Government of the Islamic Republic of Afghanistan

National Environmental Protection Agency

TECHNOLOGY NEEDS ASSESSMENT REPORT MITIGATION

February, 2020

Supported by:

TECHNOLOGY NEEDS ASSESSMENT REPORT MITIGATION
TECHNOLOGY PRIORITIZATION

National TNA Coordinator:
Rohullah Amin, NEPA, Afghanistan

National Contributors and Supporting Team:
Expert Working Group on Mitigation

National Environmental Protection Agency

National Consultants:
Mumtaz A. Ahmadi, Mitigation Expert

Noor Bibi Gouhari, Climate Change Specialist, NEPA

TNA Global Project Coordinator:

Dr. Sara Lærke Meltofte Trærup	UNEP DTU Partnership

TNA Reviewers:

Prof. Sivanappan Kumar	Asian Institute of Technology
Prof. Rajendra P. Shrestha	Asian Institute of Technology
Dr. P. Abdul Salam	Asian Institute of Technology
Dr. Fatemeh Bakhtiari	UNEP/ DTU Partnership

TABLE OF CONTENTS

LIST OF TABLES & FIGURES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AE	Alternate Energy
AIT	Asian Institute of Technology
ALGAS	Asian Least Cost GHG Abatement Strategy
CC	Climate Change
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon dioxide
DG	Director General
DTU	Technical University of Denmark
E&CC	Environment and Climate Change
EE	Energy Efficiency
EGTT	Expert Group on Technology Transfer
ENDA	Energy Environment Development Agency??
ENERCON	National Energy Conservation Centre
EPA	Environmental Protection Agency
ESTs	Environmentally Sound Technologies
GCF	Green Climate Fund
GCISC	Global Change Impact Studies Centre
GEF	Global Environment Facility
GHG	Greenhouse Gas
GHGR	Greenhouse GasReduction

GoA	Government of Afghanistan
IGCC	Integrated Gasification Combined Cycl
IBUR	Initial Biennial Update Report
TNA	Technology Need Assessment
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme

ACKNOWLEDGEMENT

Technology Needs Assessment Project implemented in collaboration with the United Nations Environment Program, Climate Technology Centre & Network (CTCN) and UNEP/DTU (https://unepdtu.org/) partnership as a part of the strategic program on technology transfer, is an encouraging step in the Afghanistan's progress towards climate change adaptation and mitigation.

For us, the ongoing Technology Needs Assessment (TNA) project in Afghanistan is an excellent opportunity to accelerate environmentally friendly technology transfer that should become the basis for Afghanistan to reach the determined GHG emission reduction targets and promote low carbon and climate resilient development of the country.

Afghanistan Natoinal Environmental Protection Agency (NEPA) hopes that the Technology Needs Assessment (TNA) project will serve as a key step towards addressing our climate change concerns by providing an assessment of the priority technology requirements. My special thanks are due to the members of the Expert Working Group on Mitigation and all other experts who contributed to the TNA process. I would also like to thank the numerous other ministries, divisions of the government, non-government and private sector experts who took time out of their busy schedule to meet with our consultants and provide data and information.

Lastly, I extend my gratitude to the Global Environmental Facility (GEF) for providing financial support. I also thank the UNEP Division of Technology, Industry and Economic for their technical support and guidance.

H.E. Schah-Zaman Maiwandi
Director General
National Environmnetal Protection Agency
Islamic Republic of Afghanistan

EXECUTIVE SUMMARY

The project on Technology Needs Assessment provides a great opportunity for Afghanistan to perform the country-driven technology assessment to identify environmentally sound technologies that might be implemented with a substantial contribution in addressing climate change mitigation needs of the country. The aim of the Technology Needs Assessment project is to support developing countries and the countries with economy in transition to meet their obligations under the United Nations Convention on Climate Change, bringing contribution to the following:

- The priority of technology needs, which can be used in an environmentally safe technology package;
- To facilitate an access to and transfer of environmentally sound technologies;
- To facilitate the implementation of paragraph 4.5 of the United Nations Convention on Climate Change on the know-how access;
- To define and prioritize the technologies, processes and techniques that are consistent with the mitigation of climate change and adaptation in the participating countries and aligned with the goals and priorities of the national development;
- To identify barriers that prevent primary/preferred acquisition, implementation and dissemination of technology;
- To develop Technology Action Plans (TAPs) to overcome barriers, which will define the scope of activities and a favourable environment that facilitates the transfer, adoption and the dissemination of the selected technologies in the participating countries.

The technology's prioritization is a first step in the framework of technological transfer, which also includes technological information, enabling environment, capacity building and understanding the mechanisms for technological transfer. The technology's prioritization is implemented by applying the methodology proposed by the United Nations Convention on Climate Change and team for Technology Needs Assessment. The applied methodology has been adjusted to the country-specific conditions. The technology's prioritization has been conducted through the following activities: the preliminary overview of options and resources; institutional arrangements and stakeholder's engagement; establishing decision's context; the assortment of priority sectors; establishing the criteria for selecting mitigation measures for prioritization; selecting priority measures; detailed analyses, assessment and stakeholder's consultation; and the selection of actions for high priority for further development and implementation. The current report provides information and data based on the existing national policies on climate change mitigation and development priorities of the country, the inventory of greenhouse gases emissions, stakeholder engagement and the institutional arrangements of Technology Needs Assessment, the process of sector prioritization, the identification of criteria, the assessment of technologies on the selected sectors by using the multi-criteria approach and technology's prioritization.

In this report prioritized technologies are provided in details, in summary, description and main conclusions. Technological fact sheets can be found in the subsequesnt annexes. Technology Needs Assessment for climate change mitigation in Afghanistan has focused on Energy and Waste sectors.

On the basis of the proposed Technology Needs Assessment methodology, national experts have prepared a long list of possible technologies and technological fact sheets for each listed technology. Criteria for the prioritization of technologies have been clustered under Economic, Social, Environmental, Climate Related, Political, Technological and other groups. On the basis of current national documents, national strategies and expert judgments, the following sectors are selected for the prioritization of mitigation technologies: 1) energy sector & 2) waste sector. The Multi Criteria Analysis (MCA) for selection of sectors includes:

- Economical Consideratoin: Capital expenditure, operational expenses & income.
- Social Consideration: The potential of job creation, impact on the human health and the level of morbidity
- Climate Change Consideration: The potential of GHG reduction, and CO2-eq. reduction cost per ton.
- Environmental Consideration: Impact on water resources, and impact on land resources
- Political Consideration: Coherence with national plans and goals

Mitigation technologies for Energy sector that received the highest scores include:

- Solar Energy - Conntected to grid
- Small Hydropower

Mitigation technologies for Waste sector that received the highest scores include:

- Methane capture at landfills
- Reduce, Reuse and Recyle (3R’s)

CHAPTER 1: INTRODUCTION

Afghanistan is a landlocked country of 647,500 sq. km. Over three-quarters of the land is mountainous, and more than one-quarter of the national territory lies above 2,500 meters of the sea level. The outstanding physical feature of the country is the Hindu Kush Mountains which forms a barrier between the north and south. The Hindu Kush and its subsidiary ranges divide Afghanistan into three distinct geographical areas: The Central Highlands, which contains the Hindu Kush and its ranges, the Northern Plains and the Southwest Plateau.

According the National Statistics and Information Authority's (NSIA) estimation, the country's population was 29.7 million in 2017 which was estimated to increase to 32.2 million in 2019-20, making the country 39th most populous country in the world. Based on the population census of the 1979 and data from 2003 and 2005, Afghanistan has a fast growing rate of 2.03% per annum, with persons of under 15 years of age accounting for 47.4% of the total population. Afghanistan's population is split nearly even along the gender lines, with 16.4% million men and 15.8 % women. In 2019,23 million (71.4%), 7.7 million (23.9%) and 1.5 million (4.7%) of the population out of the whole 32.2 million (100%) live in rural area, urban area and as nomad population respectively.

2.9 percent of land in Afghanistan was covered with forests but because of that time war, illegal exploitation and the need for firewood, 90 percent of forest cover has gone. In 2005 an estimated 3.2 million cubic meters of timber was harvest nearly 45 percent of which was used for fuel. Today the forest cover in Afghanistan accounts for only approximately 1.5-2% of the total land cover. The most of the mountains in Afghanistan are barren rather than covered with forests.

Using biomass (crop residues, dung, straw and wood) and coal, pose a serious threat to health by production of high levels of indoor air pollution in households of the country. Afghanistan continues to have one of the highest percentages of death and diseases linked to indoor air pollution in Asia. Presently, the lack of environmental protection combined with a burgeoning human population dependent upon a declining natural resource base have driven many species of plants and animals to the brink of extinction. Afghanistan has a limited stock of biomass energy; while forests have been the main source of energy for heating purposes.

In Afghanistan, theper capita consumption of electricity averages 154 kWh per year, which is significantly less than the South Asia average of 667 kWh per person per year and the average electricity usage per person world-wide of 3,100 kWh[1].Despite significant progress in developing the electricity grid, Afghanistan retains one of the lowest rates of access and usage of electricity in the world. Renewable energy development is a high priority in consideration of the remoteness of rural locations and country's topography that would make an expansion of electricity supply to rural areas through a centralized grid difficult, nor is such an expansion economically feasible. Current models (Cordex Regional Climate Model) indicate significant warming across all the regions of Afghanistan with average predicted increases in temperature between 2^{o}C and 6.2 ^{o}C by 2090s

[1] IBUR 2018, Afghansitan

dependent on global emission scenarios. The implications of temperature increase are: (i) the snowline will rise probably by several hundred meters, and snow cover depth will decline, leading to reduced snowmelt runoff during spring; (ii) glaciers will retreat and some may disappear, resulting in river flow decrease; and (iii) overall crop yield are likely to decline.

Afghanistan as one of the land-locked countries uses only land and air transportation. The total registered vehicle in 2017-18 were 1,936,686 which shows an increase of 1.6% from the previous year. In air transport, Afghanistan has four international airports and some local airports as well. Air traffic has been increasing substantially since 2001. Only in 2017-18, the government owned airline (Ariana) carried 285,000 passengers and 1,652 tons of goods from different airports. In private sector, only one airline (Kam Air) was active with 7 airplanes which carried 749,000 passengers to different routes.

As per the Rio marker definitions, climate change adaptation, climate change mitigation, biodiversity and combatting desertification are the principal objectives of the program. The program aims at maintaining and strengthening the adaptive potential of key ecosystems to climate change by preserving their natural biodiversity and preventing and reversing desertification through the development of sustainable management of rangelands, woodlands and arable agriculture and the reduction of biomass extraction for heating and cooking. Prevention of degradation and restoration of ecosystems and biodiversity will support the climate change adaptation of land-use, improve water storage capacity of the landscape, reduce erosion and flooding and ensure the availability of ecosystem services for the society within the program region and beyond. This action will contribute to achieve the Nationally Determined Contribution (NDC) targets for adaptation (building capacity) and mitigation (reforestation and introduction of renewable energy sources).

1.1. About the TNA project

The third phase of the global TNA project is implemented by UNEP and the UNPE DTU partnership with financial support from GEF, mostly across 23 Least Developed Countries and Small Island Developing States from 2018 - 2020. It is a multi-disciplinary work that is aimed mainly towards addressing both the decrease of vulnerability to climate change (adaptation) and reduction of CO_2(mitigation) technology needs of all of the 23 developing countries globally. It seems to be part of the global effort held towards tackling the climate change phenomena in the context of sustainable development. Moreover, TNA is considered to be part of exchange of experience and technical know-how at three different levels: national, regional and international. The main outcomeof the TNA project is expected to be support of all the 23 developing countries that are part of the United Nations Framework Convention on Climate Change (UNFCCC) in their sustainable development processby providing them with Technology Action Plans (TAPs) for adoption of environmentally sound technologies.

1.2. TNA Objectives:

- Based on country-driven participatory process participated in by stakeholders from across the institutions, identification/prioritization of the technologies needed to tackle the climate change and GHG emission issues by either mitigation or adaptation measures while the national sustainable development goals and priorities are still to be all satisfactorily met/realized.
- Identification of all the barriers hindering the adoptation, deployment and diffusion of the prioritized technology for the mitigation purpose.
- Developing the Technology Action Plans (TAPs) that specifies all the activities and enabling framework necessary to over all the barriers, and to facilitate the transfer, adoption and diffusion of prioritized technologies across the selected sectors in Afghanistan. For mitigaiton waste and energy is selected and for adopation water and agriculture is selected.

1.3. **Existing national policies on climate change mitigation and development priorities**

Afghanistan has implemented several activities under the multilateral environmental agreements (MEAs) which have direct relations to climate change adaptation/mitigation and development priorities. The outcomes of these tasks include a number of assessment reports, strategies and action plans. The major types of these initiatives are as follow:

1.3.1. **National Operational Strategy for Clean Development Mechanism 2006**

This operational strategy has been developed to fulfill the requirements of establishing a Designated National Authority (DNA) and ensuring transparent, participatory and effective management of Clean Development Mechanism process in the country. The strategy describes the functions and powers of the DNA and the national approval process. It builds on preliminary studies for initial projects including Asia Least Cost.

Relevance with TNA: All the identified and prioritized technologies will generate Certified Emission Reductions (CERs) and reduce carbon footprint.

1.3.2. **National Energy Conservation Policy (NECP)**

The National Energy Conservation Policy (2007) focuses on energy efficiency and conservation measures to reduce CO_2 emissions and help Afghanistan meet its international climate change responsibilities. The policy underlines that a unit of energy conserved is a unit of energy produced. Efficient use of energy in various sectors of economy to reduce the adverse local environmental effects which are otherwise attributed to energy inefficiency and wasteful energy use practices, is an important goal of the policy. Provision of energy to rural areas serves the goals of gender equality and mainstreaming energy conservation as a part of development policy process. The policy also provides sectoral guidelines for industrial; transport; building and household; and agriculture including livestock and forestry sectors.

Relevance with TNA: Rapid demograhpic growth and the need for the energy conservation is one of the key government mandates. The selected technologies will definitely help with the central and provincial governments in implementaion of national energy conservation policies.

1.3.3 **Afghanistan National Renewable Energy Policy (ANREP)**

The National Renewable Energy Policy (ANREP) aims at mainstreaming renewable energy type in the national energy sector planning, so it deploys it in different capacities and through different projects in various parts of the country. It aims at providing a thrust and direction to the Renewable Energy (REN) sector. The policy is aligned to the Power Sector Master Plan (PSMP) and the Afghanistan National Development Strategy (ANDS) to set a framework for deployment and growth of REN and it connects with Rural Renewable Energy Policy (RREP) on the other hand to ensure seamless adoption and implementation of the policy guidelines in rural energy sector. The Policy sets a target of deploying 350-450 MW of REN capacity by 2032, which is equivalent of 10% of the total energy mix of 3500-4500 MW as per the targets of PSMP. To achieve its targets, the NREP supports and facilitates for the involvement of the private sector, government and non-government organisations, donors and the people of Afghanistan. The Policy will be implemented in two terms- TERM 1 (2015- 2020) will create and support the provision of an atmosphere and activities for the development and growth of REN sector particularly in the PPP (Public –Private Partnership) mode, and TERM 2 (2021-2032) will deploy REN in full commercialization mode. The country is endowed with renewable energy resources including solar, wind, hydro, bio-mass and geothermal. The Energy Services Law aims at providing electricity through overall natural resources of the country and importing electricity, thereby ensuring the deployment of Renewable Energy (REN) for improving the overall power scenario in Afghanistan. The Ministry of Energy and Water (MEW), as one of the key ministries to plan and direct the development of energy sector in Afghanistan, has now prepared the Afghanistan Renewable Energy Policy (AREP) which aims to provide a thrust and direction to the REN sector.

Relevance with TNA: Once the TNA process is completed and the technologies are selected/prioritized, it will help with the smooth implementation, which inlcudes commercialization and privitatization of energy services.

1.3.4. **Energy for Rural Development in Afghanistan (ERDA)**

Energy consumption patterns in rural Afghanistan show one of the lowest per capita energy consumption rates in the world. Most of the energy is derived from traditional sources like firewood, animal waste and agricultural residues. Less than 15% of the rural population has access to modern sources of energy such as electricity. Access to electricity and other modern forms of energy sources are a prerequisite for meeting Afghanistan's Sustainable Development Goals (SDGs). The Government of Afghanistan in its major policy documents has recognized provision of energy services as a priority. In this context, UNDP is supporting the Ministry of Rural Rehabilitation and Development (MRRD) in capacity development and policy related activities through ERDA which is also a component ofNABDP. ERDA will also support MRRD in identifying the best practices from around the world and launching innovative pilot projects to establish their efficacy in an Afghanistan-specific context.

Relevance with the TNA: The use and promotion of systematic solar and Small Hydro Power (SHP) energy will help implement the ERDA more tangibly and within specific government framework. Micro- hydro power is not a new concpet in Afghanistan, however the operation and maintenance part has always been missing. In the TNA process, the capacity building and Operation & Maitenance (O&M) part is duely inlcuded.

1.3.5. **The National Comprehensive Agriculture Priority Program (NCAPP)**

The National Comprehensive Agriculture Priority Program is viewed as a significant contributing factor to the overall security, good governance and economic development agenda of the Government of Islamic Republic of Afghanistan. Built around the core national objectives of self-reliance and increased income and employment generation, the strategic framework sets seven key priorities. These Strategic Priorities are (i) Improving Irrigation Systems; (ii) Wheat and Cereal Production; (iii) Development of Industrial and High Value Horticulture Crops and Vegetables; (iv) Livestock Development; (v) Climate-Change Sensitive Natural Resource Management; (vi) Food and Nutrition Security and Resilience Building and (vii) Institutional Reform.

Relevance with the TNA: The TNA process includes both mitigation and adaptation in selecetd sectors. Discussions are made with the relevant intitutions on how the selected technologies and perceivedTechnology Action Plans would assist in application of the NCAPP program.

1.3.6. **The National Biodiversity Strategy and Action Plan for Afghanistan (NBSAP)**

The National Biodiversity Strategy and Action Plan for Afghanistan (NBSAP) which covers a three year period (2014-2017), aims to reduce biodiversity degradation and protect the goods and services gained from ecosystems. The strategy and action plan will monitor Afghanistan’s flora and fauna, protect ecosystems by expanding protected areas, and promote a better understanding of Afghanistan’s biodiversity. To achieve this, the strategy includes assessments and overviews of available information such as previous field work, status reporting and analysis undertaken by various organizations, as well as unpublished information from UNEP and the Wildlife Conservation Society (WCS) on Afghanistan’s biodiversity and its current status. The NBSAP also seeks to clarify the boundaries and legal status of each of the protected areas. It will facilitate the management of these protected areas by encouraging accession to the Ramsar Convention, an intergovernmental treaty that represents the member countries’ commitment to protect wetlands located on their territories, and support internationally important waterbird populations. Years of conflict have resulted in biodiversity loss and degradation in this large and ecologically diverse country. While much still remains to be documented in remote areas, monitoring efforts, additional survey work, and continuous support are necessary to ensure a sustainable conservation of Afghanistan’s biodiversity.

Relevance with TNA: The TNA exercise will help in achieving the objectives of NBSAP by facilitating preparation of plans for climate change mitigation, reduction of carbon footprints and promotion of green economy in the country through implementation of prioritized technologies.

