State of Palestine

Environment Quality Authority (EQA)

Climate Technology Centre & Network (CTCN)

"Technology Roadmap for the Implementation of Climate Action Plans in Palestine"

Technology Roadmap Implementation Report

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Foreword

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Acronyms

BSP	Biogas Sector Partnership
CSA	Climate-Smart Agricultural
CTCN	Climate Technology Center and Network
DREI	De-risking Renewable Energy Investment
EQA	Environmental Quality Authority
EV	Electrical Vehicle
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiance
GPS	Global Positioning System
ICA	Israeli Civil Administration
IEC	Israel Electric Corporation
INCR	Initial National Communication Report
JICA	Japan International Cooperation Agency
NAP	National Adaptation Plan
NDC	Nationally Determined Contributions
PENRA	Palestinian Energy and Natural Recourse Authority
PETL	Palestinian Electricity Transmission Company Ltd.
PPP	Private-Public Partnership
PV	Photovoltaic
PWA	Palestinian Water Authority
SUNREF	Sustainable Use of Natural Resources and Energy Finance
SWH	Solar Water Heating
UNFCCC	United Nations Framework Convention on Climate Change
WSRC	Water Sector Regulatory Council

1. Introduction

Overview of Palestine

The State of Palestine constitutes the Occupied Palestinian Territory, based on the borders of June 1967, and comprises the West Bank including East Jerusalem and the Gaza Strip, which are separated by Israel. The State of Palestine's population increased from 1.5 million in 1980 to 4 million in 2010 and is expected to double by 2050 to reach 8.9 million.

The country is under Israeli occupation, and Israeli settlements have been established throughout the West Bank including East Jerusalem. Consequently, the Palestinian Government does not have full control over its own territory and its natural resources, which has negative impact on the delivery of the Palestinian Government's environmental policies and climate change mitigation and adaptation actions. The occupation is considered as a multiplier and amplifier of the severe impacts of climate change on all sectors, as well as on living conditions of Palestinians.

Climate change overview

The State of Palestine is highly vulnerable to the impacts of climate change with severe implications for its economy and development. Impacts significant to the region include decreased precipitation, significant warming, more frequent extreme weather events, and rise in sea level. These could lead to greater water scarcity, decreased agricultural productivity, decreased food and water security, and saline water intrusion. For Palestine, addressing climate change impacts will help improve the country's energy security, its people's living conditions, health and environment, and overall food production. Palestine expects that climate change will most severely affect water and agricultural sectors, projecting that precipitation decrease and significant increase in temperature will lead to higher insecurity levels for food and water in the region. Specifically, impacts on the agricultural sector will include more frequent droughts and increased desertification, changes in economic viability of crops, increased crop water requirements, decline in grazing ranges and stocks and higher food prices. For the water sector, climate change will exacerbate the effects of Israel's current control on regional water sources. In addition, there is a concern of potential impact of climate change from decreased precipitation and sea level rise on the coastal aquifer in Gaza. This could severely affect communities who rely most exclusively on the coastal aquifer for their water needs.

Due to their increased physical and/or socio-economic challenges, it is expected that climate change will most severely impact Palestine's most vulnerable populations including women, children, youth (young women and men), refugees, young parents, parents of young children, the elderly, female-headed households, persons with disabilities, families with member(s) in detention and poor/underserved communities. The risks and challenges faced by these groups are outlined in the Technology Roadmap's Gender Mainstreaming Report.

Existing mitigation and adaptation actions

Adaptation to adverse impact of climate change is considered as the highest priority. In order to address expected climate change impacts, Palestine has adopted some actions. These include set up of water filling points and water tankers to secure water resources while developing rainwater harvesting technology as a necessary intervention. For the agriculture sector, measures such as climate smart agriculture and water harvesting practices have already been initiated on the ground. For the energy sector, solar PV and solar water heating technologies have been applied and are already proven technologies. Solar water heating is extensively used in the residential sector while capacity is still limited in sectors such as service and industrial. Increasing energy efficiency is another approach used to decrease energy demand. The differing needs and requirements of women and men and their subgroups - categorized by age, ability or socio-economic status – as related to climate change, the effects that climate change may have on existing gender inequalities and the ways in which gender inequalities may be exacerbated by climate change have

not been fully analyzed or addressed in current climate change adaptation actions.

