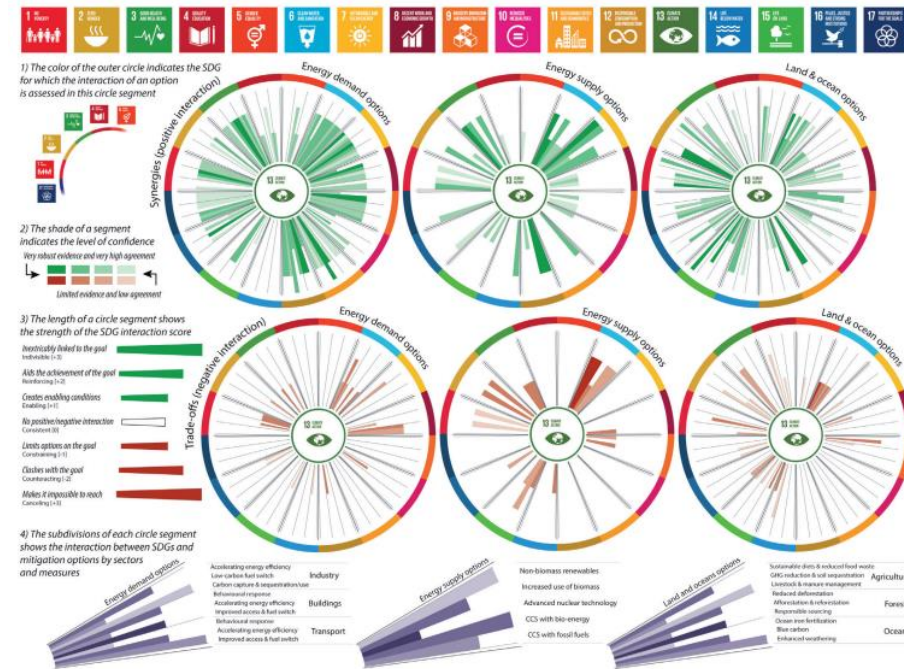
²⁰ IPCC, 2019. Special report: Global Warming of 1.5 °C
https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter5_High_Res.pdf

Figure 9 for an example of assessment of how successfully energy demand, energy supply and land & ocean mitigation options help address each of the Sustainable Development Goals, SDGs). Due to the complexity of sustainability assessment, decisions have to be taken in a structured, transparent and reliable way. Multi-criteria analysis (MCA) is one of the approaches that is commonly applied. It allows to account for multiple criteria, in order to rank, select and/or compare different abatement options based on their impacts on the climate (for example, through tonne of GHG as metrics provided by the marginal abatement cost curve), economic, social and environmental spheres (eradication of poverty, reduction of inequality, economic growth, protection of biodiversity, reduction of air pollution, etc)²¹. A wide range of methodologies and tools have been developed to perform assessments using MCA (for example, weighted sum model, goal programming, analytic hierarchy process, analytical network process, etc)²².

²¹ UNEP DTU Partnership, 2015. Identifying and prioritising technologies for mitigation. <https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2019/05/final-mca-guidance-mitigation-september2015-1.pdf>