1.3.7. National Environment Policy 2005

The policy provides guidelines for protection, conservation and restoration of Afghanistan's environment in order to improve the quality of life of citizens through sustainable development. The policy provides sectoral and cross-sectoral guidelines for environment protection and sustainable development. The Policy also focuses on climate change and ozone depletion; energy efficiency and renewable energy; water supply and management; air quality and noise; waste management; agriculture, livestock; forestry, biodiversity and protected areas and multi-lateral environmental agreements.

Relevance with TNA: The prioritized technologies will help in achieving the objectives of National Environment Policy, as the mitigation technologies will improve environment quality, andprevent/reduce GHG emission.

CHAPTER2: INSTITUTIONAL ARRANGEMENTS FOR THE TNA AND STAKEHOLDERS' INVOLVEMENT

2.1. Institutional Arrangements

The main national actors addressing climate change, natural resources management and rural energy development are the National Environment Protection Agency (NEPA) and other key & relevant intitutions. These national institutions have developed policy options and actions in the field. Despite of existent weaknesses in terms of capacities especially at the local level, a real willingness exists to implement national strategies for climate change adaptation and mitigation.These actors have been consulted extensively during the identification of sectors and formulation of TNA project and, moreover, a close and strong collaboration amongst these institutions will be ensured during implementation of the TNA.

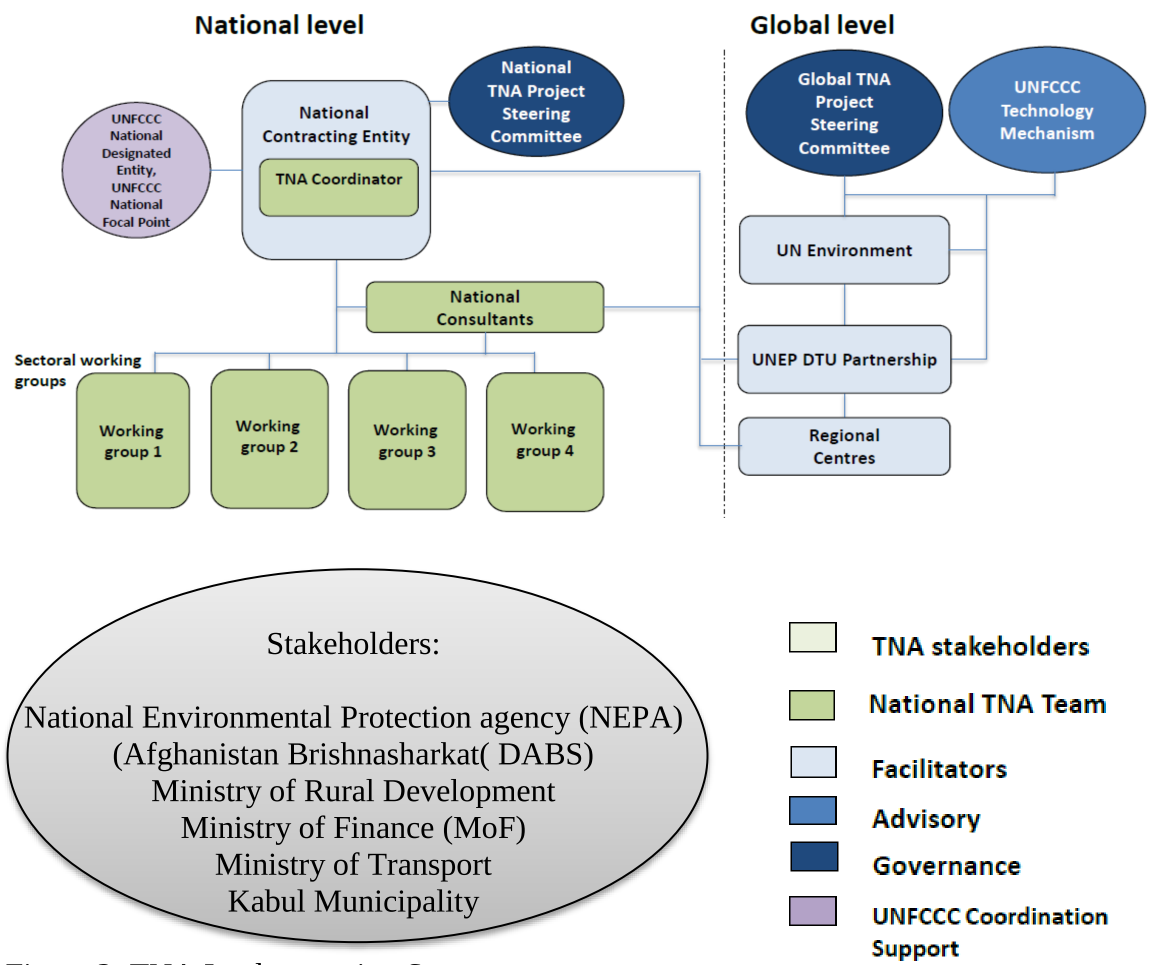


Figure 2: TNA Implementaion Structure

2.2 TNA Project Coordinator

The National project coordinator is a representatorfrom the Climate Change Directorate of National Environment Protection Agency (NEPA) and coordinates the overall process of Technology Needs Assessment (TNA) Project in Afghanistan. Moreover, the TNA Project Coordinator's office serves as the Secretariat for the TNA project.The TNA Project Coordinator facilitates both technical and administrative tasks and collaboratewith the National Consultants, UNEPDTU Office, the Asian Institute of Technology (AIT), Technical Working Group and other Stakeholders to facilitate the smooth implementation of the project. Names and details of steering committee members is included in the annexes below:

2.3. The TNA Process

The Afghanistan TNA processes commenced with the training workshop for the Asian Region partner countries' Project Coordinators and the Consultants by the International Partner Organizations namely UNEP-DTU Partnership, Climate Technology Centre & Network and Asian Institute of Technology (AIT) in May 2019 in New Delhi, India.This was followed by convening of the inception workshop in Kabul during 13-15 of July 2019.

2.4. Expert/National Consultants

Three national experts have been selected for the exercise, one for mitigation and another for adaptation and the third consultant provides support to both adaptation and mitigation experts for the whole period of TNA Project. Each expert is responsible for identification and prioritization of technologies as well as carrying out technology needs assessment, barrier analysis, and preparation of draft project proposals for priority technologies and Technology Action Plan (TAP) in consultation with stakeholders. In addition the consultant is providing process-related technical support, facilitation, including research, analysis and synthesis to the TNA Project Coordinator.The mitigation consultant prepared 18 fact sheets (shown in annex I and II) for prioritization of technologies in energy and waste sectors. The final selection of Technology fact sheets was done during the inception workshop, which was held on 13 of July 2019 followed by tehnical working group discussion for mitigation on 14 of July 2019 (annex III) and working group discussion for adaptation on 15 of July, 2019. The list of participants of theinception workshop is shown inannex IV.

2.5. Stakeholder Engagement Process

The TNA process was aimed at evolving a set of activities that is closely linked to other relevant national development processes and to reflect national response to climate change technology needs that is informed by the government & private sectors, the general public, and other stakeholders. Hence, the stakeholder involvement was considered very crucial to the success of TNA process and the implementation of recommended activities.

UNDP/UNFCCC Handbook (2009) recommends the following five steps for an active, inclusive stakeholder dialogue that will sustain over the course of the technology need assessment. These steps are;

- Identification of stakeholders
- Define the goals and objectives
- Clarification of stakeholder roles
- Establishment of an ongoing process for stakeholder engagement
- Involvement of stakeholders in each stage of the process

The stakeholders have been identified from the relevant organizations and institutions in terms of stakeholder engagement and institutional arrangements stipulated by the UNDP/UNFCCC Handbook (2010). Accordingly, the members of the Working Groups included representatives of the Government institutions having the responsibility for policy formulation and regulation, potentially vulnerable sectors, private sector industries, organizations, manufacture, import & sale of technologies, technology users, financial institutions, relevant NGOs, institutions that provide technical support, donor organizations and other relevant institutions such as Universities & research organizations. In order to get the stakeholder participation in the TNA process, (2)Technical Working Groups were established on sectoral basis representing Transport, Energy and Industry sectors as prioritized under prioritization process. The Technical Working Groups were mandated to decide on the technologies appropriate for respective sectors, undertake market/barrier analysis and recommend an enabling framework for sectors.

The goals, objectives and the working arrangements of the participatory process was discussed and agreed with all sectoral stakeholder working groups at the National Inception Workshop. The objectives of the Project and purpose of stakeholder participation was discussed and ratified at this meeting. The main purpose of the stakeholder engagement is to ensure their participation throughout the TNA process of selecting priority sectors, technology identification & prioritization, barrier analysis and development of enabling framework etc, as their participation in the process is crucial for successful implementation of the recommended technologies. Therefore, an ongoing arrangement has been established to ensure continuous and effective involvement of stakeholders at each stage of the TNA process. The roles and responsibilities of stakeholder groups have been defined during the initial meeting. Each stakeholder Sectoral Working Group included around 8 persons representing related organizations in the respective sector. The compositions of the sectoral working groups were flexible with the provision of co-opting additional members depending on the requirement. The Project Coordinator together with Consultants facilitated the Working Group discussions ensuring maximum output from the deliberations. Participants in each working groups inlcuded:

2.6. Energy Sector

- Ministry of Rehabilitation and Rural Development
- Da Afghanistan Burshna ShirkatDABS
- Ministry of Transport (Energy sub-sector)
- Kabul University
- Agha Khan Foundation
- Kabul University
- Ministry of Energy and Water
- NEPA

2.7. Waste Sector

- UN-Habitat
- Ministry of Urban Development and Land
- NEPAThe Kabul Times
- Ministry of Economy
- Kabul Municipality
- Kabul University
- Ministry of women affairs

2.8. Gender mainstreaming

Research and experience in Afghanistan provide evidence that gender consideration in planning and implementing Technology Need Assessment (TNA) process will greatly increase the prospect of success. The TNA project will contribute to reinforcement capacities and awareness of government officials from these institutions at the national level and at the local level. This will include capacity building of national and local level authorities on gender sensitivity, mainstreaming and the Right based approach (RBA).

Environmental degradation impacts at local level are particularly felt by women. Without reliable access to energy in rural areas, women and children spend most of their day performing basic tasks including physically draining tasks of collecting biomass fuels. Gender balance has been carefully considered during the inception workshp of TNA Project. Good practices developed by the TNA project will be shared with Ministry of Women's Affairs and other national stakeholders.

No policy response to climate change is gender neutral. Plans to implement gender-responsive climate action will vary both in terms of their commitment to reducing emissions and rectifying inequities. In Afghanistan Climate change affects everyone. Women are change agents, leaders, and innovators in addressing this threat. They can bring different and innovative perspectives and experiences to political processes, to natural resource management, to adaptation, mitigation and technology and their opportunities and use in climate action. Yet women and men may experience the impacts of climate change differently, women disproportionately affected due to gender inequalities in Afghanistan. Effective responses to climate change requires an understanding of how such gender inequalities affect issues such as access to and control over resources; institutional structures; social, cultural and formal networks and decision-making processes. Gender mainstreaming based on gender analysis therefore must be an integral part of the existing TNA process in Afghanistan. By mainstreaming gender considerations in climate policy and action, climate approaches will be more efficient, effective, and equitable by being responsive to and providing broader benefits to address the needs of women and men, including through compensation and shared benefits.

Luckily during the stakeholder's consultation and technical working groups process there has been a decent and sizable representation of female professionals both from government and non-government institutions. There were 11 female particpants from variouse government insitutions inlcuding NEPA. Their insights and synopsis during various stages of TNA process will remain fundamental and their role will remain vital during various stages of impending climate change TNA process.

2.9. Overview of secors, GHG emissions status and trends of the different sectors

Afghanistan's reporting obligation to the UNFCCC is administered to the National Environmental Protection Agency (NEPA). With the Environmental Law (Official Gazette No. 912/2007), that entered into force on the 25th of January 2007, NEPA has been designated as National entity with overall responsibility for meeting the country's responsibilities under the UNFCCC including the preparation of Afghanistan's National Communication Reports, National Greenhouse Gas Inventory as well as the preparation of the National Inventory Report (NIR) and the development of TNA Reports. The Afghanistan's National Greenhouse Gas Inventory as well as the NIR have been prepared by National Environmental Protection Agency (NEPA) with technical support from UN Environment Afghanistan and financial assistance from the Global Environment Facility (GEF) in close consultation and participation of key stakeholders based on Afghanistan's capabilities and best available data.

In 2017, Afghanistan's total national greenhouse gas (GHG) emissions excluding LULUCF for the three main gases (CO_2, CH_4 and N_2O) amounted to 43,471.39 Gg CO_2eq. It shows 8.9% increase in the emission of GHG compared to 2012. The most important GHG in Afghanistan is carbon dioxide (CO_2) with a share of 48.2% in 2017. The CO_2 emissions primarily result from fuel combustion activities. Methane (CH_4), which mainly arises from livestock farming, contributes to 37.8% of the national total GHG emissions, and nitrous oxide (N_2O) with agricultural soils as the main source contributes to the remaining 14.1% in 2017 (IBUR, 2018).

As part of the Afghanistan's first IBUR, GHG inventory has been provided for the time series 2012-2017 using the 2006 IPCC guidelines and software for national GHG inventories. For the first time, Afghanistan prepared a time series national GHG inventory for the period 1990 – 2017 for all anthropogenic emissions by sources and removals by sinks of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorocarbons (F-gases). The GHG precursors and air pollutants, respectively, carbon monoxide (CO), oxides of nitrogen (NOx), non-methane volatile organic compounds (NMVOCs), and sulphur dioxide (SO_2) are prepared in line with the EMEP/EEA air pollutant emission inventory guidebook 2016.

The important sectors regarding GHG emissions in Afghanistan excluding LULUCF are IPCC sector 1 Energy with 49.8% of total national GHG emissions in 2017 (43.4% in 2012), followed by the IPCC sectors 3 Agriculture with 46.2% of total national GHG emissions in 2017 (IBUR, 2018).

In 2017, Afghanistan's greenhouse gas emissions from IPCC's sector Energy amounted to 21,649.43 Gg CO_2 equivalents. Some 99% of the emissions from this sector, originate from IPCC category 1.A. Fossil Fuel Combustion. Greenhouse gas emissions from IPCC sector Industrial Processes and Other Product Use (IPPU) amounted to 245.78 Gg CO_2 equivalents, which correspond to 0.6% of the total national emissions. Meanwhile, greenhouse gas emissions from IPCC sector Agriculture, amounted to 20,073.90 Gg CO_2 equivalent, which correspond to about

46.2% of total national emissions. From 2012 to 2017 emissions decreased by 4.4%, mainly due to decreasing GHG emissions from manure management. Also, greenhouse gas emissions from IPCC sector Waste, amounted to 1,502.27 Gg CO_2 equivalents, which correspond to 3.5% of total national emissions. From 2012 to 2017, emissions from this sector increased by 13%, mainly due to an increase in solid waste disposal and increased population (IBUR, 2018).

2.10. **Sector Selection**

In TNA process, sector selection is an important step towards priority technology identification and ranking which would finally lead to the construction of technology action plan for diffusion and adoption of prioritized technologies in its respective sectors with available sources of financing. The process of sector selection started with an extensive desk review of relevant documents on climate change impacts on various sectors of the country and their degrees of vulnerability to these adverse impacts in the future along with consultation with different key experts. The sector selection for energy and waste were done in inception workshop conducted during 13th, 14th and 15th of July 2019, at NEPA conference hall. The key stakeholders and experts were invited to workshop from government and non-government agencies at country level. All participants of the mitigation technologies working group were divided into two groups on the basis of their professionalism and interests in each sector.

After a detailed discussion and consideration of the national circumstances, development needs and GHG emission reduction potential of various sectors of economy, the expert group came to conclusion that high emitting sectors should be chosen as priority sectors for climate change mitigation efforts in the country and the following resources were used for the selection of the sectors:

- Guidebook for Conducting Technology Needs Assessment for Climate Change
- The development priorities (including the sectoral ones) according to the National Strategic Plan
- Afghanistan’s Sustainable Development Goals (SDGs) Document
- National Team members’ experience
- Suggestions and confirmations by working groups and stakeholders

The identified sectors that have been considered in the TNA sector prioritization process are as follows:

2.10.1. **Energy Sector**

In spite of the fact of Afghanistan being rich in energy resources, more than three decades of continuous conflict has destroyed or severly degraded much of its infrastructure base including that of the energy. As a result, currently Afghanistan relies heavily on electricity imports from neighboring countries which account for more than three quarters of Afghanistan’s total electricity usage. In order to reduce reliance on imported electricity, Afghanistan has made it a national priority to promote generation of domestic electricity. Over the last decade, Afghanistan has made significant reconstruction efforts at all levels of the energy supply chain in particular, the electricity sector.

In the Energy Sector, emissions originating from fuel combustion activities in road traffic, in the energy and manufacturing industry and in the commercial, agricultural and residential sector \ as well as fugitive emissions from fuels are considered. However, fugitive emissions make up less than 1% of the total emissions from this sector. Emissions from the Energy Sector are the main source of GHGs in Afghanistan: in 2017 - about 49.8% of the total national GHG emissions and 95.2% of total CO_2 emissions arose from the energy sector. Total emissions from energy mainly consist of CO_2 whereas N_2O and CH_4 emissions only make up about 1.2% and 3.6%, respectively. The most important sources of GHGs in the Energy Sector is Transport and Manufacturing Industries and Construction. With regards to CO_2 emission, the source Transport was the primary source (IBUR, 2018).

In the period 2012 to 2017 GHG emissions from the Energy Sector increased by 25% from 17,324.81 Gg CO_2 eq in 2012 to 21,649.43 Gg CO_2 eq in 2017, which is mainly caused by increasing emissions from fuel combustion in Transport sector only. In 2017, greenhouse gas emissions from IPCC sector Energy amounted to 21,649.43 Gg CO2 equivalents, which correspond to about 50% of the total national emissions. Some 99% of the emissions from this sector, originate from Fossil Fuel Combustion. Fugitive Emissions from fuels are of minor importance. The main increase occurred in the transport sector and by Manufacturing Industries and Construction due to higher consumption of fossil fuels (IBUR, 2018).

The representation contained (8) participants for the Energy sector and (8) participants for Waste sector. Totally they considered (9) technologies for energy and (9) technologies for waste sector according to the country circumstances and current situation, after discussion and sharing of information among the group, finally the energy group selected (2) technologies for energy sector where as waste group selected (2) technologies from the total of the (9) technologies accordingly.

Following is the list of nine (9) considered technologies. The methodology of slection is given in chapter 3.

1. Solar energy connected to grid
2. Small Hydropower
3. Waste energy
4. Biogas
5. Wind Energy
6. Development of modern kilns manufacturing
7. Plug in hybrid electric vehicles
8. Cogeneration with biomass
9. Carbon capture & storage

The mitigaiton expert group selected the following two technoloiges for Energy Sector:

1. Solar energy connected to grid
2. Small hydropower

Although transport is determined one of the key GHG emeters, but the technical working group prioritized these two technoloiges for the energy sector. Cost/maintence and social acceptability and adoptabelity were the main reason for chosing these two technologies. In Afghanistan different technologies were introduced (some by the government and some by NGOs) but due to lack of capacity and resoruces they haven’t been sustainable. Also, since, 80% of people in Afghansitan are living in rural areas, therefore the working group agreed to select the technologies that are more instrumental in local context.