For future actions, Palestine's Nationally Determined Contribution (NDC) specifies climate actions that are implementable, given they receive international support with regard to technology transfer, capacity building and financial resources. These actions are identified as solar photovoltaic, energy efficiency in buildings, use of waste for electricity generation, reduction of methane from landfill, energy efficient lighting, hybrid electric vehicles, compressed natural gas powered vehicles, modal shift programs, afforestation, water use efficiency, livestock production and feeds improvement, climate-smart agriculture, beach rehabilitation and protection, safety systems for water, food and sanitation, and disaster risk reduction and management, among many other actions in areas of both adaptation and mitigation.

Technology roadmap

A gender responsive Technology Roadmap has been developed and is presented as part of this report. The following pages offer solutions to remove barriers and risks for the implementation of prioritized technologies in Palestine. The management plan for monitoring and evaluation is also offered within this report which details the proposed technology solutions, timeline, budget, roles and responsibilities for the implementation of the Technology Roadmap.

It is recommended that all solutions adopted by the Palestinian Government be designed through a gender and inclusion perspective. To ensure sustainable mitigation and adaptation it is vital that all segments of society have the knowledge and skills to fully participate in fulfilling the mission of the Technology Roadmap. The following (Table 1) short and long-term actions are recommended throughout the document, providing opportunities for inclusive participation, capacity and skill-building, and serving as the basis for informed decision-making:

Table 1: Gender Responsiveness Considerations in the Technology Roadmap

Short or Long-Term Action	Gender Intervention	Justification
Policy development and enforcement	Make gender mainstreaming in local and national-level policies standard practice. Conduct in-depth analyses of the relevant sectors to understand: • gendered access, knowledge, use and decision-making regarding resources and technologies; • existing adaptation techniques employed by women and men; • the ways in which existing gender inequalities can be exacerbated by climate change; • the ways in which gender inequalities can intensify the impacts of climate change for individuals and communities. Integrate gender into policies, plans and programs	Gender mainstreaming ensures that the needs and expectations of both women and men, and their subgroups (youth, persons with disabilities, refugees, etc.), are met.

	based on findings of the analyses. Develop gender-specific indicators to monitor compliance.	
Institutional capacity building	Aim for at least 20 percent representation of women in all related committees, meetings and capacity building activities. Targets should be increased as programs progress and scale up. Build the capacity of female staff in relevant entities to grow into decision-making roles through providing mentorship or job shadowing opportunities.	Including women in decision-making roles ensures that policies and regulations serve the needs of both women and men.
Technical capacity building	Aim for at least 20 percent representation of women in all capacity building activities. Targets should be increased as programs progress and scale up. Support internships or job shadowing programs to increase the technical knowledge of women and other groups, for example, for the installation and maintenance of solar PV. Employ specific outreach mechanisms, such as working with universities, civil society, female-owned enterprises, women's cooperatives and associations and relevant ministerial bodies to encourage women, youth and persons with disabilities to join capacity building activities, including internships. Identify women-owned or women-led businesses to receive capacity building support	Providing women, youth and persons with disabilities with capacity building will not only allow them to install, use and maintain different technologies, but will provide them with vital income generation skills and therefore increased resilience to climate change.
Feasibility studies and mapping exercises	Design all feasibility studies with a gender perspective. Include gender parameters in the terms of reference, ensure that gender expertise is present to conduct the study and analysis and disaggregate all data by sex.	Mainstreaming gender into the design of any program will ensure that gender is considered throughout the program cycle.
Stakeholder consultations	Ensure that all consultations are inclusive of as many segments of society as possible. Aim for equal representation of women and a percent representation of youth, persons with disabilities, refugees and female heads of households	Involving as many groups as possible means that a wide variety of perspectives are brought to the table. Women tend to bring community concerns and needs to the forefront of