²² <http://www.jocet.org/papers/193-R019.pdf>

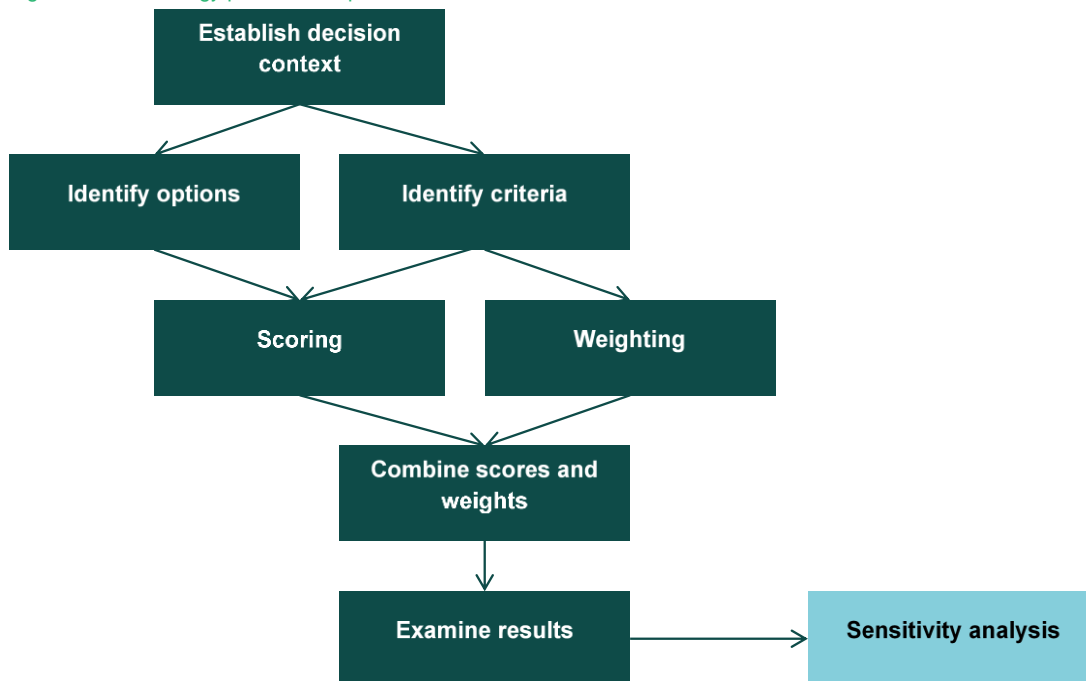
Figure 9: Interaction between Sustainable Development Goals (SDGs) and individual mitigation options



Source: IPCC (2019) Special report: Global Warming of 1.5°C

To perform the MCA, one needs to not only define the key parameters for the analysis, but also determine their relative importance, as not all of them might have equal importance or impact (e.g. poverty eradication can be more important than pure economic efficiency of mitigation measures, and improvement of air quality can be considered as more important than noise reduction). The approach suggested by UNEP-DTU in their TNA Step-by-step Guide²³ is outlined in Figure 10

Figure 10: Technology prioritization process based on MCA



²³ UNEP DTU, 2019. TNA Step-by-step guide, <https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2019/04/2019-02-tna-step-by-step-guide.pdf>

Each of the main steps is summarized below:

1. Establish decision context

This includes analysis of existing national and regional climate strategies, policies, roadmaps. This report serves as documentation of this task.