2.10.2. Waste Sector

According Afghanistan’sinitial biennial update report, In 2017, greenhouse gas emissions from IPCC sector Waste amounted 1,502.27 Gg CO_2 equivalents, which correspond to 3.5% of the total national emissions. From 2012 to 2017, emissions from this sector increased by 13%, mainly due to an increase in solid waste disposal and increased population.The GHG emissions of waste sector originate from Solid Waste Disposal with about 0.5% of total national GHG emissions,Biological Treatment of Solid Waste (Composting) with about 2.8% of total national GHG emissions,and Incineration and Open Burning of Waste with about 0.1% of total national GHG emissions. Wastewater Treatment and Discharge with about 0.1% of total national GHG.

The following 9 technologies were considered and the first two were selected. The methodology of slection is given in chapter 4.

- Reduce, Reuse, Recycle (3Rs)
- Methan capture from landfill site
- Waste to energy biomass
- Waste composting
- Mechanical & biological treatment
- Development of modern kilns manufacturing
- Plug in hybrid electric vehicles
- Cogeneration with biomass
- Carbon capture & storage

The mitigation team has agreed on considering these two technologies for the waste sector:

- Reduce, Reuse, Recycle (3Rs)
- Methan capture from landfil sit

CHAPTER3: TECHNOLOGY PRIORITIZATION FOR THE ENERGY SECTOR

Technology prioritization for energy and waste sectors was carried out by assessing technologies through multi-criteria analysis; which were based on determining assessment framework and conducting assessment on technologies based on their contribution to development goals, potential for GHG emission reduction on vulnerability reduction costs and benefits as well as use of TNA tools which were based on establishing a decision context and criteria, following which the performance of the technologies was assessed against the established criteria. Final decisions were made on the basis of reviewing assessment results as well as conducting sensitivity analysis on assessment results and deciding prioritization of technologies for the subject setors.

3.1. Technology Prioritization for Energy Sector

GHG Emissions and Existing Technologies of Energy Sector:

Emissions from the Energy Sector are the main source of GHGs in Afghanistan: in 2017 about 49.8% of the total national GHG emissions and 95.2% of total CO_2 emissions arose from the energy sector.Total emissions from energy mainly consist of CO_2 whereas N_2O and CH_4 emissions only make up about 1.2% and 3.6%, respectively.The most important sources of GHGs in the Energy Sector is Transport and Manufacturing Industries and Construction. With regards to CO_2 emission, Transport was the primary source. In the period of 2012 to 2017 GHG emissions from the Energy Sector increased by 25% from 17,324.81 Gg CO_2 eq in 2012 to 21,649.43 Gg CO_2 eq in 2017, which is mainly caused by increasing emissions from fuel combustion (IBUR, 2018).

3.1.1. Technologies Identified

At the initial deliberations of the energy sector technical stakeholder working group, the following mitigation technologies were identified for consideration;

1. Solar energy connected to grid
2. Small Hydropower
3. Waste to energy
4. Biogas
5. Wind Energy
6. Development of modern kilns manufacturing
7. Plug in hybrid electric vehicles
8. Carbon capture & storage
9. Cogeneration with biomas

* A detailed description of these technologies is found in the Technology Fact Sheets provided in Annex I.

All nine technologies fact sheets were shared with the group members and the following two technologies were prioritized:

3.1.2. Solar energy connected to grid

Technology description:

Solar radiation: globally about 5 kWh every day per one square meter of a receiver surface conditions for a proper production of electric power directly connected to national grid, or any mini-grid, are complex due to required agreements between EWSA and private sector expected to invest in large-scale PV such as 5 MW or more.

Applicability and Potentialities in Afghanistan

Based on lessons and experience for grid-connected solar PV in USA, in Europe and in North Africa, applications of large-scale PV is feasible in Afghanistan. Also, since Afghanitan mostly have 300 sunny days an year therefore, the potential for the solar energy generation is massive and if connected to grid and can reduce the cost of purchasing individual solar panels. A lot of people in rural Afghanstan cant efford it.

Potentialities - Over the whole year, the incident solar radiation is, as average, about 5 kWh/m2 .Particularly during the two rainy seasons, the solar radiation remains sufficient due to the fact that the solar declination is almost matching the latitudes in Afghanistan (Duffie et al, 2005)

Limitations - The main constraint to the deployment of solar PV systems in Afghanistan is due to initial cost of investment which is very high in addition to the fact that the payment of acquisition is cash instead of loans from Banks.

Status of the Technology in Afghanistan - Access to commercial solar PV modules is made easy due to the maturity of such technology in Europe, USA, China and Japan

Local Production - Assembly of solar calls resulting in such modules locally in Afghanistan is possible but not yet done.

Generating Costs - Projections for the year 2015: total energy generation cost is in the range of 25 to 33 US cents/kWh.

The operations and maintenance costs are negligible

GHG Emissions - Slight emissions are associated to the process of preparation and transformation at high temperature before reaching the finished solar cells

3.1.3. Mini Hydropower Plants

The potential to privatize small hydro-powers exists in Afghanistan. All these Hydor Power Plants can be erected on irrigation canals, trained (control-flow) rivers, or near the water-storage reservoirs. There are relevant governmental programs for the development of small hydropower energy in the country.

Afghanistan's abundant water resources do mean that there is a considerable potential for hydropower development estimated at 23,310MW/per year[2]yet, Afghanistan imports its needed

[2] MEW. (2016). Afghanistan Energy Efficiency Policy. Kabul: Ministry of Energy and Water/ Communication Under the UNFCCC. P.18. Kabul: National Environmental Protection Agency

electricity from neighboring countries or uses small generators for the electricity production. TheTNA project is proposed to boost the use of renewable energy (Hydropower) in the Islamic Republic of Afghanistan, improving, therefore, the well-being of the residents by providing needed energy at reasonable prices and reducing electricity imports. The followings highlight the key objectives of TNA project:

- Reduce dependence on imported electricity
- Improving self-sufficiency in electricity generation and security of supply
- Supplying a larger segment of the population with electricity

Economic benefits:

Small hydropowers have a greater potential of contribution to socio-economic development program of regions across the country and improvement of energy supply security.

Social benefits:

Small hydropowers can help improve livelihood of rural population in the rural settlement of the country and provide for more sustainable energy supply.

Environmental benefits:

Establishment of small hydropowers can contribute to reduction of GHG emissions and cut-down the deforestation rate across the country.

4.33.2. **Criteria and Process of Technology Prioritization**

The Multi Criteria Decision Analysis (MCDA) approach was used for prioritizing mitigation technologies in the energy sector. The criteria for selecting priority technologies were established through stakeholder consultations and the ten (9) potential technologies were considered for evaluation.

Multi Criteria Decision Analysis (MCDA):

a) Determination of Criteria and Weightings

The evaluation criteria agreed included the following;

- Contribution to development priorities
- Potential for GHG emission reduction
- Costs and benefits

The contribution of each technology to development priorities of the country was assessed in terms of (a) environmental, (b) social, and (c) economic development priorities (d) institutaional capacity and resources as below:

1**. Cost Criteria**

- Costs (Establishment and maintenance cost)

2. **Economic Criteria**
   - Improvement economic performance
   - Create jobs opportunity

3. **Social Criteria**
   - Reduce poverty and inequality
   - Improve health

4. **Environmental Criteria**
   - Protect biodiversity
   - Support environmental services
   - GHG reduction

5. **Institutional capacity & resources**
   - Sustainability and continuity

As a central element of the MCA analysis, scores were assigned to each criterion through stakeholder and consultation using technology option scoring justification table provided in the guidebook of MCA process by UNEP DTU (table 4). The scoring scale of 0-100 was used where a score of '0' was given to the technology option which was least preferred under that criteria and 100 was given to the most preferred option under the same criteria.

Technology scoring justificaiton table was shared with the technical working group participant. Threshod of performance (0-100) was explained as per the table below:

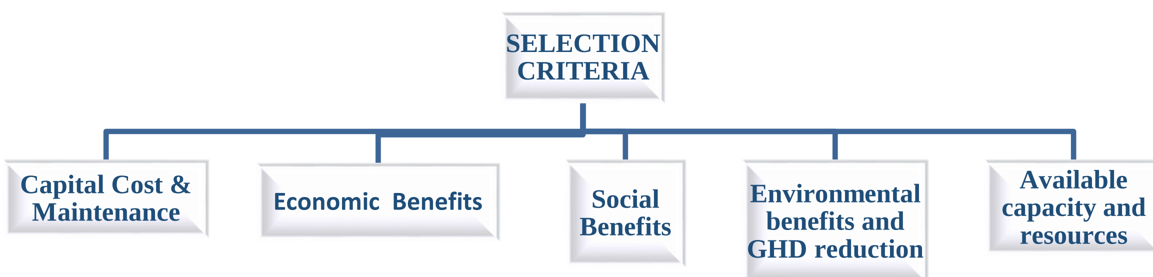


Figure 2: MCA selection Criteria

As a central element of the MCA analysis, scores were assigned to each criterion through stakeholder and consultation using technology option scoring justification table provided in the guidebook of MCA process by UNEP DTU (Table 4). The scoring scale of 0-100 was used where a score of '0' was given to the technology option which was least preferred under that criteria and 100 was given to the most preferred option under the same criteria.

Technology scoring justificaiton table was shared with the technical working group participant. Threshold of performance (0-100) was explained as per the Table 4 below:

Table 1:Technology option scoring justification table (Energy Sector)

Score	General Description
0	Used when information on a technology does not apply to the particular criteria
1-20	Extremely weak performance; strongly unfavorable
21-40	Poor performance, major improvement needed
41-60	At an acceptable or above level
61-80	Very favorable performance, but still needs improvement
81-100	Clearly outstanding performance which is way above the norm

Once the scoring process was complete, weights were assigned to the selected set of criteria including economic, environmental, social and climate related benefits while the sub-set of criteria, provided in the criteria were mention above, only used to fully comprehend the aspects of the selected criteria under consideration, so no disaggregated weights were assigned to the sub-set of the criteria. The purpose of this step was to determine the relative preference of a criterion over the others by giving a weight that represents relative strength of a criterion. The basic weights were showing in the following Table 5:

Table 2: Weighting of criteria showing assigned base weight values

PERFROMANCE MATRIX			
Criteria		Weighted value	
		Absolute value	Relative value
1	Cost	25	0.25
2	Economic benefits	20	0.2
3	Social benefits	10	0.1
4	Environmental benefits	15	0.15
5	Institutional capacity & resources	30	0.3
	Total value	100	1

The weight assignment was done in two steps of assigning first a basic weight through consultation with stakeholders for each criterion for an option. In the step of consultation the stakeholders gave marks for each criteria of each technology from 0 to 100.

Table 3:Scoring matrix-giving marks to each criterion of the technology options.

SCORING

No	Name of technology	Criteria (1)	Criteria (2)	Criteria (3)	Criteria (4)	Criteria (5)
		Cost	Economic benefits	Social benefits	Environmental benefits/GHG reduction potential	Institutional capacity and resources
1	Solar energy connected to grid	80	80	70	80	80
2	Small Hydropower	75	70	60	70	80
3	Waste energy	70	60	77	70	75
4	Biogas	70	70	70	70	70
5	Wind Energy	65	70	60	60	67
6	Development of modern kilns manufacturing	60	60	70	60	65
7	Plug in hybrid electric vehicles	60	60	70	70	65
8	Cogeneration with biomass	65	60	60	60	60
9	Carbon capture & storage	60	40	50	50	55
	SCORING (1-100)	0 = very high cost; 100 = very low cost	0=very low; 100=very high	0=very low; 100=very high	0=very low; 100=very high	0=very low; 100=very high

Finally, to get the total aggregated score for each technology option, the scores for each criterion were multiplied with its respective relative weight calculated earlier. The new weighted scores for all the criteria for an option were added up to get an overall weighted sum of scores for each mitigation technology as per the Table 7 below:

Table 4: Weighting of score for each criteria

WEIGHTING

No	Name of technology	Criteria (1) Cost	Criteria (2) Economic benefits	Criteria (3) Social benefits	Criteria (4) Environmental benefits/GHG reduction	Criteria (5) Institutional capacity & resources	Decision matrix
1	Solar energy connected to grid	20	16	7	12	24	79
2	Small Hydropower	18.75	14	6	10.5	24	73.25
3	Waste energy	17.5	12	7.7	10.5	22.5	70.2
4	Biogas	17.5	14	7	10.5	21	70
5	Wind Energy	16.25	14	6	9	20.1	65.35
6	Development of modern kilns manufacturing	15	12	7	9	19.5	62.5
7	Plug in hybrid electric vehicles	15	12	7	10.5	19.5	64
8	Cogeneration with biomass	16.25	12	6	9	18	61.25
9	Carbon capture & storage	15	8	5	7.5	16.5	52
	Criterion weight	0.25	0.2	0.1	0.15	0.3	1

On the basis of total weighted scores, the technology options were prioritized and ranked by the Expert Working Group' from high priority to low priority order. According to the result, thus Solar energy connected to grid of (79%) and thus the most preferred option. According to MCA result, the top two mitigation technologies with the highest priority ranking in the energy sector are given in the table below:

Table 5: Priority mitigaiton technologies in energy sector

Name of the technology	Prioritized

Solar energy connected to grid	**1**
Small Hydropower	**2**

The prioritized technologies approved in consultation with the Expert Working Group' were further confirmed by the National TNA Committee and the TNA Steering Committee in their meeting held in July, 2019.

CHAPTER 4: TECHNOLOGY PRIORITIZATION FOR WASTE SECTOR

In 2017, greenhouse gas emissions from IPCC sector Waste amounted to 1,502.27 Gg CO_2 equivalents, which correspond to 3.5% of the total national emissions. From 2012 to 2017, emissions from this sector increased by 13%, mainly due to an increase in solid waste disposal and increased population.Biological Treatment of Solid Waste (Composting) with about 2.8% of total national GHG emissions.In 2017, the most important greenhouse gas from Waste secotr is CH4 with a share of 84.4% in total GHG emissions from this sector, followed by N_2O with 15.2% and CO_2 with 0.4%. According to a survey conducted in 2008 by JICA, only 25-48% of the solid waste was collected and disposed of in open dumps. The more waste is collected and disposed of in managed dump sites; the more methane gas could be recovered and used. The project consists of using anaerobic sanitary managed landfills equipped with methane collecting system and electric generator to convert methane in electricity (IBUR,2018).

4.1. The Prioritized/Selected Technologies for waste sector

During the stakeholders consultations and after careful MCA process the following two technoloiges were prioriized for waste sector:

4.1.1. **Reuse, Reduce and Recycle (3Rs)**

The 3R's Concept of technologies to be implemented can substaintailly contribute to the reduction of the amount of wastes disposed on land. To carry out the implementation of the 3R's concept of technologies requires a high degree of coordination and organization of the waste management chain.

For the purpose of reduction of the waste problems in future, reduction in waste generation and reuse of old products such as electronics can be one of the most important factors. The reduction, for example, possible at consumption level includes better buying habits and cutting down on the use and purchase of disposable products and packaging. In addition, recycling is viable and the best option for a range of waste products. In some economies there are already well-organized recycling businesses processes in place for a range of products (e.g. furniture, clothing textile and etc) and materials (e.g. paper, iron, glass and steel).

Objectives:

With ultimate goal of reducing the disposal of wastes at uncontrolled sites and hence to reduce GHG emissions, the 3Rs' technology is aimed at achieving the followings:

- Reduce pollution problems and improve the livelihood across the country
- Create job opportunities and improve the socio-economic status of the urban population
- Reduce GHG emissions across the country especially in the urban settlement.

Economic Benefits:

Reduction of energy use in the material/product production process such as mining, quarrying, processing, etc. For instance, the copper recycling process results in energy savings of up to 85% compared to primary production .

Social Benefits:

Increased employment associated with handling and processing of waste streams, additional employment could be in waste collection, waste handling and processing, secondary material/product trade (e.g. second-hand store).

Environmental Benefits

Lower volumes of waste to be disposed, thereby reducing pressure on land and also the associated GHG emissions. Lower air and water pollution impact due to avoidance of primary production processes.

4.1.2. **Methane capture from landfills**

Municipal Solid Waste (MSW) is the waste generated by commercial and household sources that is collected and then either recycled, incinerated or disposed of in MSW landfills. The primary target of MSWM is to protect the health of the population, promote environmental quality, develop sustainability, and provide support to economic productivity. Landfill Gas (LFG) is created as solid waste decomposes in a landfill. Methane capture from landfills entails the recovery and use of Landfill Gas (LFG) as an energy source. This gas consists of about 50 percent methane (the primary component of natural gas), about 50 percent carbon dioxide (CO2) and a small amount of non-methane organic compounds.

Objective:

With the ultimate goal of reducing GHG emission and meeting the NDC conditional goals, methane gas recovery from MSW is proposed to improve the socio-economic conditions in urban areas and reduce the pollution caused by MSWDs. Followings are the key objective of the project:

- Reduce pollution problems and improve the livelihood of urban areas
- Create job opportunities and improve the socio-economic status of the urban population
- Increase domestic electricity generation and ensure electricity security

Economic Benefits:

Methane capture from landfills have greater potential contribution to socio-economic development of the regions across the country by expansion of employment opportunities.Moreover, it improves security of energy supply.

Social Benefits:

Methane capture from landfills improves livelihood of people in the rural settlement of the country and as well as it provides the sustainable supply of energy and enhances population health by removing the hazards they face from the landfills both in the short and long runs. .

Environment Benefits:

Methane capture from landfills potentially contributes to the reduction of GHG emissions.

4.2. Criteria and Process of Technology Prioritization

The Multi Criteria Decision Analysis (MCDA) approach was used for prioritizing mitigation technologies in the energy sector. The criteria for selecting priority technologies were established through stakeholder consultations and the ten (9) potential technologies were considered for evaluation.

Multi Criteria Decision Analysis (MCDA):

a) Determination of Criteria and Weightings

The evaluation criteria agreed included the following;

- Contribution to development priorities
- Potential for GHG emission reduction
- Costs and benefits

The contribution of each technology to development priorities of the country was assessed in terms of (a) environmental, (b) social, and (c) economic development priorities (d) institutaional capacity and resources. he criteria used are as follows;

1. **Cost Criteria**

- Costs (Establishment and maintenance cost)

2. **Economic Criteria**

- Improvement economic performance
- Create jobs opportunity

3**. Social Criteria**

- Reduce poverty and inequality
- Improve health

4. **Environmental Criteria**

- Protect biodiversity
- Support environmental services
- GHG reduction

5. **Institutional capacity & resources**

- Sustainability and continuity

As a central element of the MCA analysis, scores were assigned to each criterion through stakeholder and consultation using technology option scoring justification table provided in the guidebook of

MCA process by UNEP DTU (table 8). The scoring scale of 0-100 was used where a score of '0' was given to the technology option which was least preferred under that criteria and 100 was given to the most preferred option under the same criteria.