		planning meetings and discussions.
Awareness raising	Ensure that communications strategies target key users and influencers such as women and youth. Behavior change messages and means of communication -social media, radio, TV, home visits - should be specially crafted for the different targeted groups. Persons with certain disabilities such as the seeing or hearing-impaired require accommodations in messaging, as do those with literacy issues, including elderly women. Notes: Care must be taken that messaging does not reinforce gender stereotypes. Care must be taken not to advocate for the increase of the domestic/unpaid burden on women (through the promotion of solid waste management practices at the household level for example).	Women and youth generally act as behavior change influencers among their immediate families, neighborhoods and communities.
Financing scheme development	Include a gender perspective in training offered to financial sources. Set targets for the access to green finance for women and female-owned or led businesses. Identify income generation/access to finance opportunities for persons with disabilities. Develop and implement tailored products and services to meet financial needs of women entrepreneurs and female heads of household. Identify women-owned businesses as project vendors to supply technologies and/or services where possible.	Designing financing schemes with a gender perspective ensures that women and other groups overcome common barriers to accessing finance.

2. Prioritized technologies and summary of prioritization process

The long list of technologies

In determining applicable sectors and technologies, documents made available from the State of Palestine were reviewed and analyzed. In addition, an extensive desktop review, coupled with interviews with relevant stakeholders during the first mission in January 2019, was performed which resulted in the long list of climate mitigation and adaptation technologies (referred to as the “long list”, Annex 1).

Shortlist of technologies

In order to shortlist technologies to carry out further assessments, the long list of technologies was scored by relevant stakeholders. The scoring was based on the following six criteria:

1. Relevance to Palestine context;
2. Linkage to Palestine’s NDC;
3. Co-benefits;
4. Acceptability;
5. Transferability to the country; and
6. Possible occupation related challenges.

Upon completion of the scoring process, top-rated technologies (top 50 percent based on aggregated scores) from each sector were selected for further assessments. These assessments included the identification of key barriers, de-risking measures and policy assessment. As a result, a total of 19 technologies were shortlisted. For those technologies that were not prioritized from this process, the consulting team did not perform further assessments and were, therefore, not in scope of the identification of key barriers, de-risking measures and policy assessment. However, these technologies remained as consideration for the future and final prioritization.

Final prioritization of technologies

To consider short-term, medium-term and/or long-term introduction of the technology and the level of de-risking measures and external support required for introduction of the technology, the shortlisted technologies were further scored on three criteria:

1. Feasibility of current policy environment;
2. Risk assessment; and
3. The need for external support for the introduction of technologies.

This second-set of scoring resulted in the final list of prioritized technologies for the Technology Roadmap, in which a total of 19 technologies were prioritized. This list is presented in Table 2, in order of ranking, for each technology in each sector.

Scoring results were discussed and finalized with stakeholder during targeted consultations with sectoral working group and the prioritization workshop which was organized with the purpose to finalize the prioritized technologies for each sector during the second mission in May 2019.

Table 2: List of Prioritized Technologies for the Technology Roadmap

Sector	Technology
Energy	1. National grid assessment and electricity grid upgrade
	2. Various applications of solar PV technologies
	3. Energy efficiency
	4. Solar water heating
Agriculture	1. Climate smart agriculture (precision agriculture)
	2. Efficient irrigation
	3. Resilient animal fodder
	4. Conservation agriculture
	5. Water harvesting
Water and wastewater	1. Rainwater harvesting
	2. Water resources monitoring technologies
	3. Wastewater collection and treatment plants and advanced wastewater treatment technologies
Transportation	1. Upgrade of the existing vehicle fleet
	2. Public transportation (modal shift)
Solid waste	1. Waste sorting
	2. Composting
	3. Recycling
Others	1. Provision of beach nourishment, reclamation and beach drift rehabilitation
	2. Development of water, food and sanitation monitoring and safety systems using high technology related to health