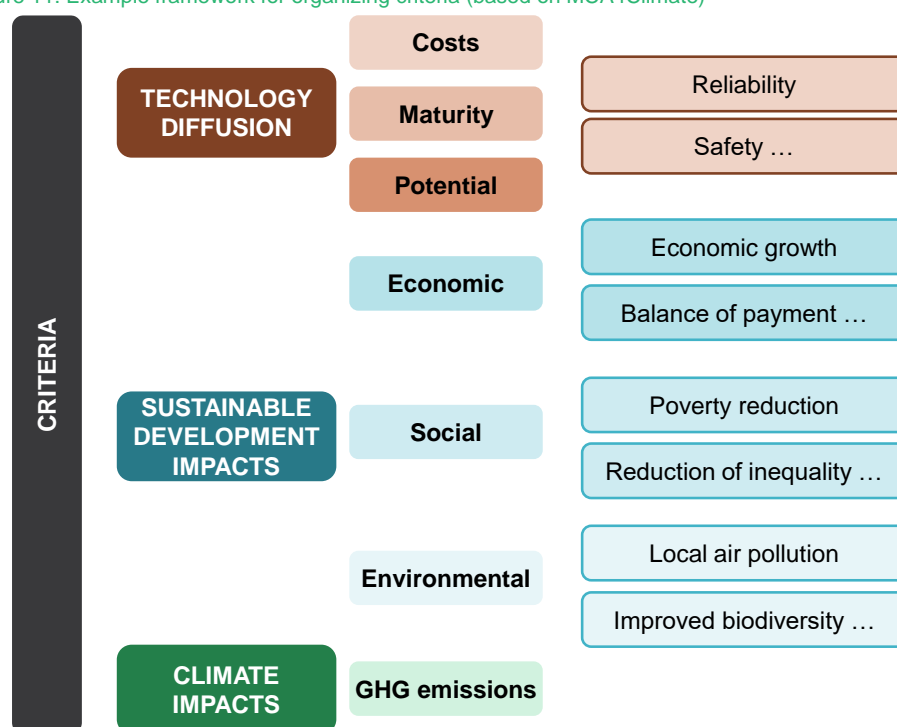
2. Identify options

The existing planning documents (especially the NDC, but also other national and sectoral strategic documents) need to be reviewed and information about specified technologies will be collected. External sources of information (Climate Techwiki, IEA Technology Perspectives, etc.) as well as sectoral experts will be consulted to expand the long list of technologies considered relevant for each sector²⁴. All technologies should be included at this point and discussed with the relevant stakeholders to ensure a high level of “buy in”. Technology factsheets for mitigation and adaptation technologies developed by UNEP DTU will be used for collection and summary of information.

3. Identify criteria

The criteria will be related to climate change mitigation/adaptation impacts, as well as broader development priorities of Iraq. MCA4Climate²⁵ suggests using three broad categories of criteria for analysis of climate technologies:

Figure 11: Example framework for organizing criteria (based on MCA4Climate)



Criteria will be selected through a participative process ensuring fair gender representation, which will be facilitated by the consultant team. The initial long list of criteria will be obtained through brainstorming to ensure that all relevant stakeholders can express their views. Through further discussions, the list will be refined to limit the number of final criteria to 7-10 most relevant items

²⁴ In addition to the general guidance documents on conducting MCA for identifying and prioritizing technologies for adaptation/mitigation, UNEP DTU has also developed a number of sector-specific guidebooks, covering transport and building sector for mitigation and water, agriculture and coastal erosion/flooding for adaptation technologies (<https://tech-action.unepdtu.org/tna-methodology/>). These will also be utilized in the project for the relevant sectors.

²⁵ <http://www.mca4climate.info/>

(as recommended in the UNEP DTU's Guidance on multi-criteria analysis for identifying and prioritizing technologies for mitigation²⁶).

4. Scoring

Under this step, technologies are evaluated using the selected criteria. In order to do so, an evaluation scale is selected for each criterion – for example, capital costs can be compared using USD, GHG emission reductions using tonnes CO_{2e}, while qualitative parameters can be evaluated using a Likert scale²⁷. Performance matrix, including all criteria (and corresponding units) is filled out for all technologies. It is then converted into a scoring matrix, in which the scales for all criteria are the same, for example 0-100. The most preferred option is assigned a score of 100, while the least preferred is given a score of 0. The scores for the remaining options should reflect differences in the strength of each preference. An illustrative example is presented below:

Table 7: Example of performance matrix

Technology	Criterion 1 Cost (USD)	Criterion 2 Abatement potential (tCO _{2e})
A	1000	500
B	750	150
C	450	200

Or with scores:

Technology	Criterion 1 Cost (USD)	Criterion 2 Abatement potential (tCO _{2e})
A	0	100
B	$(750 - 1000)/(450 - 1000) = 45$	0
C	100	$(200 - 150)/(500 - 150) = 14$

As part of this exercise, all existing information on various technologies will be collected and utilized to establish quantitative values, where possible. If information is not available, own analysis might be performed by the consultant team. For example, marginal abatement costs and potential of various technologies can be estimated using established approaches²⁸. All values will be validated with stakeholders.

The output of this step includes a matrix with a score for each technology option per criterion.