Technology scoring justificaiton table was shared with the technical working group participant. Threshold of performance (0-100) was explained as per the Table 9 below:

Table 6: Technology option scoring justification table (Waste Sector)

Score	General Description
0	Used when information on a technology does not apply to the particular criteria
1-20	Extremely weak performance; strongly unfavorable
21-40	Poor performance, major improvement needed
41-60	At an acceptable or above level
61-80	Very favorable performance, but still needs improvement
81-100	Clearly outstanding performance which is way above the norm

Once the scoring process was complete, weights were assigned to the selected set of criteria including economic, environmental, social and climate related benefits while the sub-set of criteria, provided in the criteria were mention above, only used to fully comprehend the aspects of the selected criteria under consideration, so no disaggregated weights were assigned to the sub-set of the criteria. The purpose of this step was to determine the relative preference of a criterion over the others by giving a weight that represents relative strength of a criterion. The basic weights were showing in the following Table 10:

Table 7: Weighting of criteria showing assigned base weight values:

PERFROMANCE MATRIX			
Criteria		Weighted value	
		Absolute value	Relative value
1	Cost	25	0.25
2	Economic benefits	20	0.2
3	Social benefits	10	0.1
4	Environmental benefits	15	0.15
5	Institutional capacity & resources	30	0.3
	Total value	100	1

The weight assignment was done in two steps of assigning first a basic weight through consultation with stakeholders for each criterion for an option. In the step of consultation the stakeholders gave marks for each criteria of each technology from 0 to 100.

Table 8: Scoring matrix-giving marks to each criterion of the technology options.

NO	NAME OF TECHNOLOGY	CRITERIA (1)	CRITERIA (2)	CRITERIA (3)	CRITERIA (4)	CRITERIA (5)
		Cost	Economic benefits	Social benefits	Environmental benefits/GHG reduction	Institutional capacity & resources
1	Reduce, Reuse, Recycle (3Rs)	90	80	70	90	80
2	Methan capture from landfill site	90	70	60	70	80
3	Waste to energy biomass	87	70	70	70	75
4	Waste composting	85	70	70	70	70
5	Mechanical & biological treatment	88	70	60	60	70
6	Development of modern kilns manufacturing	80	60	70	70	70
7	Plug in hybrid electric vehicles	80	60	70	60	70
8	Cogeneration with biomass	82	50	60	60	60
9	Carbon capture & storage	70	30	50	50	70
	SCORING (1-100)	0=very high cost; 100=very low cost	0=very low; 100=very high	0=very low; 100=very high	0=very low; 100=very high	0=very low; 100=very high

To get the total aggregated score for each technology option, the scores for each criterion were multiplied with its respective relative weight calculated earlier. The new weighted scores for all the criteria for an option were added up to get an overall weighted sum of scores for each mitigation technology (Table 12).

Table 9: Decision matrix or weighted scores for the selected technologies in waste sector

Table3 – WEIGHTING							
NO	NAME OF TECHNOLOGY	CRITERIA (1)	CRITERIA (2)	CRITERIA (3)	CRITERIA (4)	CRITERIA (5)	
		Cost	Economic benefits	Social benefits	Environmental benefits/GHG reduction	Institutional capacity &resource	DECISION MATRIX
1	Reduce, Reuse, Recycle (3Rs)	22.5	16	7	13.5	24	83
2	Methane capture from landfill site	22.5	14	6	10.5	24	77
3	Waste to energy biomass	21.75	14	6	10.5	22.5	74.75
4	Waste composting	21.25	14	7	10.5	21	73.75
5	Mechanical & biological treatment	21.25	14	6	9	21	71.25
6	Development of modern kilns manufacturing	20	12	7	10.5	21	70.5
7	Plug in hybrid electric vehicles	20	12	7	9	21	69
8	Cogeneration with biomass	20.5	10	6	9	18	63.5
9	Carbon capture & storage	17.5	6	5	7.5	10.5	46.5
	Criterion weight	0.25	0.2	0.1	0.15	0.3	1

On the basis of total weighted scores, the technology options were prioritized and ranked by the Expert Working Group' from high priority to low priority order. According to the result, thus Reduce, Reuse, Recycle (3Rs) of (83%) and thus the most preferred option. According to MCA result, the top two mitigation technologies with the highest priority ranking in the water sector of Afghanistan are given in the table below:

The table below shows the priority mitigaiton technologies in waste sector:

Table 10: Prioritized Technologies waste sector

Name of the technology	Technology priority order
Reduce, Reuse, Recycle (3Rs)	**1**
Methane capture from landfill site	**2**

The prioritized technologies approved in consultation with the Expert Working Group' were further confirmed by the National TNA Committee and the TNA Steering Committee in their meeting held in July, 2019.

CHAPTER 5: SUMMARY & CONCLUSION

The Technology Needs Assessment Project (TNA) is performed based on the agreement signed between Afghanistan National Environmental Protection Agency (NEPA) and the United Nations Environmental Program (UNEP) DTU, and supported by the Global Environmental Facility (GEF) grant financing. The UNEP, through its Division of Technology, Industry and Economics (DTIE) is responsible for the implementation of the project and provides overall project oversight and strategic coordination.

The first step in this work is to establish project implementation structure including project coordinator, the national team and wide spectrum of stakeholders. Great attention has been given to the continued consultation process with the stakeholders in every step of the project. This has been possible by different ways of communication including; one national consultation workshops, a series of sector meeting and working sessions. One of the main outcomes of project methodology is the establishment of a motivated network that can further assist in implementing the outcomes of the TNA project.

The methodology adopted in the identification process is composed of four consecutive steps. The first step (sectors/subsectors identification) has been undertaken by the national team and presented to discussion in the first consultation workshop. This step has been conducted to identify, rank and select the main sources of GHG emissions in the country as reported in the Afghanistan's First National Communication under the United Nations Framework Convention on Climate Change (UNFCCC). Secondly the developmental plans and strategies, whether at a macro or sector level, have been thoroughly studied with the aim to identify and classify the developmental priorities in Afghanistan. Further, modifications of the sector content to match the TNA guidelines have been carried out. Lastly, a process of subdivision into the sub-sectors has been undertaken. Two combined criteria have been taken into consideration for assessing the technologies; contribution to development and to reduction of GHG emissions. The highest prioritized sectors have been chosen for further investigation. Further on, main emissions sources have been identified in each sub-sector. The activities responsible for these emissions have been highlighted and their contribution to the sustainable development has been assessed. This sector/sub-sector identification process resulted in identifying the following sectors:

- Energy sector which includes; (i) Solar Energy connected to gird (ii) Small hydropower
- Waste Sector, includes; (i) 3Rs (ii) Methan capture from landfill sits.

The second step of development of this report involved the process of technology identification. This process started by holding a set of meetings between the stakeholders and the national team members who coordinated this sector. It resulted in the preparation of a long list of technologies; each technology has been described according to Technology Fact Sheet requirements. The third step has taken place during the workshop; a process of multi criteria decision analysis (MCDA) has been conducted. The adopted criteria are as follows: High GHG reduction potential/high sequestration potential as main criteria, the second criterion is the developmental criterion which includes environmental, social and economic criteria. The MCDA process starts by agreeing upon the suitable indicator for each sub-sector. Ultimately, ranking process took place and a short list of technologies has been created. As result of consultation and information obtained during the workshop, the list has further been refined.

Table 11: Assesesedand selected technology fact sheets in energy and waste sectors:

Energy Sector

Selected	Name of Technology
x	Solar energy connected to grid
x	Small Hydropower
	Waste energy
	Biogas
	Wind Energy
	development of modrenklins manufacturing
	Plug in hybrid electric vehicles
	Cogeneration with biomss
	Carbon capture & storage

Waste Sector

Selected	Name of Technology
x	Reduce,Reuse, Recycle (3Rs)
x	Methancapature from landfil site
	Waste to energy biomass
	Waste composting
	Mechanical & biological treatment
	Development of modrenklins manufacturing
	Plug in hybrid electric vehicles
	Cogeneration with biomss
	Carbon capture & storage

REFERENCES

- Addison, M.W. (2007). Energy Sector Strategy of Islamic Republic of Afghanistan for the Afghanistan National Development Strategy. Kabul: USAID & Bearing Point.
- Aich, V. &Khoshbeen, A.J. (2016). Afghanistan: Climate Change Science Perspectives. Kabul: National Environmental Protection Agency (NEPA) and UN Environment. Available at:https://postconflict.unep.ch/publications/Afghanistan/UNEP_AFG_CC_SciencePrespective_20161215.pdf
- Ashok, K. &Saji, N.H. (n.d.). On Impacts of ENSO and Indian Ocean Dipole Events on the Sub-regional Indian Summer Monsoon Rainfall [unpublished]. Available (December 2016) at: http://www.jamstec.go.jp/frsgc/research/d1/iod/publications/newmons-provaccept.pdf
- Azad, A.W. (2015). Solid Waste Management in Kabul City of Afghanistan. Unpublished MA thesis. Available at: https://www.academia.edu/12919045/Solid_waste_management_in_Kabul_city_of_Afghanistan.
- Bajrakharya, S.R. & Shrestha, B. (eds.) (2011). The Status of Glaciers in the Hindukush Himalayas. Kathmandu: International Centre for Integrated Mountain Development.
- Bayani, N., Estrella, M., Franklin, K., Hassany, M.S., Knuerr, A., & Scanlon, A. (2016). Mountain Partners: Applying Ecosystem-based Disaster Risk Reduction (Eco-DRR) for Sustainable and Resilient Development Planning in the Koh-e Baba Mountains, Afghanistan.
- Blood, P.R. (ed.). (2001). Afghanistan: A Country Study. Washington, DC: GPO for the Library of Congress.
- Breckle, S.W. &Rafiqpoor, M.D. (2010). Field Guide Afghanistan: Flora and Vegetation. Bonn: Scientia Bonnensis.
- Brown, O. & Blankenship, E. (2013). Natural Resource Management and Peacebuilding in Afghanistan. Kabul: UN Environment. Available at: http://postconflict.unep.ch/publications/Afghanistan/UNEP_Afghanistan_NRM.pdf
- CBD. (n.d.). Climate Change and Biodiversity, available (December 2016) at: https://www.cbd.int/climate
- Davis, P.H. (Ed). (1971). Plant Life of South-West Asia. Edinburgh: Royal Botanic Garden.
- Doosti, A.A. &Sherzad, M.H. (2015). Climate Change and Governance in Afghanistan. Kabul: National Environmental Protection Agency and UN Environment. Available at: http://postconflict.unep.ch/publications/Afghanistan/Report_CC_Governance_Afghanistan_EN_v2.pdf.
- Duffie and Beckman, (2005)Solar Engineeringof Thermal Processes
- Environmental Protection Agency; Climate leaders Greenhouse Gas Inventory Protocal offset Project Methodology,. U.S.A; August 2008. Handbook for Conducting Technology Needs Assessment for Climate Change, November 2010. ANNEX I: Tehnology Factseheets (Energy sector)

- FAO. (2010a). Forests and Climate Change in the Asia-Pacific Region: Forests and Climate Change Working Paper 7. Rome: Food and Agriculture Organization of the United Nations.
- FAO. (2010b). Global Forest Resources Assessment 2010: Country Reports, Afghanistan. Rome: Food and Agriculture Organization of the United Nations.
- FAO. (2014). Global Forest Resources Assessment 2015: Country Report, Afghanistan. Rome: Food and Agriculture Organization (FAO). Available at: http://www.fao. org/3/a-az145e.pdf.
- Fitzherbert, A. (2014). An Introductory Guide to Sources of Traditional Fodder and Forage and Usage. Kabul: UN Environment. Available at: http://postconflict.unep. ch/publications/Afghanistan/Introductory_guide_sources_traditional_fodder_ forage_usage_Afghanistan_2015.pdf
- GEF. (n.d.). Background Information on the NAPAs. Available at: http://unfccc.int/ adaptation/workstreams/national_adaptation_programmes_of_action/items/7572. php
- Gouhari, S., Knuerr, A., &Snyman, D. (2017). Gendering Resilience: Women, Natural Resources and Climate Change in Afghanistan. Kabul: Afghanistan Resilience Consortium.
- Grace, J. & Pain, A. (2004). Rethinking Rural Livelihoods in Afghanistan. Kabul: Afghanistan Research and Evaluation Unit.
- Gurung, D.J., Giraj, A., Aung, K.S., Shrestha, B. & Kulkarni, A.V. (2011). Snow Cover Mapping and Monitoring in the Hindukush Himalayas. Kathmandu: International Centre for Integrated Mountain Development.
- Hansen, J., Ruedy, R., Sato, M. & Lo, K. (2010). ‘Global Surface Temperature Change.’ Review of Geophysics, Vol 48, RG4004.
- Initial biennial update report, afghanistan, 2018.
- Ives, J., Shrestha, R. &Mool, R. (2010). Formation of Glacial Lakes in the Hindukush-Himalayas and GLOF Risk Assessment. Kathmandu: International Centre for Integrated Mountain Development
- Pesaran et al. 2009. Plug in Hybrid Electric Vehicles
- Second national communication, Afghanistan 2017

ANNEX 1: TECHNOLOGY FACT SHEETS – ENERGY SECTOR

Solar energy connected to grid

Technology description:

Solar radiation: globally about 5 kWh every day per one square meter of a receiver surface conditions for a proper production of electric power directly connected to national grid, or any mini-grid, are complex due to required agreements between EWSA and private sector expected to invest in large-scale PV such as 5 MW or more.

Applicability and Potentialities in Afghanistan

Based on lessons and experience for grid-connected solar PV in USA, in Europe and in North Africa, applications of large-scale PV is feasible in Afghanistan.

Potentialities - Over the whole year, the incident solar radiation is, as average, about 5 kWh/m2 .Particularly during the two rainy seasons, the solar radiation remains sufficient due to the fact that the solar declination is almost matching the latitudes in Afghanistan (Duffie et al, 1988)

Limitations - The main constraint to the deployment of solar PV systems in Afghanistan is due to initial cost of investment which is very high in addition to the fact that the payment of acquisition is cash instead of loans from Banks.

Status of the Technology in Afghanistan - Access to commercial solar PV modules is made easy due to the maturity of such technology in Europe, USA, China and Japan

Local Production - Assembly of solar calls resulting in such modules locally in Afghanistan is possible but not yet done.

Generating Costs - Projections for the year 2015: total energy generation cost is in the range of 25 to 33 US cents/kWh

The operation and maintenance costs are negligible

GHG Emissions - Slight emissions are associated to the process of preparation and transformation at high temperature before reaching the finished solar cells

Mini Hydropower Plants

The potential to privatize small hydro-powers exists in Afghanistan. All these Hydro Power Plants can be erected on irrigation canals, trained (control-flow) rivers, or near the water-storage reservoirs. There are relevant governmental programs for the development of small hydropower energy in the country.

Afghanistan's abundant water resources do mean that there is a considerable potential for hydropower development estimated at 23,310MW[3] yet, Afghanistan imports its needed electricity from neighboring countries or uses small generators for the electricity production. TheTNA project is proposed to boost the use of renewable energy (Hydropower) in the Islamic Republic of Afghanistan, improving, therefore, the well-being of the residents by providing needed energy at reasonable prices and reducing electricity imports. The followings highlight the key objectives of the TNA project:

- Reduce dependence on imported electricity
- Improving self-sufficiency in electricity generation and security of supply
- Supplying a larger segment of the population with electricity

Economic benefits:

Small hydropowers have a greater potential of contribution to socio-economic development program of regions across the country and improvement of energy supply security.

Social benefits:

Small hydropowers can help improve livelihood of rural population in the rural settlement of the country and provide for more sustainable energy supply.

Environmental benefits:

Establishment of small hydropowers can contribute to reduction of GHG emissions and cut-down the deforestation rate across the country.

Development of modern kilns manufacturing

Introduction

The experts considered Hybrid hoffman kiln technology (see the link):https://www.shareweb.ch/site/Climate-Change-and-Environment/about%20us/about%20gpcc/Documents/06%20Hybrid%20Hoffman%20Kiln.pdf)

Background

The primitive kilns, which run 365 days a year in Kabul, burn a range of fuels, including coal, wood and car tyres. Kilns of this type occur worldwide but the sector's emissions are poorly understood, in part because of the range of fuels used and the variation in kiln design. However it is thought that emissions may include sulphur oxides, nitrogen dioxide, carbon monoxide, carbon dioxide, forms of particulate matter including black carbon, and additional compounds released by the burning of coal and other fuels. While NEPA have stated that they will address the issue of pollution with kiln owners, given that they are routinely flouting recent laws barring the use of child labour on kilns, it seems questionable whether any reduction in emissions is likely.

[3] MEW. (2016). Afghanistan Energy Efficiency Policy. Kabul: Ministry of Energy and Water/ Communication Under the UNFCCC. P.18. Kabul: National Environmental Protection Agency

It uses new technology to operate all year while emitting half the pollution. Full-time employment means more money and a permanent family home. Additional money generated by the kiln’s reduced carbon emissions pays for regular health care, new bathrooms, a dining area and other improved facilities.

This technology was Originally developed in Germany, the HHK technology was imported to Bangladesh after improvement by the Chinese and now has been redesigned to suit local soil conditions, humidity levels and climate. It deploys a mix of pulverized coal and clay to improve the quality and proper burning of the bricks. In addition, the waste heat from the kiln is collected and re-used to dry the green bricks before they enter the kiln. Due to those innovations, HHKs use only half the amount of coal compared to fixed chimney kilns and trap coal particles inside the brick to prevent them from becoming air-borne fly ash.

Multiple Benefits

The multiple benefits - less pollution, improved quality of life and opportunity, more efficient production — exemplify the clean energy development needed for the world to successfully minimize climate change in coming decades.

Conclusion: HHK techncology was not considered for prioritization due to its maintenance & operation cost and tehnical resoruces.

Wind Power

The conversion of the kinetic energy in the wind into electrical power is known as wind energy. There are a number of ways in which this conversion can be done. However after a period of experimentation and development one design has come to dominate the market. This is known as the Horizontal Axis Wind Turbine (HAWT) with its archetypal three-bladed rotor. A large wind turbine primarily consists of a main supporting tower upon which sits a nacelle (the structure containing the mechanical to electrical conversion equipment). Extending from the nacelle is the large rotor (three blades attached to a central hub) that acts to turn a main shaft, which in turn drives a gearbox and subsequently an electrical generator. In addition to this there will be a control system, an emergency brake (to shut down the turbine in the event of a major fault) and various other ancillary systems that act to maintain or monitor the wind turbine. Modern multi megawatt wind turbines have main towers that are typically 70 to 120 meters high supporting rotors with a similar range of diameters. Inside the tower there is a mechanism that ensures that the nacelle/rotor faces into the wind (i.e. is yawed correctly) to give maximum generation and maintain symmetric loads on the three blades and drive shaft.

Special provisions:

The cost of wind power is high compared to other generation options (e.g. more generation on existing thermal plants) and the prices on Afghanistan market. Therefore special support measures are needed in order to deploy and disseminate this technology. It should be supported by government through legislation, grants, subsidies, feed in tariffs or tax schemes and/or reliable access to foreign markets with higher cost of power.

Impact statements

Social development priorities: Introduction of wind power will create additional jobs and increase employment. It will pose higher requirements on maintenance and operation personnel. Therefore this will have a positive social benefit of introducing modern technical knowledge to country. Wind power development will stimulate the technical development of grid and its operations.

Economic development priorities: Site and foundation for preparation of wind power as well as electric installation and connection works will provide employment opportunities, contribute to economic activity and reduction in unemployment. Wind power in some locations can be competitive with small hydro power and, therefore, it can contribute to economic competitiveness of the country. Additionally, wind power has a potential to contribute to country's energy security and export potential.

Environmental development priorities: Along with general benefit of GHG mitigation, in certain locations wind turbines may have less environmental impacts than alternative Hydro power plants.