3. Technology roadmap

The technology roadmap focuses on the final list of prioritized technologies. It will create synergies with the Green Climate Fund's (GCF) Country Programme and implementation action plan of Palestine's Nationally Determined Contribution (NDC), as well as identify synergies and nexuses across the different sectors such as agriculture, waste and energy sectors. It will achieve this by clearly identifying short-term and long-term technology priorities that will support relevant projects and programmes to realize a paradigm shift in achieving low-emission and climate-resilient development. It will also support the implementation of the NDC by aligning needs of external funding support in achieving necessary mitigation and adaptation actions identified in the NDC. Where possible, the Roadmap will specify how the different technologies will benefit women, youth (young women and men), persons with disabilities and other groups.

The timeline for the implementation of prioritized technologies will align with the GCF's Country Programme as well as with the timeframe of national strategies and action plans. These timelines are 2019-2022 reflecting short-term actions, and 2023-2025 reflecting long-term actions. For this purpose, the prioritized technologies have been categorized into four categories to take into account their potential for short-term, medium-term and/or long-term implementation, level of de-risking measures for its introduction, and the level of external support required. This categorization of technologies is reflected in the roadmap. Below defines each category of technology group:

Technologies under each category

1. **Low-hanging fruit technologies** have no significant needs for de-risking and long-term negotiations. Although some of them, such as rainwater harvesting, may require de-risking and negotiations if applied to the entire West Bank, they can be introduced or applied in the short-term in limited areas, such as Area A, where there are no significant risks related to occupation.

Most of these technologies require some degree of external support, especially in the form of financial support or technical assistance, however, they could also be introduced by the State of Palestine or the private sector under the right framework. Table 3 presents technologies under this category.

Table 3: Low-hanging Fruit Technologies

Sector	Technology	Needs for external support	Needs for de-risking	Occupation challenges
Energy	1. Various applications of solar PV technologies	Medium	Medium	Medium
Agriculture	2. Climate smart agriculture (precision agriculture)	Medium	Low	Low
	3. Efficient irrigation	Medium	Low	Low
	4. Conservation agriculture	Medium	Low	Low
Water and wastewater	5. Rainwater harvesting	Medium	Medium	Medium

2. **Technologies requiring external support** for de-risking support and negotiations with Israel. However, the main driver obstructing their introduction remains the need for external support, both in terms of financial and technical assistance. The technologies under this category are shown in Table 4.

Table 4: Technologies Requiring External Support

Sector	Technology	Needs for external support	Needs for de-risking	Occupation challenges
Energy	6. Energy efficiency	High	Medium	Medium
Agriculture	7. Water harvesting	High	Medium	Medium

3. **Technologies requiring de-risking** mainly experience challenges related to regulations and market development. De-risking is linked with external support, as technical assistance or financial support may be required to implement de-risking measures. For example, although solar water heating has been scored as having low risks for de-risking, the development of regulations and of a local market will require external support and are linked with de-risking. The technologies under this category are shown in Table 5.

Table 5: Technologies Requiring De-risking

Sector	Technology	Needs for external support	Needs for de-risking	Occupation challenges
Energy	8. Solar water heating	High	Low	Low
Agriculture	9. Resilient animal fodder	Medium	Medium	Medium
Solid Waste	10. Waste sorting	Medium	High	Medium
	11. Composting	Medium	Medium	Medium
	12. Recycling	High	High	Medium
Transport	13. Public transportation (modal shift)	High	High	Medium

4. **Long-term technologies require negotiations with Israel.** These technologies are also in high need of external support and often require significant de-risking to be introduced. The technologies under this category are shown in Table 6.