5. Weighting

The criteria selected for evaluation of various technologies do not necessarily have the same importance for decision-makers and also might not contribute to the overall goal (climate mitigation

²⁶ <https://tech-action.unepdtu.org/tna-methodology/>

²⁷ Likert scale, rating system that is designed to measure people's attitudes, opinions, or perceptions. Subjects choose from a range of possible responses to a specific question or statement. Often, the categories of response are coded numerically, such as 1 = strongly agree, 2 = agree, and so on. (<https://www.britannica.com/topic/Likert-Scale>)

²⁸ **Marginal / incremental costs** are associated with emission reductions achievable by various options at a given point in time (for example in 2030, the target year for Iraq's NDC). It reflects the costs and potential of emission reductions relative to a **baseline (reference case)**. The baseline reflects technology choices under a business-as-usual scenario that includes limited low carbon policy measures (if any). The emissions reduction potential (**abatement potential**) represents emission reductions that can be achieved in a given year (for example, 2030) by implementing that abatement option compared to a baseline.

or adaptation, development, etc.) in the same way. Therefore, the weights given to each criterion should reflect their relative importance in the choice of technology options. There are different ways to assign weights, both participatory and statistical. According to the existing TNA guidance, it is recommended that the weights reflect, first and foremost, the views and priorities of stakeholders.

The output of this step is a list of weights for the previously selected criteria.

6. Results

All the analysis will be summarized and final scores per technology estimated, by summing up the result of multiplication of the individual technologies' scores for each criterion by the weight of the specific criterion. The technology options will then be ordered according to their total score, and the two or three best-scoring technologies can be selected for further analysis. Sensitivity analysis can help assess whether, and how much, the ordering of the options will change depending on the chosen weights or the preference allocation. This can be very helpful in building a consensus if, for example, different groups of stakeholders have very different views on the criteria weights or on the qualitative scores given to a specific technology.

The key output at this stage will be a short list of technologies prioritized for the fulfilment of Iraq's NDC and selected for further analysis.

The results of the prioritization exercise will be documented in two corresponding reports: Technology Needs Assessment report for adaptation and Technology Needs Assessment for mitigation.

Annex: Outcomes of the stakeholder consultations during preparation of the GCF Readiness proposal²⁹

On the basis of the consultations with officials within the Government of Iraq the following sectors have been derived. These result from a number of identified measures that act as a framework that will enable the desired impact to be achieved. A number of potential measures (and impacts) have been derived from national policy documents and from identified barriers to the achievement of objectives:

Sector	Challenge	Potential measures and Impact
Energy (including electricity and housing)	<p>To overcome issues with production and electric power shortage of clean energy. The national electricity system experiences a shortage of electric power generation with average processing power of 8 hours per day and the absence of such power has led to widespread deployment of diesel generators.</p> <p>To reduce dependence on kerosene and gasoline.</p> <p>To increase production of energy from waste.</p> <p>To enhance specification associated with energy and housing standards.</p> <p>To reduce carbon (gases) emissions per unit of energy</p> <p>To increase demand on housing appliances with high energy efficiency.</p> <p>To increase number of housing units reliant on clean fuel and efficient lighting</p>	<p>Decreased use of private generators to satisfy needs and introduce combined cycle units, steam and hydroelectric in power-gen stations.</p> <p>Expand transmission and distribution networks to reduce vulnerability.</p> <p>Enhance electrical services to consumers (domestic, commercial, industrial and government).</p> <p>Introduction of transformative fuels and commission wind/ solar atlas and land-use change mapping.</p> <p>Commission databases on relevant technologies to forecast contribution to (un)conditional targets.</p> <p>Increase electricity supply coverage - production linked to network.</p> <p>Renewable energy (photoelectric power and CSP) to generate electricity in public buildings in small areas and cities.</p> <p>Decarbonisation of energy supply through increased renewable energy penetration (wind, solar, hydro and biomass and CHP).</p> <p>Adopt cleaner production techniques to reduce pollutant gases. Management of harvested wood products and bioenergy products. Provide private economic incentives.</p> <p>Efficiency technologies deployed from housing/ building retrofit initiatives across public sector, industry and residential sector.</p> <p>Mechanisms deployed to stimulate R&D and information dissemination on housing materials, energy efficient equipment, energy conservation and efficiency.</p> <p>Enhanced housing/building codes, legislative requirements to drive renovation of building stock, white appliances, building performance and labelling.</p>