Other consideration and priorities such as market potential: Due to abundance of hydropower and export orientation of the system, state backed guaranteed power sale at acceptable feed in tariff might be problematic. Due to intermittent and partly unpredictable pattern of production it will be more difficult to sell the wind power. There will be a need of balancing mechanisms to compensate for the varying output of wind power plant. Therefore a more intensive involvement of balancing energy market may become necessary. Due to availability of hydro that can be easily regulated, wind is not a country priority technology and therefore, there is no support from government and market is undeveloped

Capital costs over 10 years:

Operational costs over 10 years: Negligible
Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

- Improves livelihood of rural population
- Provides sustainable energy supply

b) Countries economic development priorities

- Contributes to socio-economic development program of regions of the country
- Improves security of energy supply

c) Countries environmental development priorities

- Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Incineration – Waste to Energy

This energy process is one way of utilising unrecyclable waste and minimising volumes going to landfills (which create landfill gases). This processed energy could be eligible for certain renewables grants in Afghanistan.

Energy from Waste Benefits

- Reduced Carbon Footprint
- Can be attached to existing system
- only 5-10% bottom ash left

Typical Uses for Energy Generated from Waste

- Permanent Warm Air throughout burn cycle
- Ideal Aid Agencies and Emergency Camps
- Combined Waste/Cleaning Solution for Kennels/Catteries. It is not really signifcant for Afghansitan however, in some parts of the coutnry in where other options are not feasible this can be a good option.

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

- Improves livelihood of rural population
- Provides sustainable energy supply

b) Countries economic development priorities

- Contributes to socio-economic development program of regions of the country
- Improves security of energy supply

c) Countries environmental development priorities

- Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Carbon Capture & Storage

Introduction:

Carbon capture and storage (CCS) is a combination of technologies designed to prevent the release of CO2 generated through conventional power generation and industrial production processes by injecting the CO2 in suitable underground storage reservoirs. Basically,capture technology separates CO2 emissions from the process, after which the compressed CO2 is transported to a suitable geological storage location and injected. Feasible methods of transporting of CO2 include both pipelines and shipping. Appropriate geological storage locations for CO2 include abandoned oil and gas fields, deep saline formations and unmixable coal seams. The dominant reason to do CCS is for CO2 emission reductions from industry and power generation; without incentives for such emission reductions, little CCS can be expected. The deployment of CCS in the industrial and power generation sectors would allow fossil fuel use to continue with a signifi:cant decrease in CO_2 emissions.

How it works:

When a coal, oil or gas plant burns fuel to create electricity, a major by-product is the greenhouse gas carbon dioxide (CO_2).

One approach to keeping carbon emissions under control is the use of carbon capture and storage (CCS) technologies that use underground rocks as “storage tanks”. But how do these technologies work?

When fossil fuels are burnt they produce a range of different gases including oxygen, nitrogen and CO_2.

CCS focuses on selectively pulling this CO_2 out of the gas mixture and preparing it for underground storage. Three main approaches have been developed to do this – pre-combustion, post-combustion and oxyfuel combustion.

Pre-combustion

As the name says, a pre-combustion setup focuses on capturing CO_2 before the fuel is burnt.

First, an air separator strips oxygen from the atmosphere, producing an almost pure stream of oxygen gas. This is then fed into a unit known as the gasifier, which bakes the coal at around 700 °C, releasing a mixture of gases including hydrogen, carbon monoxide, CO_2 and steam. Collectively this is known as syngas.

By adding water to this syngas in a shift reactor it is converted into hydrogen and CO_2. Separating these two gases produces a stream of hydrogen, which is burnt off, and CO_2 which is dehydrated to remove any leftover water and compressed to concentrate the gas into a liquid form for transport and storage.

To maximise efficiency of the process, the heat produced by burning the hydrogen is redirected to convert water to steam and so produce more electricity using conventional steam turbines.

Post-combustion

Post-combustion is another technique used to capture CO_2. It has the advantage of being able to be retrofitted to existing power plants.

Fuel is injected into a boiler with air and burnt in the same way you would typically find at a coal, oil, or gas-fired power plant.

The heat produced inside this boiler is used to convert water to steam that in turn powers a set or turbines to produce energy.

The by-product of this burn is a mixture of nitrogen, CO_2 and water collectively termed flue gas.

A wide variety of filtration systems can pluck the CO2 from this mixture. Some examples currently used or being investigated are ultra-porous crystals, ammonia and limestone membranes that can selectively bind and release CO2, and even populations of algae or cyanobacteria which feed on the gas to survive.

This filtration pulls the CO2 from the flue gas, which can then be dehydrated and compressed ready for transport and storage.

Oxyfuel combustion

Oxyfuel combustion systems burn coal using flue gas and pure oxygen, produced with an air separation unit. From this reaction comes heat, which is used to convert water to steam, and a mixture of flue gas and water.

This mixture can be used to regulate the temperature of the boiler before being passed through a CO2 purification unit that first removes other pollutants including sulfur and nitrogen.

It then compresses the CO2 and separates it from other non-reactive gases including oxygen and nitrogen to produce a stream of water that has a very high concentration of CO2.

Storage

Once the CO2 has been captured from the energy production process it is ready to be stored.

After transportation by trucks or pipeline, the liquid gas is pumped into porous rock formations that can be kilometres below the surface.

At these depths, the temperature and pressure keeps the gas in its liquid form where it is trapped within the geological layer.

Depleted oil fields are often used as storage tanks because a large amount of geological data is readily available, produced during the prospecting process.

The most important part of selecting a storage site is the presence of an impermeable rock layer above the porous rock known as “cap rock”, which prevents the liquid gas from escapin

Biogas for heating and electricity and efficient stoves

Biogas for cooking and electricity and use of efficient stoves is mainly suitable for application in rural areas, mostly remote areas with no gas supply and dependent to wood resources. It will lead to less harm to forest resources and reduce of GHG emission subsequently. Biogas is a gaseous mixture generated during anaerobic digestion processes using wastewater, solid waste (e.g. at landfills), organic waste, e.g. animal manure, and other sources of biomass. Biogas can be produced on a very small scale for household use, mainly for cooking and water heating. A small domestic biogas system will typically consist of the following components: Manure collection: raw, liquid, slurry, semi-solid and solid manure can all be used for biogas production. Anaerobic digester: The digester is the component of the manure management system that optimizes naturally occurring anaerobic bacteria to decompose and treat the manure while producing biogas.

Effluent storage: The products of the anaerobic digestion of manure in digesters are biogas and effluent. The effluent is a stabilized organic solution that has value as a fertilizer and other potential uses. Waste storage facilities are required to store treated effluent because the nutrients in the effluent cannot be applied to land and crops year round.

Gas handling: piping; gas pump or blower; gas meter; pressure regulator; and condensate drain(s). Gas use: a cooker or boiler

Advantages of the technology:

Biogas can make a positive contribution to multiple goals in government programs, it has the potential to increasingly become one of the most efficient and economical sources of renewable fuel with anaerobic digestion an economically viable technology for both small-scale rural applications in developing countries.

Disadvantages of the technology:

Possible negative aspects of the biogas installations are the possible reduction in soil fertility since animal dung is now used as feedstock for the biogas installation instead of for fertilization. Another potential problem is related to the possible build-up of pathogens (worms, protozoa and some fatal bacteria such as salmonella) in the biogas system.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)

In Afghanistan, there is a huge potential for application of biogas in rural areas, especially in remote communities still not supplied with gas. Along with social benefits, application of biogas reduces amount of GHG emission. There were a number of initiatives under different project for application of biogas in rural areas on the country.

A plug in hybrid electric vehicle (PHEV)

Although higher percentage of people in Afgahnistan don’t have access to regular electricity, but major cities mainly Kabul is unliveable due to very poor air conditions. It’s mostly contributed by low quality fuel and therefore the working group decided to include the PHEV as one of the evaluated technologies.

Plug in hybrid electric vehicle (PHEV) is a hybrid electric vehicle with the ability to recharge its energy storage with electricity from an off-board power source such as a grid. (Pesaran et.al, 2009) The PHEV can run either on its Internal Combustion Engine (ICE) or on its battery. A full electric vehicle uses its energy far more efficiently than a vehicle with an Internal Combustion Engine (ICE) and can drive about 2.5 times further with the same energy. For this reason it is expected that the electric vehicle will replace the ICE vehicle in the long run. However, in the coming 20 years or so vehicles will probably still be equipped with IC engines, possibly in combination with electric engines, because per unit of weight an ICE vehicle can still drive about 40 times further. In this 20 year period the IC engine is expected to improve substantially (Sharpe et al. 2009). The key advantage of PHEV technology relative to full Battery Electric Vehicles (BEV) is the fuel flexibility. PHEVs have no limitation of the driving range and if the recharging infrastructure is spatially or temporally unavailable, it doesn't restrict the use of the vehicle. A possible drawback of the PHEV is that it contains two systems to propel the vehicle, making it more costly to build than a BEV. However, the car manufacturing industry expects that PHEVs will be introduced to the market first, and that the switch to BEV could be made when the PHEVs are found to be economically and technological viable. This particular technology is assessed in urban areas inlcuding Kabul and other major cities. Air pollution is currently a serious environmetal and poltiical issue for the central government and any remedy such as this will have very high political acceptance and ratio.

Implementation

Plug-in hybrid vehicles (PHEVs) have the potential to displace a significant amount of fuel in the next 10 to 20 years. The main barriers to the commercialization of PHEVs are the cost, weight, safety, volume and lifespan of the batteries. It is expected that more and more car manufactures will bring plug in vehicles to the market in the coming years.
Implementation barriers:

- high costs of the vehicles;
- lack of recharging infrastructure;
- lack of standards for vehicles recharging equipment

GHG emissions reduction (megatons CO_2 equivalent) – 428 thousand tons CO_2 in 2030.
Studies estimate that a PHEV with usable electrical energy storage equivalent to 30 kilometers of electric travel would reduce fuel consumption by 36 - 45% relative to that of a comparable combustion engine vehicle assuming that the PHEV drives in full electric mode in the city and as a hybrid on rural roads and on the highway (Pesaran et al. 2009, CalCars, 2009). The final CO_2 emission reduction depends strongly on the source of the electricity used.
Impact on development priorities:
a) social
b) economic

- increase energy security of the country;
- improve balance of payments by reducing imports of fossil fuels.

c) environmental

- improve local air quality due to low NOx emissions and particulate matter; reduce noise.
- price is about $1700 for a 15 kilometer battery and about $3400 for a 60 kilometer battery

ANNEX 2 -TECHNOLOGY FACTSHEETS - WASTE SECTOR

Reuse, Reduce and Recycle:

The 3R's Concept of technologies to be implemented can substaintailly contribute to the reduction of the amount of wastes disposed on land. To carry out the implementation of the 3R's concept of technologies requires a high degree of coordination and organization of the waste management chain.

For the purpose of reduction of the waste problems in future, reduction in waste generation and reuse of old products such as electronics can be one of the most important factors. The reduction, for example, possible at consumption level includes better buying habits and cutting down on the use and purchase of disposable products and packaging. In addition, recycling is viable and the best option for a range of waste products. In some economies there are already well-organized recycling businesses processes in place for a range of products (e.g. furniture, clothing textile and etc) and materials (e.g. paper, iron, glass and steel).

Objectives:

With ultimate goal of reducing the disposal of wastes at uncontrolled sites and hence to reduce GHG emissions, the 3Rs' technology is aimed at achieving the followings:

- Reduce pollution problems and improve the livelihood across the country
- Create job opportunities and improve the socio-economic status of the urban population
- Reduce GHG emissions across the country especially in the urban settlement.

Economic Benefits:

Reduction of energy use in the material/product production process such as mining, quarrying, processing, etc. For instance, the copper recycling process results in energy savings of up to 85% compared to primary production .

Social Benefits:

Increased employment associated with handling and processing of waste streams, additional employment could be in waste collection, waste handling and processing, secondary material/product trade (e.g. second-hand store).

Environmental Benefits:

Lower volumes of waste to be disposed, thereby reducing pressure on land and also the associated GHG emissions. Lower air and water pollution impact due to avoidance of primary production processes.

Methan capture from landfills:

Municipal Solid Waste (MSW) is the waste generated by commercial and household sources that is collected and then either recycled, incinerated or disposed of in MSW landfills. The primary target of MSWM is to protect the health of the population, promote environmental quality, develop sustainability, and provide support to economic productivity. Landfill Gas (LFG) is created as solid waste decomposes in a landfill. Methane capture from landfills entails the recovery and use of Landfill Gas (LFG) as an energy source. This gas consists of about 50 percent methane (the primary component of natural gas), about 50 percent carbon dioxide (CO2) and a small amount of non-methane organic compounds.

Objective:

With the ultimate goal of reducing GHG emission and meeting the NDC conditional goals, methane gas recovery from MSW is proposed to improve the socio-economic conditions in urban areas and reduce the pollution caused by MSWDs. Followings are the key objective of theTNA project:

- Reduce pollution problems and improve the livelihood of urban areas
- Create job opportunities and improve the socio-economic status of the urban population
- Increase domestic electricity generation and ensure electricity security

Economic Benefits:

Methane capture from landfills have greater potential contribution to socio-economic development of the regions across the country by expansion of employment opportunities.Moreover, it improves security of energy supply.

Social Benefits:

Methane capture from landfills improves livelihood of people in the rural settlement of the country and as well as it provides the sustainable supply of energy and enhances population health by removing the hazards they face from the landfills both in the short and long runs. .

Environment Benefits:

Methane capture from landfills potentially contributes to the reduction of GHG emissions

Cogeneration with biomass

Introduction

A more profitable and efficient way of generating process steam is to first generate steam at much higher pressure and temperature and then pass such steam through a back-pressure turbine. The pressure and temperature of the exhaust steam from the steam turbine is designed to match the process steam requirements. The steam turbine while expanding the stem from high pressure to the desired pressure is made to drive an electric alternator, thus generating electrical energy. The advantage of this technology is that the net efficiency of a back-pressure turbine is very high (over 90%) as the exhaust stem is directly used as process steam. In a conventional thermal power plant, the exhaust steam from the turbine is sent to a condenser. In the condenser nearly 65 to 75% of the total energy input is removed by the condenser cooling medium. This heat is at a very low temperature. Hence it cannot be used for any practical applications.

One limitation in this process of using a backpressure turbine is that the electrical output will be directly proportional to the flow of steam passed through the turbine. This steam flow rate is determined by the process steam demand of the factory. Hence the electrical output from this system will vary according to the steam consumption rate in the factory.

Technology Name:Cogeneration with Biomass

Technology Characteristics: (Feasibility of technology and operational necessities*)*

Cogeneration has been practiced in many parts of the world for many decades. We need to demonstrate the practical and economical aspects of this technology in an industrial environment. The economical aspects has become a reality with the introduction of government policy on generation of electricity and the introduction of an attractive Standardized Power Purchase Tariff for biomass based electricity generation.

Benefits:(How the technology could contribute to socio-economic development and environmental protection).
The introduction of this technology in Afghanistan would bring the following benefits:

Social Benefits:
A new technology is introduced to the country.

Installation, commissioning and operation of high pressure boilers, turbines, generators etc. would require skilled and semi-skilled workforce. Hence employment opportunities increased in this sector. This will provide additional employment opportunities in the rural locations, he harvesting and transporting of these additional biomass will also increase occupation opportunities.

Economic Benefits
Industrial sector will be able to earn a significant income from the sale of electricity generated at very low cost. The additional biomass fuels would increase the revenue for the rural communities engaged in the production of such fuels. The country would reduce the amount of imported fossil fuels used for the generation of electricity, thus conserving foreign exchange.

Environmental benefits
Lower emissions of SO_2, NO_2 and hazardous particulate due to reduced generation of electricity from fossil fuel, particularly from coal.

Lower GHG emission. National reduction estimate from this technology: 126,160 tCO_2/y.

Operations:It’s a low cost technology.

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

- Improves livelihood of rural population
- Provides sustainable energy supply

b) Countries economic development priorities

- Contributes to socio-economic development program of regions of the country
- Improves security of energy supply

c) Countries environmental development priorities

- Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Energy & Waster (Inceneration)

This energy process is one way of utilising unrecyclable waste and minimising volumes going to landfills (which create landfill gases). This processed energy could be eligible for certain renewables grants in your region. Alternatively it could go towards meeting your zero-waste landfill obligations.

Energy from Waste Benefits

- Reduced Carbon Footprint
- Can be attached to existing system
- only 5-10% bottom ash left

Typical Uses for Energy Generated from Waste

- Permanent Warm Air throughout burn cycle
- Ideal Aid Agencies and Emergency Camps
- Combined Waste/Cleaning Solution for Kennels/Catteries

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

- Improves livelihood of rural population
- Provides sustainable energy supply

b) Countries economic development priorities

- Contributes to socio-economic development program of regions of the country
- Improves security of energy supply

c) Countries environmental development priorities

- Contribute to the reduction of GHG emissions?

A mechanical biological treatment system

Introduction

A mechanical biological treatment (MBT) system is a waste processing facility that combines a waste sorting facility with biological treatment methods e.g. anaerobic digestion and/or composting. MBT plants are designed to process mixed household waste as well as commercial and industrial waste. Therefore, MBT is neither a single technology nor a complete solution, since it combines a wide range of techniques and processing operations (mechanical and biological) dictated by the market needs of the end products. Thus, MBT systems vary greatly in their complexity and functionality.

The products of the Mechanical Biological Treatment technology are: Recyclable materials such as metals, paper, plastics, glass etc. Unusable materials (inert materials) safely disposed to sanitary landfill Biogas (anaerobic digestion) Organic stabilized end product refuse derived fuel.

This systems can form an integral part of a region's waste treatment infrastructure. These systems are typically integrated with curb side collection schemes. In the event that a derife fuel is produced as a by-product then a combustion facility would be required. Alternatively MBT practices can diminish the need for home separation and curb side collection of recyclable elements of waste. A key advantage of MBT is that it can be configured to achieve several different aims. Some typical aims of MBT plants include the:

- Pre-treatment of waste going to landfill;
- Diversion of non-biodegradable and biodegradable MSW going to landfill through the mechanical sorting of MSW into materials for recycling and/or energy recovery as refuse derived fuel (RDF);
- Diversion of biodegradable MSW going to landfill by:
- Reducing the dry mass of organic waste prior to landfill;
- Reducing the biodegradability of organic waste prior to landfill;
- Stabilisation into a compost-like output for use on land;
- Conversion into a combustible biogas for energy recovery; and/or
- Drying materials to produce a high calorific organic rich fraction for use as RDF

MBT plants may be configured in a variety of ways to achieve the required recycling, recovery and biodegradable municipal waste (BMW) diversion performance

Technical requirements

A) Waste Preparation

MSW requires preparation before biological treatment or sorting of materials can be achieved. Initial waste preparation may take the form of simple removal of contrary objects, such as mattresses, carpets or other bulky wastes, which could cause problems with processing equipment downstream. Further mechanical waste preparation techniques may be used which aim to prepare the materials for subsequent separation stages. The objective of these techniques may be to split open refuse bags, thereby liberating the materials inside; or to shred and homogenise the waste into smaller particle sizes suitable for a variety of separation processes, or subsequent biological treatment depending on the MBT process employed (DEFRA, 2007).

B) Waste Separation

A common aspect of many MBT plant used for MSW management in the sorting of mixed waste into different fractions using mechanical means. The sorting of material may be achieved before or after biological treatment. No sorting is required if the objective of the MBT process is to pre-treat all the residual MSW to produce a stabilised output for disposal to landfill. Sorting the waste allows an MBT process to separate different materials which are suitable for different end uses. Potential end uses include material recycling, biological treatment, energy recovery through the production of RDF, and landfill. A variety of different techniques can be employed, and most MBT facilities use a series of several different techniques in combination to achieve specific end use requirements for different materials. Separation technologies exploit varying properties of the different materials in the waste. These properties include the size and shape of different objects, their density, weight, magnetism, and electrical (DEFRA, 2007).