Table 6: Long-term Technologies

Sector	Technology	Needs for external support	Needs for de-risking	Occupation challenges
Energy	14. National grid assessment and electricity grid upgrade	High	Medium	Medium
Transport	15. Upgrade of the existing vehicle fleet	High	Medium	Medium
Water and wastewater	16. Water resources monitoring technologies	High	Medium	Medium
	17. Wastewater collection and	High	High	High

	treatment plants and advanced wastewater treatment technologies			
Others	18. Provision of beach nourishment, reclamation and beach drift rehabilitation	High	High	Medium
	19. Development of water, food and sanitation monitoring and safety systems using high technology related to health	High	High	Medium

3.1. Energy Sector

3.1.1. Current status of the sector

The energy sector is crucial to the development and economic growth of Palestine. In recent years, energy demand is growing due to high population growth, increased industrial activities and increased living standards in the country. However, the sector is facing challenges in meeting electricity demand. Due to the limited power supply, electricity is rationed through rolling blackouts.

Palestine relies primarily on electricity imports from Israel to meet its energy needs. About 90 percent of their electricity was supplied by the Israeli Electric Corporation (IEC) in 2015 and about 4 percent supplied from Jordan and Egypt combined, in addition to electricity generated by the Gaza Power Plant.

Palestine face significant constraints in developing its energy sector due to the scarcity of indigenous energy sources. With the limited energy resources that they do have, their ability to exploit them is hindered by their current political situation. This results in Palestine having to depend largely on energy imports. In addition to local conditions, the changing global climate conditions is contributing to worsening this problem. Extreme weather conditions such as temperature extremes increase energy demands for both heating and cooling.

The Palestinian government has taken significant institutional reforms in the sector with the aim to streamline governance. For example, the sector was reorganized to cluster most of the former municipal service providers into six local distribution utilities. The Electricity Law of 2009 established the Palestinian Electricity Transmission Company Ltd as the national transmission operator and buyer of electricity, and the Palestinian Electricity Regulatory Council responsible for electricity regulations. The government also has taken initiatives to promote the development of renewable energy such as providing tax exemptions on renewable energy related equipment. So far, about 18 MW in capacity of renewable energy projects have been implemented.

However, these efforts still need to be improved in order to address challenges that the energy sector face. To support the development of the sector to meet the growing energy demands as well as to contribute to the mitigation of climate change, the transfer of technologies will be crucial.

3.1.2. Institutional Framework

The implementation and scaling up of prioritized technologies in the energy sector of Palestine involves the engagement and participation of key government institutions. The following key government institutions

were identified which would play the leading role:

Table 7: Key Government Institutions in the Energy Sector

Lead Institution	Description
Palestinian Energy and Natural Resources Authority	The State of Palestine has established the Palestinian Energy and Natural Resources Authority (PENRA) as the main institution responsible for the energy and electricity sector. It holds the responsibility of setting up the legal, institutional, economic and financial framework for the sector's development. PENRA will play a key role in laying out the enabling environment so that public and private resources could be mobilized for the implementation of prioritized technologies in the energy sector. This would ensure that investments in the sector would make business sense, and at the same time, allow PENRA to provide reliable clean electricity to Palestinians at affordable prices.
Palestinian Electricity Transmission Company Ltd.	Established through the Electricity Law of 2009 and supported by the Energy Sector Strategy, the Palestinian Electricity Transmission Company Ltd. (PETL) holds the responsibility of building, owning and operating the Palestinian electricity transmission system. PETL plays a crucial role as the key implementing entity for initiating and conducting the national grid assessment and eventually executing the grid upgrading works which will pave the way for the expansion of the sector in terms of generating their own power and from various sources with renewable energy and solar PV technologies being one of the priority sources. It has to ensure that the country's growing demand for electricity is met. PETL will be involved with power purchase agreements with the generators, and would eventually sell to the regional power distribution utilities.
Palestinian Electricity Regulatory Council	The Palestinian Electricity Regulatory Council (PERC) is the designated electricity regulatory authority by the Electricity Law of 2009. PERC will play a key role in the dissemination of prioritized technologies in the energy sector being the authority with the responsibility of reviewing and monitoring tariff applications, and issuing licenses for electricity generation. PERC is tasked to provide the enabling environment for the dissemination of these technologies, especially for renewable energy and solar applications, ensuring that investments in them makes business sense for investors, and that procedures for obtaining the necessary licenses are not onerous. For smaller-scale actions and programs such as solar roof-top generation, incentives such as net-metering should be enforced to allow for the sale of surplus energy back to the distribution grid. Additionally, with PERC being tasked with dissemination information and increasing public awareness regarding renewable energy, its role will further inform stakeholders with appropriate knowledge to enhance their decision-making toward renewable energy.
Ministry of Public Works and Housing	The Palestinian Ministry of Public Works and Housing (MOPWH) is the main government entity responsible for the building and construction sector. It holds the responsibility of setting up the legal, institutional, economic and financial framework of the sector's development. For the implementation of energy efficiency technologies and measures in the sector, MOPWH holds the responsibility in the development of regulations and standards that would promote these measures such as setting conditions for issuance of new building licenses and setting standards in building codes.