²⁹ The text is taken directly from the GCF Readiness Proposal for Technology Needs Assessment and associated action plan for climate change mitigation and adaptation in Iraq's most vulnerable sectors

		<p>Introduce initiatives to increase consumption efficiency.</p> <p>Training/accreditation of installers, building technicians and power engineers.</p> <p>Modernized technologies used in electricity sector, including advanced smart meters.</p> <p>Increased local building material manufacture and standards across all technical installations, providing more low carbon solutions to economy.</p> <p>Improved cooking stoves, solar water heaters and mechanisms for thermal insulation.</p> <p>Conduct engineering fields tests (EFTs) and demonstration projects. Provide private economic incentives.</p> <p>Decarbonisation through deployment of LEDs.</p> <p>Increased networking and exchange of best energy efficiency practice by the largest users</p>
<p>Industry (including oil and gas)</p>	<p>Iraq industry is dominated by SMEs and family businesses operating in retail, construction and transportation services.</p> <p>Over 33,000 SMEs operating in Iraq until the late 1990s have closed due to insecurity and cheap imports competition.</p> <p>Problems and impediments to industry include inappropriate legislative and regulatory framework, lack of enforcement of existing frameworks. The contribution of the industry sector has decreased 11.5% from 2009-2010. Currently, SMEs include construction, chemical, textiles, engineering and food industries.</p> <p>Globally, Iraq has the third largest reserves of conventional oil and plans to increase crude oil production to 6 million barrels a day from 2019.</p> <p>To strengthen SMEs and entrepreneurs.</p>	<p>To attract international business communities and non-oil economic actors through enhancing skills development and annual GDP growth rates.</p> <p>To update/ introduce an appropriate legislative and regulatory framework, and strengthen enforcement of existing frameworks</p> <p>To increase private sector contribution to efficient manufacturing.</p> <p>To introduce targeted schemes providing assessments of energy use and advice on energy management.</p> <p>To initiative a programme of factory rehabilitation.</p> <p>To stimulate waste heat recycling from industrial processes for energy recovery.</p> <p>To initiate a targeted scheme providing assessments of energy use and advice on energy management.</p> <p>To enhance efficiency of its provision of energy services.</p> <p>Apply technological solutions such as virtualization, co-location, efficient IT hardware, optimized cooling technologies, and energy management controls</p>

	To enhance private sector investment	
Water	<p>To protect and improve water quality</p> <p>To target strategy aimed at Dust and weather adverse impact upon landscape and resulting degradation</p>	<p>Management of surface water resources and operation of dams.</p> <p>Develop a program to collectively operate reservoirs and dams via centralized control models and remote monitoring.</p> <p>Establish a plan for integration of water resources and buildings. Establish annual water budgets to enable water demand management.</p> <p>Establish procedures for early warning systems in cases of drought and flood disaster.</p> <p>Introduce water treatment units. Decreased use of private generators.</p>
Agriculture	<p>The agricultural sector is one of the most consuming sectors of water in Iraq and the impact of climate change on water resources is expected to reduce agricultural production.</p> <p>To increase productivity and strengthen the adaptive capacities of people that are heavily dependent on agriculture.</p> <p>To control land degradation and combat desertification.</p> <p>To enhance skills capacity of farmers.</p> <p>To introduce waste collection and disposal systems across environment to prevent incineration and pollution.</p>	<p>Improved management of rain fed agriculture through digging water wells and associated irrigation (Sprinkler, drip, surface methods)</p> <p>Skills capacity of farmers enhanced through capacity development from enhanced crop production and pest management techniques (reducing pesticides and herbicides).</p> <p>Increased use of crop diversification, land use planning, water harvesting and green areas.</p> <p>Increased research into crop varieties and apply advanced systems to increase natural vegetation in pastoral areas.</p> <p>Enhanced soil management and stabilization practices, crop management to increase carbon storage in soils and improved techniques of nitrogen fertilizers.</p> <p>Introduce salinization maps and identify impact type.</p> <p>Enhanced crop production techniques (wheat and barley) and harvesting techniques in desert areas to exploit rain flooding.</p> <p>Promote green belts around urban areas.</p>