Status of the technology and its future market potential

The concept of MBT originated in Germany where it is an established waste treatment method. Regulatory restrictions on landfill space, the search for alternatives to incineration and increased costs of landfill disposal have been the major drivers for the development of these technologies. The largest European markets for established MBT plant include Germany, Austria, Italy, Switzerland and the Netherlands, with others such as the UK growing fast. Furthermore, other countries outside Europe are also using this technology.
Since the early 1990s, MBT processes have changed significantly, so today, numerous configurations of plant have developed, and these are provided by a variety of companies. There are over 70 MBT facilities in operation in Europe, with over 40 MBT facilities operating in Germany.

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

- Improves livelihood of rural population
- Provides sustainable energy supply

b) Countries economic development priorities

- Contributes to socio-economic development program of regions of the country
- Improves security of energy supply

c) Countries environmental development priorities

- Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Plastic Solid Waste Recycling

Municipal Solid Waste (MSW) is waste generated by commercial and household sources that is collected and either recycled, incinerated, or disposed of in MSW landfills. The primary target of MSWM is to protect the health of the population, promote environmental quality, develop sustainability, and provide support to economic productivity.

Technology Characteristics

Recycling refers to the separation and collection of wastes and their subsequent transformation or remanufacture into usable or marketable materials. Recycling, including composting diverts potentially large volumes of material from landfills and combustors.

Country Specific Applicability and Potential

Plastic poles in Afghanistan are used as electric poles, for fencing properties and national parks among others.

Status of technology in country

There are no private entities in Afghanistan who are actively engaged in municipal solid collection and sell the same to the waste recyclers who make plastic poles.

Benefits to economic/social and environmental development

Economic benefits

- Creation of jobs and poverty reduction

Waste compositing

Introduction:

Compositing is the decomposition of biodegradable organic matter to produce compost. Wastewater decomposition is facilitated by aerobic bacteria under controlled environment. Compositing can be divided into home compositing and industrial compositing. Essentially, the same biological processes are involved in both scales of compositing. Different materials are suitable for decomposition, but carbon and nitrogen containing materials are normally preferred. These include green plant material, dry straw, leaves, paper and wood chips.

Technology Characteristics:

Generally there are two major approaches to compositing. Active and passive. Active (hot)compositing is compositing close to ideal conditions allowing aerobic bacteria to thrive. To achieve good results the composite material must be kept warm, insulated and moist. Passivecomposition is compositing in which the level of physical intervention is kept to a minimum. Most industrial compositing operations use active compositing techniques while home compositing operations use passive techniques.

Waste compositing involves, waste collection, segregation/sorting, piling and sprinkling with water.

Country Specific Applicability and Potential:

In Afghanistan, waste compositing can be undertaken at both commercial and home levels as compostable material is found in large quantities in both rural and urban setting. In urban areas about 50% of municipal waste is of organic origin while in rural setting most of the agricultural waste is available for compositing. With the current clammer for organic farming in the country, waste com has a wide apositingpplication nationally.

Status of technology in country

Not happening.

Benefits to economic/social and environmental development

Waste decomposing in Afghanistan could result in great social economic and environmental benefits. In rural setting waste collection, segregation and transport could go a long way in poverty reduction, as these activities are labor intensive. Waste collection itself results in cleaner environment. In addition, the composite manure so produced is a cheaper alternative to imported chemicals fertilisers that consume large sums of the country's scarce foreign exchange.

Climate change mitigation benefits
Waste compositing replace natural decomposition which takes place under anaerobic conditions that would result in emissions of methane gas. The carbon dioxide that is emitted during the de-compositing process is of lower global warming potential than methane and therefore contributor to climate change mitigation
Financial requirements and costs

The capital requirement for waste compositing depends on the scale of operations. At home compositing, the operation can be undertaken through household labour thereby minimising costs. Commercial compositing can be undertaken at small scale or medium scale. In most operators using basic equipment that do not require large capital outlay.

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

Improves livelihood of rural population

Provides sustainable energy supply

b) Countries economic development priorities

Contributes to socio-economic development program of regions of the country

Improves security of energy supply

c) Countries environmental development priorities

Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Environmental benefits

i) Energy conservation and preservation of biodiversity

ii) Prevents the unnecessary waste of natural resources and raw materials

Climate change mitigation benefits

Reduction of greenhouse CO2 gas emissions from burning of plastic wastes and therefore has potential for reduction of GHGs emissions

Financial requirements and costs

This technology requires high initial investment costs

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

Improves livelihood of rural population

Provides sustainable energy supply

b) Countries economic development priorities

Contributes to socio-economic development program of regions of the country

Improves security of energy supply

c) Countries environmental development priorities

Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Waste Paper Recycling

Introduction:

Waste paper recycling is the process of turning waste paper into new paper products. The process involves waste paper collecting, sorting and mixing it with chemicals to break it down.

Technology Characteristics:

Paper recycling is the recovery of waste paper products and reprocessing them into new products. The paper recycling process involves collection of waste paper, sorting it out into categories, pulping the waste paper, which feeds back into the paper making process. The rationale behind paper recycling is to recover the valuable raw materials and recycle it to create new paper.

Country Specific Applicability and Potential

Waste paper recycling therefore presents an option to address the landfill site shortage. Waste paper also presents a source of cheaper raw material than virgin paper. Most plastic and paper containers and wrapping materials are reused only to a limited. There are opportunities for manufacturing higher quality containers which can be reused effectively.

Status of technology in country: Not happening

Benefits to economic/social and environmental development

Expansion of waste paper recycling in Afghanistan would result in creation of additional jobs in collection, separation and processing of recycled paper. The recycled paper would substitute imported paper and conserve foreign exchange earnings. The recycled paper reduces the amount of waste that would go to landfills thus prolonging the life of landfill sites.

Climate change mitigation benefits

Recycling of waste paper avoids production of methane gas that would have resulted from anaerobic decomposition of waste paper thus contributing to climate change mitigation. In addition waste paper recycling significantly reduces energy use as the recovered pulp uses this energy than virgin pulp thus conserving energy.

Financial requirements and costs

Paper recycling plants are major investments that require large capital outlays. However, as demand for paper in the country remains unsatisfied, the investment will be recovered in the long term.

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

Improves livelihood of rural population

Provides sustainable energy supply

b) Countries economic development priorities

Contributes to socio-economic development program of regions of the country

Improves security of energy supply

c) Countries environmental development priorities

Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

Waste Reuse

Introduction

In practice, wastes reuse involves the use of manufactured goods for the same purpose for which they were made or for a different and equally beneficial purpose

Technology Characteristics

Technically although the goods were manufactured for specific use their quality and characteristics are such that they can be used for a different purpose or can be used repeatedly for the original purpose without modification.

Country Specific Applicability and Potential

Goods such as bottles wrapping, materials and box containers are being reused for storage of similar substances in households or individual levels. The main requirement is that the quality of the container is such that it is suitable for the intended reuse.

Status of technology in country

Most plastic and paper containers and wrapping materials are reused only to a limited. There are opportunities for manufacturing higher quality containers which can be reused effectively.

Benefits to economic/social and environmental development

Containers that are reused will lead to lower cost of goods that they carry resulting in lower cost of living. It will also lead to cleaner environment.

Climate change mitigation benefits

Manufacturing of glass, plastic and papers consume energy with the associated emissions of greenhouse gases. Reuse of containers will result in lower energy use and hence reduced emissions of the gases.

Financial requirements and costs

Reuse of glass, plastic and paper containers will result in significant savings on the side of the industries that use them for storing goods.

Impact statements (How the options impact countries development priorities)

a) Countries social development priorities

Improves livelihood of rural population

Provides sustainable energy supply

b) Countries economic development priorities

Contributes to socio-economic development program of regions of the country

Improves security of energy supply

c) Countries environmental development priorities

Contribute to the reduction of GHG emissions?

d) Should be selected as prioritized Technology? Yes/No

ANNEX 3: TNA WORKING GROUPS FOR ENERGY AND WASTE SECTORS

No	Name	Designation	Organization	Cell phone	Email	Remarks
1	Gh- Sarwar Fayyaz	Se Rasis Engineer	Ministry of Rehabilitation and Rural Development	0799058455	sarwarfayyaz@mrrd.gov.af	
2	Esmat Sharif	RE Manager	Da Afghanistan Burshna Shirkat	0799025573	Esmat.sharif@dabs.af	
3	Eng.Gul Rasool Hamdard	Technical Manager	DABS	0729002732	Gulrasool.hamdard@dabs.af	
4	Geeti Amanzada	Policy and Plan Director	Ministry of Transport	0700222190	geetiamanzada@yahoo.com	
5	Sayed Kazem Hashemi	Lecturer	Kabul University	0790230122	Sayedkazem15@gmail.com	
6	Payenda Mohammad	Technical SR Expert	Agha Khan Agency for Habitat	0775067699	paindamohammadkhuroshan@akdn.org	
7	Noorgul Shirzoy	Industrial Affairs Sustainable Development	NEPA	0780222343	usernoor@yahoo.com	
8	Mohammad .Monib Noori	BUR Coordinator	UNEP	0790697310	Monib.noori@un.org	
9	Nassiba Aryan	Climate Change Project Expert	NEPA	0781307691	nasibaaryan@gmail.com	

10	Mohammad Nazir Safi	Employee	NEPA	0744811956	Mohammadnazirsafi2019@gmail.com	
11	Basir Ahmad Nesar	H.Water supply and Canalization	Ministry of Urban Development and Land	0784104562	basirahmadnesar@yahoo.com	
12	Habibullah Tahiry	Loss and Damage Expert	NEPA	0776511350	habibullaht@hotmail.com	
13	Aria Neiaeesh	Head of Climate Change Mitigation	NEPA	0778825790	Aria.gardizi@gmail.com	
14	Jawid Ahmad	Hydro Engineer	Ministry of Energy and Water	0799990899	Jawed_seraj@yahoo.com	
15	Zaher Maher	Climate Finance Expert	NEPA	0773066320	Zaher.maher2014@gmail.com	
16	Shamila	GRB Officer	NEPA	0788259155	Shamila.afzali2017@gmail.com	
17	Nadera. Rashidi	Head of Gender Department	NEPA	0749880027	Nadera.rashidi@yahoo.com	
18	Hamidullah Arefi	Media	The Kabul Times	0700163568	Hamidi1992@gmail.com	
19	Sohila Usofzai	Manager	Ministry of Economy	0772030707	Sohila.besmil@gmail.com	
20	Sediqullah.Omarzai	Director MIS	Kabul Municipality	0795999599	Sediqullah_omarzia@km.gov.af	

21	Reshad Azimi	DB Manager	Kabul Municipality	0785453648	razimi@km.gov.af	
22	Noor Ahamd Akhunzadah	Dean and Lecturer Faculty of Environment	Kabul University	0707083359	Noorahmad.akhundzadah@gmail.com	

ANNEX 4: LIST OF WORKSHOP PARTICIPANTS

NO	Name	Title/Position	Ministry/Agency	Contact No	Email Address	Remarks
1	Bashir Ahmad Rashidi	Head of Observation Net Work	Afghanistan Meteorology Organization	0700195957 0744380858	Bashirrashedi05@gmail.com	
2	NajiaKharoti	Advisor	Ministry Rehabilitation and Rural Development	0700204196	Najia.kharoti@mrrd.gov.af	
3	Gh. SarwarFayyaz	Se Design Engineer	Ministry Rehabilitation and Rural Development	0799058455	Sarwar.fayyaz@mrrd.gov.af	
4	Mohammad Emal	Hydrology Engineer	Ministry Rehabilitation and Rural Development		mohammademalnoori@gmail.com	
5	Sediqullah.Omarzai	Director MIS	Kabul Municipality	0795999599	Sediqullah.omarzai@km.gov.af	
6	ReshadAzimi	DB Manager	Kabul Municipality	0785453648	razimi@km.gov.af	

7	TahibBromand	Water Resources Climate Change Specialist	Ministry of Energy and Water	0785218854	t.bromand22@gmail.com	
8	Jawid Ahmad Seraj	Hydrology Establishment Management Member	Ministry of Energy and Water	0792990899	Jawed_seraj@yahoo.com	
9	Sadia Bariz	Engineer	Ministry of Energy and Water	0774816309	sadiabariz@yahoo.com	
10	NoorullahNizi	Climate Budget Specialist	Ministry of Finance	0788999004	Niazinoor83@gmail.com	
11	Ahamd Bilal Akbary	National Knowledge Management Associate	Food and Agriculture Organization	0785260257	Ahmad.bilal3@gmail.com	
12	Mustafa Sahebzada	GCF Focal Point	Food and Agriculture Organization	0779313616	Mohammad.sahebzada@fao.org	
13	SharifaSultani	Journalist	National Environmental Protection Agency	0792426107	Sharifa.sultani1998@gmail.com	
14	MohammdaTawab	Journalist	NEPA	0772852080		
15	Zolfaqar Karim Baloch	International Relations Director	NEPA	0798024623	zolfaqarb@gmail.com	
16	Esmat Sharif	RE Manager	Da Afghanistan BrushnaShirkat	0799025573	Esmat.sharif@dabs.af	

17	Eng. Gul RasoolHamdard	Technical manager	Da Afghanistan BrushnaShirkat	0729002732	Gulrasool.hamdard@dabs.af	
18	Mohammad QasimSeddiqi	Professor	Kabul Polytechnic University	0700047366	seddeqi@gmail.com	
19	Fawad Ahmad Rahyab	Assistant Professor	Kabul Polytechnic University	0772019493 0794272772	rahyabf@gmail.com rahyab@kpu.edu.af	
20	Noor Ahmad akhundzadah	Dean and Lecturer	Faculty of Environment, Kabul University	0707083359	Noorahmad.akhundzadah@gmail.com	
21	Sayed KazimHashemi	Lecturer	Faculty of Environment, Kabul University	0790232122	Sayedkazim15@gmail.com	
22	Abdul BasitDaiie	Associate Professor	Faculty of Geo Science Kabul University	0774760180	metbasit@gmail.com	
23	Abdul Ghias Safi	Dean and Lecturer	Faculty of Geo Science Kabul University	0700160803	ghiassafi@yahoo.com	
24	GeetiAmanzada	Policy and Plan Director	Ministry of Transport	0700222190	geetiamanzada@yahoo.com	
25	Payenda Mohammad	Technical SR Expert	Agha Khan Agency for Habitat	0775067699	paindamohammadkhuroshan@akdn.or g	
26	HamidullahArefi	Editor and Chief	Media, Kabul Times	0700163568	h.arefi1992@gmail.com	
27	RezwanullahShpoon	Head of Department	Ministry of Culture and Information	0778865788	Shpoon.no3@gmail.com	
28	SohilaUsofzai	Manager	Ministry of Economy	0772030702	Sohila.besmil@gmail.com	

29	Bashir Ahmad Nesar	Head of Water Supply	Ministry of Urban Development and Land	0784104552	basirahmadnesar@yahoo.com	
30	RafiulahNasrati	Researcher at Academy of Science	Academy of Science	0773379055	Rafiullah_nasrati@yahoo.com	
31	Mohammad Haroon	Qari Sahib	NEPA	0784689710		
32	SaifullahNaikandish	Medicinal Plant Specialist	Ministry of Agriculture, livestock and Irrigation	0791716862	Saifullahn2012@gmail.com	
33	ShakibaYosufi	General Manager of Analysis	Ministry of Women affairs	0700595546	Shakiba.yosufi2018@gmail.com	
34	Abdul BasitHaqjo	Evaluation Officer	Ministry of Women affairs	0772292641	Abdulbasithaqjo79@gmail.com	
35	Dirk Snyman	Chief Technical Advisor	UN Environment	0790697325	Dirk.snyman@un.org	
36	Mohammad MonibNoori	BUR Coordinator	UN Environment	079069310	Monib.noori@un.org	
37	Ahmad SamimHoshmand	Acting Climate Change Director	NEPA	0791478486	Samim.hoshmand@gmail.com ccd.nepa@gmail.com	
38	Eng. Aria Neiaeesh	Head of Mitigation Department	NEPA	0778825790	aria.gardizi@gmail.com	
39	HabibullahTahiry	Loss and Damage Expert	NEPA	0776311350	habibullaht@hotmail.com	
40	AtiullahEshanzada	Water Resources Expert	NEPA	0786826163	Atiullah_eshanzada@hotmail.com	

41	Ahmad ShoibJahesh	Forestry Expert	NEPA	0779136585	Ahmad.jahesh@gmail.com	
42	TawfiqMuradi	Vulnerability Assessment Expert	NEPA	0789332725	Tawfiq_muradi@yahoo.com	
43	Khan Mohammad Hasani	Agriculture Expert	NEPA	0784947871	Khanhasani74@gmail.com	
44	Zaheer Maher	Climate Change Expert	NEPA	0773066329	Zaheer.maher2014@gamil.com	
45	NajibullahHaqbeen	Executive Manager	NEPA	0747668649	Najibullah.haqbeen@gmail.com	
46	Mohammad Nazir Safi	Employee	NEPA	0744811956	Mohammadnazirsafi2019@gmail.com	
47	Nassiba Aryan	Climate Change Project Expert	NEPA	0781307691	nasibaaryan@gmail.com	
48	Ahmad FatehYousofzai	Technology Transfer Expert	NEPA	0786728755	Yousofzai.charkhy@gmail.com	
49	Mohammad SolaimanBakhshi	Climate Finance Advisor	NEPA	0783664067	m.solaiman.bakhshi@gmail.com	
50	Shamila	GRB Officer	NEPA		Shamila.afzali2017@yahoo.com	
51	KhpelwakSulaimanzai	Environmental Expert	NEPA	0781955005	Kheplwak-selimanzai@yahoo.com	
52	NaderaRashidi	Head of Gender	NEPA	07499880027	Nadera.rashidi@yahoo.com	

53	NoorgulShirzoy	Industrial Officer Specialist	NEPA	0780222343	usernoor@yahoo.com	
54	Ghulam Sakhi Sakha	Head of Information	NEPA			
55	Jawad Samadi	Photographer	NEPA	0786191516	jsamadi@gmail.com	
56	Rohullah Amin	Head of Adaptation to Climate Change and TNA Coordinator	NEPA + TNA Project	0744748301	Rohullah_amin512@hotmail.com	
57	Mohammad Gulab Omari	Expert Adaptation Consultant	TNA Project	0730676714	gulabomari@gmail.com	
58	Mumtaz Ahmad Ahmadi	Expert Mitigation Consultant	TNA Project	0765820572	mumahmadi@gmail.com	
59	Noor Bibi Gouhari	TNA Project Consultant	TNA Project	0793600893	noorbibigouhari@mail.com	