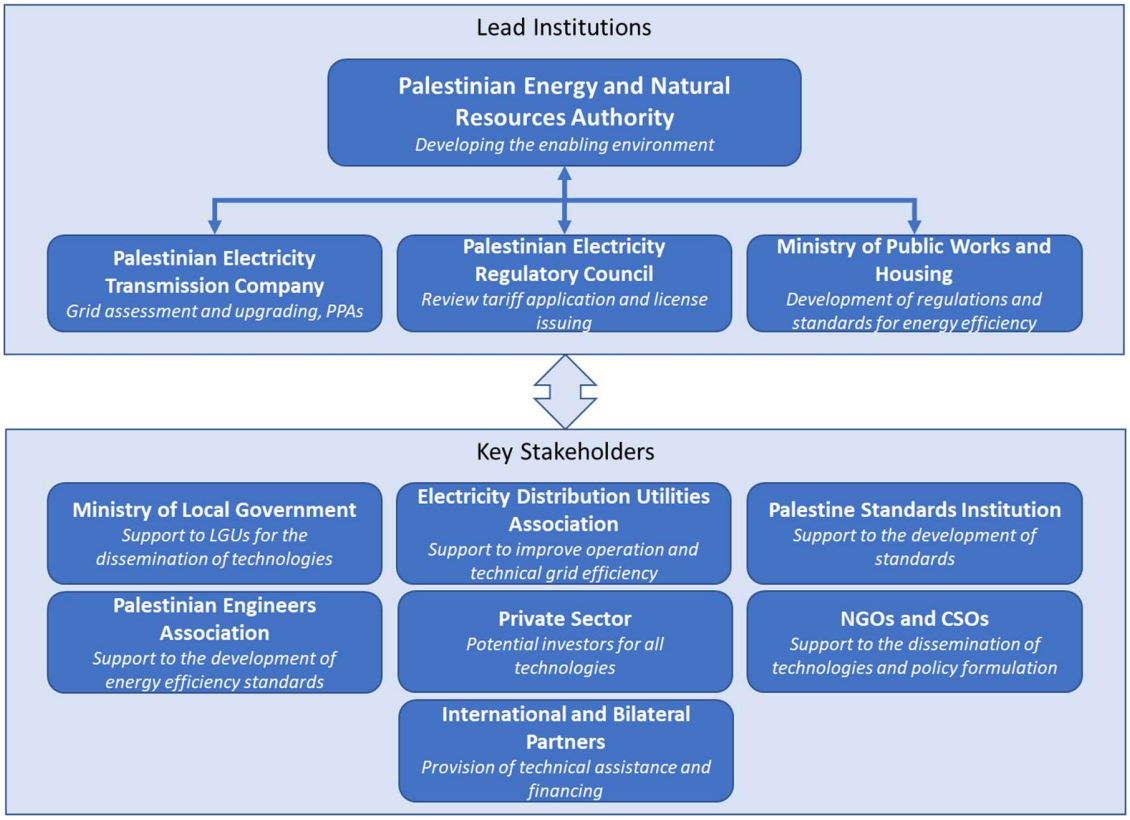
The following key stakeholders were also identified which would play major roles in the implementation of prioritized technologies under the energy sector, as well as supporting lead institutions:

Table 8: Key Stakeholders in the Energy Sector

Key Stakeholders	Description
Ministry of Local Government	The MOLG is responsible for ensuring that local government units have the ability and tools to take actions in meeting strategic objectives. MOLG will play a critical role in ensuring that local governments have the resources necessary, financially and technically, to implement and disseminate prioritized technologies in the energy sector.
Electricity Distribution Utilities Association	Distribution utilities in Palestine plays a key role in achieving PENRA's objective to increase their operational and technical efficiencies through end-use energy efficiency, energy conservation, better load management and diversification of electricity supply sources.
Palestine Standards Institution	The Palestine Standards Institution (PSI) aims to facilitate trade and investment in Palestine by meeting the metrology, standards, testing and quality related needs of the business community while ensuring consumer and environmental safety. PSI will play a key role in establishing standards and testing facilities in the sector.
Palestinian Engineers Association	The Palestinian Engineers Association (PEA) has developed the National Green Building Guidelines. This sets the framework for a national green building code which promotes energy efficiency in buildings and use of environment-friendly and energy efficient materials. It aims to improve architectural quality of infrastructures with reduced energy consumption. Although the guidelines are not mandatory, this could be built upon for the development of a legal framework. As such, PEA plays a key role in the implementation of energy efficiency actions.
Private Sector	Private sector actors in the energy sector includes potential investors for small-scale to large-scale renewable energy generation, public-private partnership with the government, independent power producers, distribution companies, system designers and manufacturers of technologies. These stakeholders play an important role in improving the energy sector, and will be instrumental in the implementation of the prioritized technologies and its dissemination.
NGOs and CSOs	Non-governmental organizations and civil society organizations relevant to the energy sector in Palestine will be key to the implementation of prioritized technologies. Their engagement and participation will be important for activities in the implementation plan such as policy formulation. They also may provide financial resources for the implementation of activities under the roadmap.
International and Bilateral Partners	Plays a key role as partners to the Palestinian government in providing support in consideration of the country's limited resources. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the energy sector is illustrated in Figure 1.

Figure 1: Energy Sector Institutional Framework



3.1.3. Objectives and goals of the sector

The State of Palestine intends to reduce 24.4 percent of its GHG emissions by 2040 relative to business-as-usual (BAU) under an independence scenario conditional to receiving international support, or 12.8 percent by 2040 relative to BAU under a status quo scenario. Under Palestine's NDC, the energy sector is considered the main sector that will contribute to achieving these targets.

The NDC enumerates mitigation actions in the energy sector to be implemented conditional on receiving international support. This includes the generation of 20 - 33 percent of electricity using solar photovoltaic technologies, energy efficiency measures in buildings by developing existing regulations and building standards, use of municipal solid waste as fuel substitute for coal in cement production, waste to energy generation, use of landfill gas for power generation, energy efficient lighting, as well as other energy sector related adaptation actions such as upgrading the national grid system to improve resilience of the sector.

Specific to energy efficiency, the Palestinian National Energy Efficiency Action Plan (NEEAP) for 2020 – 2030 has set a reduction target for total electricity consumption of 500 GWh each year, or 5,000 GWh total, for the 10-year timeframe. This target is more ambitious than the target set for the previous NEEAP 2012-2020 which was 43 GWh per year, or 384 GWh total for the time period.

The implementation of the prioritized technologies under the energy sector will therefore greatly contribute to achieving its goals. The technology roadmap for the sector will focus on establishing an enabling environment for the prioritized technologies to be deployed and up-scaled, and for the private sector to be heavily engaged.

3.1.4.Technologies overview

The technologies prioritized under the energy sector are the implementation of a national grid assessment and electricity grid system upgrade, various solar PV technologies, energy efficiency technologies and measures, and solar water heating.

3.1.4.1. National Grid Assessment and Electricity Grid Upgrade Technologies

Palestine has growing demand in electricity as population and living standards in the country continue to increase. However, its energy infrastructure is significantly old and has been degrading, causing challenges in providing reliable supply of energy. Currently, more than 20 percent of grid electricity is being lost through technical inefficiencies, transmission loss, and illegal connections. Therefore, there is a clear need for Palestine to upgrade its electricity infrastructure to add resilience to its electric grid system. This would allow for improved reliability in energy supply, improved efficiency of delivery reducing overall losses, integration of diversified energy sources such as from renewable energy, and better preparedness to respond in cases of emergencies.