ANNEX 5- TREND OF GHG EMISSIONS IN CO2 EQUIVALENT BY SOURCES AND REMOVALS BY SINKS FOR 2012 – 2017

Greenhouse gas source and sink categories	2012	2013	2014	2015	2016	2017
Greenhouse gases (GHG)	Gg CO2 equivalent					
1. Energy	17,324.81	18,155.72	18,784.66	19,614.68	20,664.69	21,649.43
A. Fuel combustion (sectoral approach)	17,270.70	18,101.34	18,732.09	19,561.77	20,609.17	21,593.37
1. Energy industries	301.92	334.93	341.15	292.41	336.20	408.05
2. Manufacturing industries and construction	4,040.54	4,405.10	3,979.55	4,040.48	4,816.94	5,962.76
3. Transport	12,156.56	12,649.52	12,880.92	13,015.30	13,136.61	13,136.61
4. Other sectors	771.67	711.79	1,530.47	2,213.58	2,319.42	2,085.95
5. Other	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	54.11	54.39	52.56	52.91	55.52	56.05
1. Solid fuels	35.43	35.80	35.47	35.51	36.20	37.27
2. Oil and natural gas	18.68	18.58	17.09	17.40	19.33	18.78
2. Industrial processes	260.30	261.31	223.77	233.87	278.59	245.78
A. Mineral products	126.82	131.18	95.66	99.92	125.82	81.68
B. Chemical industry	100.04	96.70	94.67	100.51	119.33	130.67
C. Metal production	NO	NO	NO	NO	NO	NO

D. Other production	33.43	33.43	33.43	33.43	33.43	33.43
E. Production of halocarbons and SF6	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NE	NE	NE	NE	NE	NE
G. Other (please specify)	NE	NE	NE	NE	NE	NE
3. Agriculture	21,006.13	21,227.59	21,800.63	20,729.34	20,490.89	20,073.90
A. Enteric fermentation	10,194.85	10,084.85	10,505.79	10,309.18	10,265.21	10,273.23
B. Manure management	2,360.80	2,346.65	2,369.36	2,188.64	2,182.39	2,183.59
C. Rice cultivation	1,901.44	1,901.44	2,040.57	2,040.57	2,040.57	2,040.57
D. Agricultural soils	6,466.34	6,785.64	6,790.57	6,099.17	5,911.65	5,487.00
E. Prescribed TNAning of savannahs	NA	NA	NA	NA	NA	NA
F. Field TNAning of agricultural residues	22.48	25.19	26.43	23.87	23.16	21.60
G. Other	60.22	83.82	67.92	67.92	67.92	67.92
4. Land-use change and forestry (LULUCF)	NE	NE	NE	NE	NE	NE
5. Waste	1,333.39	1,358.72	1,386.69	1,417.30	1,446.59	1,502.27
A. Solid waste disposal on land	147.49	155.76	166.71	180.36	197.11	216.36
B. Waste-water handling	1,108.86	1,124.05	1,139.43	1,154.99	1,169.23	1,202.92
C. Waste incineration	30.33	30.46	30.41	30.19	28.76	28.87
D. Other – Composting	46.70	48.45	50.14	51.76	51.49	54.13

6. Other	NO	NO	NO	NO	NO	NO
Total national emissions and removals	39,924.62	41,003.34	42,195.75	41,995.19	42,880.77	43,471.39
Memo items						
International bunkers	31.69	31.69	32.01	31.38	31.69	31.69
Aviation	31.69	31.69	32.01	31.38	31.69	31.69
Marine	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	4,168.42	4,111.53	4,185.72	4,234.56	4,218.94	4,230.35

ANNEX 6 - TREND OF CH4 EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2012 – 2017

Greenhouse gas source and sink categories	2012	2013	2014	2015	2016	2017
Methane (CH4)	Gg					
1. Energy	25.81	26.36	27.42	27.18	28.70	30.96
A. Fuel combustion (sectoral approach)	24.12	24.63	25.73	25.49	26.96	29.18
1. Energy industries	8.31	8.84	9.64	9.14	10.55	12.59
2. Manufacturing industries and construction	0.35	0.39	0.34	0.35	0.43	0.55
3. Transport	2.65	2.75	2.79	2.81	2.83	2.83
4. Other sectors	12.81	12.66	12.97	13.19	13.15	13.21
5. Other (please specify)	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	1.70	1.72	1.69	1.69	1.74	1.77
1. Solid fuels	1.42	1.43	1.42	1.42	1.45	1.49
2. Oil and natural gas	0.28	0.29	0.27	0.27	0.29	0.28
2. Industrial processes	NO	NO	NO	NO	NO	NO
A. Mineral products	NO	NO	NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO
C. Metal production	NO	NO	NO	NO	NO	NO
D. Other production	0.00	0.00	0.00	0.00	0.00	0.00

E. Production of halocarbons and SF6	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO
3. Agriculture	573.48	568.69	591.93	576.75	574.74	575.05
A. Enteric fermentation	407.79	403.39	420.23	412.37	410.61	410.93
B. Manure management	88.90	88.44	89.24	82.01	81.79	81.83
C. Rice cultivation	76.06	76.06	81.62	81.62	81.62	81.62
D. Agricultural soils	0.00	0.00	0.00	0.00	0.00	0.00
E. Prescribed TNAning of savannahs	NO	NO	NO	NO	NO	NO
F. Field TNAning of agricultural residues	0.73	0.80	0.84	0.75	0.73	0.67
G. Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00
4. Land-use change and forestry (LULUCF)	NE	NE	NE	NE	NE	NE
5. Waste	45.09	45.94	46.90	47.97	49.06	50.73
A. Solid waste disposal on land	5.90	6.23	6.67	7.21	7.88	8.65
B. Waste-water handling	38.03	38.50	38.99	39.47	39.91	40.74
C. Waste incineration	0.08	0.08	0.08	0.08	0.07	0.07
D. Other – Composting	1.09	1.13	1.17	1.21	1.20	1.26
6. Other (please specify)	NO	NO	NO	NO	NO	NO

Total national emissions and removals	644.39	640.99	666.25	651.91	652.50	656.74
Memo items						
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00
Marine	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass						

ANNEX 7- TREND OF N2O EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2012 – 2017

Greenhouse gas source and sink categories	2012	2013	2014	2015	2016	2017
Nitrous oxide (N2O)	Gg					
1. Energy	0.79	0.82	0.83	0.84	0.85	0.87
A. Fuel combustion (sectoral approach)	0.79	0.82	0.83	0.84	0.85	0.87
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.05	0.06	0.05	0.05	0.06	0.08
3. Transport	0.57	0.60	0.61	0.61	0.62	0.62
4. Other sectors	0.17	0.16	0.17	0.17	0.17	0.17
5. Other (please specify)	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NA	NA	NA	NA	NA	NA
2. Oil and natural gas	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial processes	NO	NO	NO	NO	NO	NO
A. Mineral products	NO	NO	NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO
C. Metal production	NO	NO	NO	NO	NO	NO
D. Other production	0.00	0.00	0.00	0.00	0.00	0.00

E. Production of halocarbons and SF6	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NO	NO	NO	NO	NO	NO
G. Other (please specify)	NO	NO	NO	NO	NO	NO
3. Agriculture	22.18	23.24	23.27	20.95	20.32	18.89
A. Enteric fermentation	NA	NA	NA	NA	NA	NA
B. Manure management	0.46	0.46	0.46	0.46	0.46	0.46
C. Rice cultivation	NO	NO	NO	NO	NO	NO
D. Agricultural soils	21.70	22.77	22.79	20.47	19.84	18.41
E. Prescribed TNAning of savannahs	NO	NO	NO	NO	NO	NO
F. Field TNAning of agricultural residues	0.01	0.02	0.02	0.02	0.02	0.02
G. Other – Liming	0.00	0.00	0.00	0.00	0.00	0.00
4. Land-use change and forestry (LULUCF)	NE	NE	NE	NE	NE	NE
5. Waste	0.67	0.68	0.70	0.71	0.72	0.76
A. Solid waste disposal on land	0.00	0.00	0.00	0.00	0.00	0.00
B. Waste-water handling	0.53	0.54	0.55	0.56	0.58	0.62
C. Waste incineration	0.07	0.07	0.07	0.07	0.07	0.07
D. Other – Composting	0.07	0.07	0.07	0.07	0.07	0.08
6. Other	NO	NO	NO	NO	NO	NO

Total national emissions and removals	23.64	24.74	24.79	22.50	21.89	20.53
Memo items						
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00
Marine	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass						

ANNEX 8 - NATIONAL GHG INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2017

Greenhouse gas source and sink categories	GHG	CO_2 emissions	CO_2 removals	CH_4	N_2O	CO	NOx	NMVOC	SOx
	Gg eq	Gg							
1. Energy	21,649.43	20,615.03	NA	30.96	0.87	820.40	625.38	89.10	597.80
A. Fuel combustion (sectoral approach)	21,593.37	20,603.33	NA	29.18	0.87	820.40	625.38	88.67	597.80
1. Energy industries	408.05	93.30	NA	12.59	0.00	28.27	0.10	6.86	0.14
2. Manufacturing industries and construction	5,962.76	5,924.39	NA	0.55	0.08	55.95	10.62	5.40	54.00
3. Transport	13,136.61	12,881.00	NA	2.83	0.62	344.83	37.22	44.93	0.51
4. Other sectors	2,085.95	1,704.65	NA	13.21	0.17	391.35	577.44	31.47	543.14
5. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	56.05	11.71	NA	1.77	0.00	NA	NA	0.43	NA
1. Solid fuels	37.27	NA	NA	1.49	NA	NA	NA	NA	NA
2. Oil and natural gas	18.78	11.71	NA	0.28	0.00	NA	NA	0.43	NA
2. Industrial processes	245.78	245.78	NA	NO	NO	0.00	0.02	0.08	NE
A. Mineral products	81.68	81.68	NA	NO	NO	NO	NO	NO	NO
B. Chemical industry	130.67	130.67	NA	NO	NO	0.00	0.02	NO	NO

C. Metal production	NO	NO	NA	NO	NO	NO	NO	NO	NO
D. Other production	33.43	33.43	NA	0.00	0.00	0.00	0.00	0.08	0.00
E. Production of halocarbons and SF6	NO	NO	NA	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NE	NE	NA	NE	NE	NE	NE	NE	NE
G. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
3. Agriculture	20,073.90	67.92	NA	575.05	18.89	14.13	4.78	35.20	NA
A. Enteric fermentation	10,273.23	NA	NA	410.93	NA	NA	NA	NA	NA
B. Manure management	2,183.59	NA	NA	81.83	0.46	NA	1.03	NA	NA
C. Rice cultivation	2,040.57	NA	NA	81.62	NO	NA	NA	NA	NA
D. Agricultural soils	5,487.00	0.00	NA	0.00	18.41	0.00	2.13	35.20	0.00
E. Prescribed TNAning of savannahs	NA	NA	NA	NO	NO	NO	NO	NO	NA
F. Field TNAning of agricultural residues	21.60	NA	NA	0.67	0.02	14.13	0.58	NA	NA
G. Other (urea application)	67.92	67.92	NA	0.00	0.00	0.00	0.00	0.00	0.00
4. Land-use change and forestry	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Waste	1,502.27	6.25	NA	50.73	0.76	69.43	3.95	4.04	0.14
A. Solid waste disposal on land	216.36	0.00	NA	8.65	0.00	NA	NA	2.51	NA
B. Waste-water handling	54.13	NA	NA	1.26	0.08	NE	NE	NE	NE
C. Waste incineration	28.87	6.25	NA	0.07	0.07	69.43	3.95	1.53	0.14

D. Other - Composting	1,202.92	NA	NA	40.74	0.62	NA	NA	NA	NA
6. Other	NO	NO	NA	NO	NO	NO	NO	NO	NO
Total national emissions and removals	43,471.39	20,934.98	NE	656.74	20.53	903.96	634.13	128.42	597.94
Memo items									
International bunkers	31.69	31.53	NA	0.00	0.00	NE	0.11	NE	NE
Aviation	31.69	31.53	NA	0.00	0.00	NE	0.11	NE	NE
Marine	NO	NO	NA	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	4,230.35	4,230.35	NA	NA	NA	NA	NA	NA	NA

ANNEX 9- NATIONAL GHG INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2015

Greenhouse gas source and sink categories	GHG	CO2 emissions	CO2 removals	CH4	N2O	CO	NOx	NMVOC	SOx
	Gg eq	Gg							
1. Energy	19,614.68	18,685.63	NA	27.18	0.84	780.31	578.14	86.12	538.59
A. Fuel combustion (sectoral approach)	19,561.77	18,674.95	NA	25.49	0.84	780.31	578.14	85.66	538.59
1. Energy industries	292.41	63.78	NA	9.14	0.00	26.75	0.07	6.50	0.06
2. Manufacturing industries and construction	4,040.48	4,016.18	NA	0.35	0.05	37.14	7.14	3.61	35.81
3. Transport	13,015.30	12,761.96	NA	2.81	0.61	341.58	36.89	44.52	0.50
4. Other sectors	2,213.58	1,833.02	NA	13.19	0.17	374.84	534.04	31.03	502.21
5. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	52.91	10.68	NA	1.69	0.00	NA	NA	0.47	NA
1. Solid fuels	35.51	NA	NA	1.42	NA	NA	NA	NA	NA
2. Oil and natural gas	17.40	10.68	NA	0.27	0.00	NA	NA	0.47	NA
2. Industrial processes	233.87	233.87	NA	NO	NO	0.00	0.02	0.08	NE

A. Mineral products	99.92	99.92	NA	NO	NO	NO	NO	NO	NO
B. Chemical industry	100.51	100.51	NA	NO	NO	0.00	0.02	NO	NO
C. Metal production	NO	NO	NA	NO	NO	NO	NO	NO	NO
D. Other production	33.43	33.43	NA	0.00	0.00	0.00	0.00	0.08	0.00
E. Production of halocarbons and SF6	NO	NO	NA	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NE	NE	NA	NE	NE	NE	NE	NE	NE
G. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
3. Agriculture	20,729.34	67.92	NA	576.75	20.95	15.75	4.82	34.20	NA
A. Enteric fermentation	10,309.18	NA	NA	412.37	NA	NA	NA	NA	NA
B. Manure management	2,188.64	NA	NA	82.01	0.46	NA	1.03	NA	NA
C. Rice cultivation	2,040.57	NA	NA	81.62	NO	NA	NA	NA	NA
D. Agricultural soils	6,099.17	0.00	NA	0.00	20.47	0.00	2.13	34.20	0.00
E. Prescribed TNAning of savannahs	NA	NA	NA	NO	NO	NO	NO	NO	NO
F. Field TNAning of agricultural residues	23.87	NA	NA	0.75	0.02	15.75	0.62	NA	NA
G. Other (urea application)	67.92	67.92	NA	0.00	0.00	0.00	0.00	0.00	0.00
4. Land-use change and forestry	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Waste	1,417.30	6.53	NA	47.97	0.71	72.61	4.14	3.44	0.14

A. Solid waste disposal on land	180.36	0.00	NA	7.21	0.00	NA	NA	1.84	NA
B. Waste-water handling	51.76	NA	NA	1.21	0.07	NE	NE	NE	NE
C. Waste incineration	30.19	6.53	NA	0.08	0.07	72.61	4.14	1.60	0.14
D. Other - Composting	1,154.99	NA	NA	39.47	0.56	NA	NA	NA	NA
6. Other	NO	NO	NA	NO	NO	NO	NO	NO	NO
Total national emissions and removals	41,995.19	18,993.95	NE	651.91	22.50	868.68	587.11	123.84	538.73
Memo items									
International bunkers	31.38	31.22	NA	0.00	0.00	NE	0.11	NE	NE
Aviation	31.38	31.22	NA	0.00	0.00	NE	0.11	NE	NE
Marine	NO	NO	NA	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	4,234.56	4,234.56	NA	NA	NA	NA	NA	NA	NA

ANNEX 10 - NATIONAL GHG INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2014

Greenhouse gas source and sink categories	GHG	CO2 emissions	CO2 removals	CH4	N2O	CO	NOx	NMVOC	SOx
	Gg eq	Gg							
1. Energy	18,784.66	17,852.65	NA	27.42	0.83	763.57	552.08	84.95	513.66
A. Fuel combustion (sectoral approach)	18,732.09	17,842.29	NA	25.73	0.83	763.57	552.08	84.44	513.66
1. Energy industries	341.15	100.08	NA	9.64	0.00	26.01	0.10	6.31	0.08
2. Manufacturing industries and construction	3,979.55	3,955.79	NA	0.34	0.05	36.55	7.03	3.55	35.24
3. Transport	12,880.92	12,630.02	NA	2.79	0.61	338.40	36.50	44.11	0.50
4. Other sectors	1,530.47	1,156.39	NA	12.97	0.17	362.61	508.45	30.46	477.84
5. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	52.56	10.37	NA	1.69	0.00	NA	NA	0.51	NA
1. Solid fuels	35.47	NA	NA	1.42	NA	NA	NA	NA	NA
2. Oil and natural gas	17.09	10.37	NA	0.27	0.00	NA	NA	0.51	NA
2. Industrial processes	223.77	223.77	NA	NO	NO	0.00	0.02	0.15	NE

A. Mineral products	95.66	95.66	NA	NO	NO	NO	NO	NO	NO
B. Chemical industry	94.67	94.67	NA	NO	NO	0.00	0.02	NO	NO
C. Metal production	NO	NO	NA	NO	NO	NO	NO	NO	NO
D. Other production	33.43	33.43	NA	0.00	0.00	0.00	0.00	0.15	0.00
E. Production of halocarbons and SF6	NO	NO	NA	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NE	NE	NA	NE	NE	NE	NE	NE	NE
G. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
3. Agriculture	21,800.6 3	67.92	NA	591.93	23.27	17.62	4.97	33.94	NA
A. Enteric fermentation	10,505.7 9	NA	NA	420.23	NA	NA	NA	NA	NA
B. Manure management	2,369.36	NA	NA	89.24	0.46	NA	1.09	NA	NA
C. Rice cultivation	2,040.57	NA	NA	81.62	NO	NA	NA	NA	NA
D. Agricultural soils	6,790.57	0.00	NA	0.00	22.79	0.00	2.13	33.94	0.00
E. Prescribed TNAning of savannahs	NA	NA	NA	NO	NO	NO	NO	NO	NO
F. Field TNAning of agricultural residues	26.43	NA	NA	0.84	0.02	17.62	0.66	NA	NA
G. Other (urea application)	67.92	67.92	NA	0.00	0.00	0.00	0.00	0.00	0.00
4. Land-use change and forestry	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Waste	1,386.69	6.58	NA	46.90	0.70	73.15	4.17	3.09	0.14

A. Solid waste disposal on land	166.71	0.00	NA	6.67	0.00	NA	NA	1.48	NA
B. Waste-water handling	50.14	NA	NA	1.17	0.07	NE	NE	NE	NE
C. Waste incineration	30.41	6.58	NA	0.08	0.07	73.15	4.17	1.61	0.14
D. Other - Composting	1,139.43	NA	NA	38.99	0.55	NA	NA	NA	NA
6. Other	NO	NO	NA	NO	NO	NO	NO	NO	NO
Total national emissions and removals	42,195.75	18,150.92	NE	666.25	24.79	854.34	561.24	122.13	513.80
Memo items									
International bunkers	32.01	31.85	NA	0.00	0.00	NE	0.11	NE	NE
Aviation	32.01	31.85	NA	0.00	0.00	NE	0.11	NE	NE
Marine	NO	NO	NA	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	4,185.72	4,185.72	NA	NA	NA	NA	NA	NA	NA

ANNEX 11 - NATIONAL GHG INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2013

Greenhouse gas source and sink categories	GHG	CO2 emissions	CO2 removals	CH4	N2O	CO	NOx	NMVOC	SOx
	Gg eq	Gg							
1. Energy	18,155.72	17,253.01	NA	26.36	0.82	747.45	526.93	83.70	493.35
A. Fuel combustion (sectoral approach)	18,101.34	17,241.72	NA	24.63	0.82	747.45	526.93	83.15	493.35
1. Energy industries	334.93	113.65	NA	8.84	0.00	25.29	0.11	6.14	0.08
2. Manufacturing industries and construction	4,405.10	4,378.36	NA	0.39	0.06	40.50	7.79	3.94	39.05
3. Transport	12,649.52	12,402.97	NA	2.75	0.60	332.26	35.86	43.34	0.49
4. Other sectors	711.79	346.74	NA	12.66	0.16	349.41	483.16	29.74	453.72
5. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	54.39	11.29	NA	1.72	0.00	NA	NA	0.55	NA
1. Solid fuels	35.80	NA	NA	1.43	NA	NA	NA	NA	NA
2. Oil and natural gas	18.58	11.29	NA	0.29	0.00	NA	NA	0.55	NA
2. Industrial processes	261.31	261.31	NA	NO	NO	0.00	0.02	0.38	NE

A. Mineral products	131.18	131.18	NA	NO	NO	NO	NO	NO	NO
B. Chemical industry	96.70	96.70	NA	NO	NO	0.00	0.02	NO	NO
C. Metal production	NO	NO	NA	NO	NO	NO	NO	NO	NO
D. Other production	33.43	33.43	NA	0.00	0.00	0.00	0.00	0.38	0.00
E. Production of halocarbons and SF6	NO	NO	NA	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NE	NE	NA	NE	NE	NE	NE	NE	NE
G. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
5. Waste	1,358.72	6.59	NA	45.94	0.68	73.26	4.17	2.77	0.14
A. Solid waste disposal on land	155.76	0.00	NA	6.23	0.00	NA	NA	1.16	NA
B. Waste-water handling	48.45	NA	NA	1.13	0.07	NE	NE	NE	NE
C. Waste incineration	30.46	6.59	NA	0.08	0.07	73.26	4.17	1.61	0.14
D. Other - Composting	1,124.05	NA	NA	38.50	0.54	NA	NA	NA	NA
6. Other	NO	NO	NA	NO	NO	NO	NO	NO	NO
Total national emissions and removals	41,003.34	17,604.73	NE	640.99	24.74	837.55	536.53	120.47	493.49
Memo items									
International bunkers	31.69	31.53	NA	0.00	0.00	NE	0.11	NE	NE

Aviation	31.69	31.53	NA	0.00	0.00	NE	0.11	NE	NE
Marine	NO	NO	NA	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	4,111.53	4,111.53	NA	NA	NA	NA	NA	NA	NA

ANNEX 12- NATIONAL GHG INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2012

Greenhouse gas source and sink categories	GHG	CO2 emissions	CO2 removals	CH4	N2O	CO	NOx	NMVOC	SOx
	Gg eq	Gg							
1. Energy	17,324.81	16,443.91	NA	25.81	0.79	723.04	500.83	81.42	467.08
A. Fuel combustion (sectoral approach)	17,270.70	16,432.20	NA	24.12	0.79	723.04	500.83	81.02	467.08
1. Energy industries	301.92	93.97	NA	8.31	0.00	24.58	0.10	5.97	0.06
2. Manufacturing industries and construction	4,040.54	4,016.52	NA	0.35	0.05	36.87	7.13	3.59	35.54
3. Transport	12,156.56	11,919.48	NA	2.65	0.57	319.18	34.49	41.64	0.47
4. Other sectors	771.67	402.23	NA	12.81	0.17	342.40	459.13	29.82	431.01
5. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
B. Fugitive emissions from fuels	54.11	11.70	NA	1.70	0.00	NA	NA	0.40	NA
1. Solid fuels	35.43	NA	NA	1.42	NA	NA	NA	NA	NA
2. Oil and natural gas	18.68	11.70	NA	0.28	0.00	NA	NA	0.40	NA
2. Industrial processes	260.30	260.30	NA	NO	NO	0.00	0.02	0.09	NE

A. Mineral products	126.82	126.82	NA	NO	NO	NO	NO	NO	NO
B. Chemical industry	100.04	100.04	NA	NO	NO	0.00	0.02	NO	NO
C. Metal production	NO	NO	NA	NO	NO	NO	NO	NO	NO
D. Other production	33.43	33.43	NA	0.00	0.00	0.00	0.00	0.09	0.00
E. Production of halocarbons and SF6	NO	NO	NA	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and SF6	NE	NE	NA	NE	NE	NE	NE	NE	NE
G. Other (please specify)	NE	NE	NA	NE	NE	NE	NE	NE	NE
5. Waste	1,333.39	6.56	NA	45.09	0.67	72.95	4.16	2.48	0.14
A. Solid waste disposal on land	147.49	0.00	NA	5.90	0.00	NA	NA	0.87	NA
B. Waste-water handling	46.70	NA	NA	1.09	0.07	NE	NE	NE	NE
C. Waste incineration	30.33	6.56	NA	0.08	0.07	72.95	4.16	1.61	0.14
D. Other - Composting	1,108.86	NA	NA	38.03	0.53	NA	NA	NA	NA
6. Other	NO	NO	NA	NO	NO	NO	NO	NO	NO
Total national emissions and removals	39,924.6 2	16,770.9 9	NE	644.39	23.64	811.33	509.57	117.82	467.23
Memo items									
International bunkers	31.69	31.53	NA	0.00	0.00	NE	0.11	NE	NE
Aviation	31.69	31.53	NA	0.00	0.00	NE	0.11	NE	NE

Marine	NO	NO	NA	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	4,168.42	4,168.42	NA	NA	NA	NA	NA	NA	NA

ANNEX 13 - EMISSIONS OF GHG, CO2, CH4 AND N2O FROM IPCC SECTOR 1 ENERGY FOR THE PERIOD 2012 – 2017 (IBUR, 2018).

Greenhouse gas source and sink categories		2012	2013	2014	2015	2016	2017
Greenhouse gas emissions (GHG)		GHG (Gg CO_2 equivalent)					
1	Energy	17,324.81	18,155.72	18,784.66	19,614.68	20,664.69	21,649.43
1.A	Fuel Combustion Activities	17,270.70	18,101.34	18,732.09	19,561.77	20,609.17	21,593.37
1.A.1	Energy Industries	301.92	334.93	341.15	292.41	336.20	408.05
1.A.2	Manufacturing Industries & Construction	4,040.54	4,405.10	3,979.55	4,040.48	4,816.94	5,962.76
1.A.3	Transport	12,156.56	12,649.52	12,880.92	13,015.30	13,136.61	13,136.61
1.A.4	Other Sectors	771.67	711.79	1,530.47	2,213.58	2,319.42	2,085.95
1.A.5	Non-Specified	NE	NE	NE	NE	NE	NE
1.B	Fugitive Emissions from Fuels	54.11	54.39	52.56	52.91	55.52	56.05
1.B.1	Solid Fuels	35.43	35.80	35.47	35.51	36.20	37.27
1.B.2	Oil and Natural Gas	18.68	18.58	17.09	17.40	19.33	18.78
Total national GHG emissions (excluding LULUCF)		39,924.62	41,003.34	42,195.75	41,995.19	42,880.77	43,471.39
CO_2 emissions		CO_2 (Gg)					
1	Energy	16,443.91	17,253.01	17,852.65	18,685.63	19,692.65	20,615.03

1.A	Fuel Combustion Activities	16,432.20	17,241.72	17,842.29	18,674.95	19,680.58	20,603.33
1.A.1	Energy Industries	93.97	113.65	100.08	63.78	72.41	93.30
1.A.2	Manufacturing Industries & Construction	4,016.52	4,378.36	3,955.79	4,016.18	4,787.07	5,924.39
1.A.3	Transport	11,919.48	12,402.97	12,630.02	12,761.96	12,881.00	12,881.00
1.A.4	Other Sectors	402.23	346.74	1,156.39	1,833.02	1,940.11	1,704.65
1.A.5	Non-Specified	NE	NE	NE	NE	NE	NE
1.B	Fugitive Emissions from Fuels	11.70	11.29	10.37	10.68	12.07	11.71
1.B.1	Solid Fuels	NA	NA	NA	NA	NA	NA
1.B.2	Oil and Natural Gas	11.70	11.29	10.37	10.68	12.07	11.71
Total national CO_2 emissions (excluding LULUCF)		16,770.99	17,604.73	18,150.92	18,993.95	20,045.39	20,934.98
CH_4 emissions		CH_4 (Gg)					
1	Energy	25.81	26.36	27.42	27.18	28.70	30.96
1.A	Fuel Combustion Activities	24.12	24.63	25.73	25.49	26.96	29.18
1.A.1	Energy Industries	8.31	8.84	9.64	9.14	10.55	12.59
1.A.2	Manufacturing Industries &Construction	0.35	0.39	0.34	0.35	0.43	0.55
1.A.3	Transport	2.65	2.75	2.79	2.81	2.83	2.83
1.A.4	Other Sectors	12.81	12.66	12.97	13.19	13.15	13.21

1.A.5	Non-Specified	NE	NE	NE	NE	NE	NE
1.B	Fugitive Emissions from Fuels	1.70	1.72	1.69	1.69	1.74	1.77
1.B.1	Solid Fuels	1.42	1.43	1.42	1.42	1.45	1.49
1.B.2	Oil and Natural Gas	0.28	0.29	0.27	0.27	0.29	0.28
Total national CH_4 emissions (excluding LULUCF)		644.39	640.99	666.25	651.91	652.50	656.74
N_2O emissions		N_2O (Gg)					
1	Energy	0.79	0.82	0.83	0.84	0.85	0.87
1.A	Fuel Combustion Activities	0.79	0.82	0.83	0.84	0.85	0.87
1.A.1	Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2	Manufacturing Industries & Construction	0.05	0.06	0.05	0.05	0.06	0.08
1.A.3	Transport	0.57	0.60	0.61	0.61	0.62	0.62
1.A.4	Other Sectors	0.17	0.16	0.17	0.17	0.17	0.17
1.A.5	Non-Specified	NE	NE	NE	NE	NE	NE
1.B	Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1	Solid Fuels	NA	NA	NA	NA	NA	NA
1.B.2	Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00
Total national CH4 emissions (excluding LULUCF)		23.64	24.74	24.79	22.50	21.89	20.53

ANNEX 14: EMISSIONS OF GHG FROM THE WASTE SECTOR FOR THE PERIOD OF 2012 – 2017 (IBUR, 2018).

Greenhouse gas source and sink categories		2012	2013	2014	2015	2016	2017
Greenhouse gas emissions (GHG)		GHG (Gg CO_2 equivalent)					
5	Waste	1,333.39	1,358.72	1,386.69	1,417.30	1,446.59	1,502.27
5.A	Solid Waste Disposal	147.49	155.76	166.71	180.36	197.11	216.36
5.B	Biological Treatment of Solid Waste	46.70	48.45	50.14	51.76	51.49	54.13
5.C	Incineration and Open Burning of Waste	30.33	30.46	30.41	30.19	28.76	28.87
5.D	Wastewater Treatment and Discharge	1,108.86	1,124.05	1,139.43	1,154.99	1,169.23	1,202.92
Total national GHG emissions (excluding LULUCF)		39,924.62	41,003.34	42,195.75	41,995.19	42,880.77	43,471.39
CO_2 emissions		CO_2 (Gg)					
5	Waste	6.56	6.59	6.58	6.53	6.22	6.25
5.A	Solid Waste Disposal	0.00	0.00	0.00	0.00	0.00	0.00
5.B	Biological Treatment of Solid Waste	NA	NA	NA	NA	NA	NA
5.C	Incineration and Open Burning of Waste	6.56	6.59	6.58	6.53	6.22	6.25
5.D	Wastewater Treatment and Discharge	NA	NA	NA	NA	NA	NA
Total national CO_2 emissions (excluding LULUCF)		16,770.99	17,604.73	18,150.92	18,993.95	20,045.39	20,934.98
CH_4 emissions		CH_4 (Gg)					
5	Waste	45.09	45.94	46.90	47.97	49.06	50.73
5.A	Solid Waste Disposal	5.90	6.23	6.67	7.21	7.88	8.65
5.B	Biological Treatment of Solid Waste	38.03	38.50	38.99	39.47	39.91	1.26
5.C	Incineration and Open Burning of Waste	0.08	0.08	0.08	0.08	0.07	0.07

5.D	Wastewater Treatment and Discharge	1.09	1.13	1.17	1.21	1.20	40.74
Total national CH_4 emissions (excluding LULUCF)		644.39	640.99	666.25	651.91	652.50	656.74
N_2O emissions		N_2O (Gg)					
5	Waste	0.67	0.68	0.70	0.71	0.72	0.76
5.A	Solid Waste Disposal	0.00	0.00	0.00	0.00	0.00	0.00
5.B	Biological Treatment of Solid Waste	0.53	0.54	0.55	0.56	0.58	0.08
5.C	Incineration and Open Burning of Waste	0.07	0.07	0.07	0.07	0.07	0.07
5.D	Wastewater Treatment and Discharge	0.07	0.07	0.07	0.07	0.07	0.62
Total national N_2O emissions (excluding LULUCF)		23.64	24.74	24.79	22.50	21.89	20.53

ANNEX 15 – TNA WORKSHP AGENDA & ARRANGEMENTS

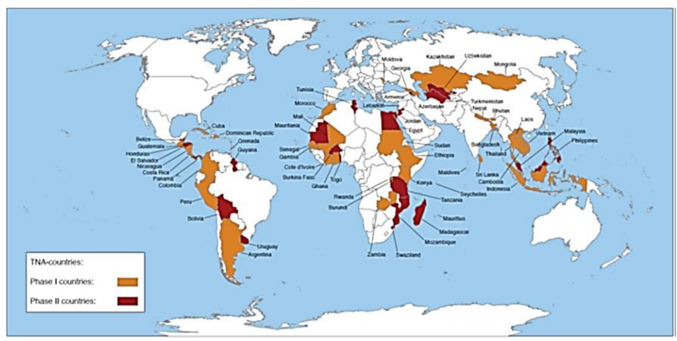
GEF-Funded Technology Needs Assessment Project

Technology Needs Assessment Inception Workshop

TNA Phase III – Afghanistan

July 13 – 14 - 15, 2019
NEPA

CONTEXT



UNEP, on behalf of the UNFCCC and the GEF, is implementing the Phase III of Technology Needs Assessments (TNAs), with objectives that go beyond a narrow identification of technology needs. The TNAs will lead to the development of national Technology Action Plans (TAPs) that recommend enabling frameworks for the diffusion of these prioritized technologies and facilitate identification of good technology transfer projects with links to relevant financing sources. The TAP will systematically suggest practical actions necessary to reduce or remove policy, finance and technology related barriers. UNEP DTIE in collaboration with the UNEP DTU Partnerships providing targeted financial, technical, and methodological support to assist countries to conduct TNA projects in the TNA Phase III. The TNA Phase III was initiated in May 2018 and 24 countries in Asia& Pacific, Africa, Latin & Central America, and Europe were invited for participating in this third Phase. Afghanistan is one the country that is invited to participate in the phase III of the TNA project, including Fiji, Myanmar, Nauru and Vanuatu.

OBJECTIVE:

1. Familiarization with climate technologies in reference to adaptation and mitigation.

2. To determine climate technology priorities

3. To identify and prioritize mitigation and adaptation technologies for selected sectors

4. Familiarization with database support- Climate Techwiki, Guidebook and helpdesk facilities

Day 1: Introduction, Technology Familiarisation and MCA

Time	Activity	Responsible
09:00 – 9:30	Registration	
09:30 – 10:45	Background Session	
9:30 – 9:35 9:35 – 9:40 9:40 – 9:50 9:50 – 10:30 10:30 – 10:45	• Recitation of Holy Quran • National Anthem of the Islamic Republic of Afghanistan • Opening Remarks • Context / Objectives of the workshop, expected outputs and work plan • Questions/ Answers	Qari Sahib Technical Team TBD Rohullah Amin, TNA Coordinator
10:45 – 11:00	Tea/ coffee break	
11:00– 12:30	Technology Familiarisation & linkage to Technology Mechanism	
11:00 – 11:45 11:45 – 12:30	• Technology & CTCN role in technology mechanism • Discussion	Noor Bibi Gouhari TNA Team & Participants
Learning Outcome	Participants will know how technologies are defined, what a technology is and the different types of categories which a technology can be part of, within the context of the TNA project and also will know the technology fact sheets.	
12:30 – 1:30	Lunch	
1:30– 4:30	TNA Methodology – Part 1 & Group Classifications	
1:30 – 2:00 2:00 – 2:45	• Technology Fact Sheets • Methodology for technology prioritisation – an introduction to MCA (Step 1 to 3) • Group Classifications	Ahmadi Omari

2:45 – 3:00 3:00 – 3:45 3:45 – 4:15	• Group Exercise • Presentation of Result	Amin Group Representatives
	Participants are familiar with the approach of MCA and how to establish a decision context, identify options (technologies) and criteria, and how to evaluate the technologies.	
4:15 -4:30	Tea/Coffee break	

4:30- 4:35	Summary and Conclusion of Day 1	Ahmadi

Day 2: Working Group Sessions (Mitigation)

Time	Activity	Responsible
09:00 – 11:30	TNA Methodology – Part 2	
9:00 – 9:45 9:45 – 10:30 10:30 – 11:15 11:15 – 11:30	• MCA Steps 4 to 8 • Group Exercise • Presentation of Results • Discussion	Ahmadi & Omari Participants Group Representatives
Learning Outcome	To clarify any issues regarding the steps.	
11:30 –11:45	Tea/Coffee break	
11:45 – 1:00	MCA Steps (Continue)	
Learning Outcome	Participants are familiar with the last steps of the MCA methodology, to do scoring, weight against criteria for evaluating technologies, interpret results and carry out sensitivity analysis. Participants have worked with the MCA and the last steps for assessing and prioritizing technologies.	

1:00 – 2:00	Lunch

2:00 – 4:00	Technology Prioritization	
2:00 – 2:30 2:30 – 3:30 3:30 – 4:00 4:00 – 4:15	• Criteria for mitigation • Group Exercise • Presentations of the Result • Discussion	M. A. Ahamdi Participants Group Representatives

4:15 – 4:30	Tea/ Coffee break	
4:30- 4:45	Summary and Conclusion of Day 2	Ahmadi

Day 3: Working Group Sessions (Adaptation)

Time	Activity	
09:00 – 11:	A revisit for MCA (Step 1 to 8)	
9:00 – 10:15 10:30 – 11:30 11:30 – 12:00	• MCA Steps 1 to 8 • Group Exercise • MCA: Criteria for adaptation	Omari &Ahamdi: Supportive partner Omari
Learning Outcome	To clarify any issues regarding the steps.	
10:15 –10:30	Tea/Coffee break	
12:00 – 1:00	MCA Steps (Continue)	
Learning Outcome	Participants are familiar with the last steps of the MCA methodology, to do scoring, weight against criteria for evaluating technologies, interpret results and carry out sensitivity analysis. Participants have worked with the MCA and the last steps for assessing and prioritizing technologies.	

1:00 – 2:00	Lunch

2:00 – 4:00	Technology Prioritization (Adaptation Side)	
2:00 – 3:00 3:00 – 3:30	• Group Exercise • Presentations of the Result • Discussion	Omari Presentation of the Results

3:30 – 3:45	Tea/ Coffee break	
3:45– 4:30	Lesson learned and next steps	Chair: Ahmadi
	Lesson learned – Discussion Workshop Feedback Next Steps	