There are various types of available technologies associated with upgrading the electricity grid system. The consideration on the applicability of these technologies in the Palestinian context will depend on a thorough assessment of its needs.

To meet the current Palestinian needs from a technology perspective, upgrading its national grid system in terms of infrastructure improvements is essential. Currently, PETL is managing the national grid system with four connection points with IEC. It has streamlined its operations by reducing the previously large number of low- and medium-voltage connection points directly with distribution companies, municipalities and village councils. However, the existing electricity network is old and connection points are saturated. It cannot efficiently accommodate high voltage electricity supplied by the IEC leading to power cuts during peak load conditions. Upgrading of the Palestinian electricity grid system will therefore entail building additional infrastructure to accommodate higher capacities from imports and in-country generation. This will lead to increased electricity supplied to the country, increased diversification of supply, and reduced losses.

Upgrading the national electricity network will mainly involve the development of transmission infrastructure. Specific to the needs of Palestine, this includes the installation of high-voltage 161 kV transmission lines and 161kV/33kV substations to improve overall transmission and regional interconnection. This also includes the rehabilitation of existing distribution networks and expansion of distribution networks to support connection points with high-voltage transmission.

Advancements in grid technologies, specifically the concept of smart grid, can also be integrated as part of the electricity grid upgrading. Although definition of smart grid varies across geographies and regions, the general concept entails the modernization of electricity grids. In the Palestinian context, smart grid can be defined as integrating modern power system technologies into its electricity network. This involves the use of information and communication technologies (ICT) and electronic power systems which allows for the sustainable management of the grid. This results in improved operations, reduced costs, enhanced efficiency, reliability and security, enhanced markets, increased integration of renewable energy and enhanced regional interconnectivity. Different components of smart grid and associated technologies are enumerated in Table 9.

Table 9: Smart-Grid Technologies

Technologies	Description
Smart grid components in monitoring and control	
Distribution Automation	Monitors the status of distribution networks in real time and controls

System	electrical switching devices remotely. Major functions include (i) automatic fault detection and remote recovery of distribution lines; (ii) real-time data acquisition; (iii) remote control and monitoring of switches; and (iv) load balancing of distribution networks using modern technologies.
Wide Area Monitoring System	Support system stabilization to avoid system outages, coordinated voltage regulation, and oscillation damping. Phasor measurement units and synchrophasors are used to improve power system reliability and assessment of performance. Time-stamping through phasor measurement units allows measurements from different locations and utilities to be synchronized and combined, providing a precise and comprehensive view of the entire interconnection. Synchrophasor measurements can be used to indicate grid stress, and can be used to trigger faster corrective actions in emergency situations.
Flexible Alternate Current Transmission System	Based on power electronics technology developed to control power flow flexibly and quickly to ensure optimal flow, quality, and reliability of power supply.
Smart grid components in renewable energy	
Weather Forecasting Systems	Renewable energy sources such as solar and wind are intermittent in nature. Predicting their availability is important in optimal usage of resources. Commercial off-the-shelf solutions in advanced power and weather modeling are available, which help in effective integration of renewable energy sources. These solutions deploy cameras, sensors, imaging techniques, and computer-based data and analytics systems to forecast availability of renewable sources and calculate amount of renewable energy that can be generated.
Energy Storage System	Battery solutions is an energy storage system used to (i) regulate the power supply frequency by balancing power supply and demand, (ii) store renewable energy, and (iii) manage capacity by shave or shift peak.
Simulation Systems	Simulation systems in national or regional control centers help in forecasting, controlling, and monitoring renewable energy generation including fluctuation of system parameters such as voltage and frequency.
Distributed Generator Monitoring and Control	Minimize problems in evacuation of renewable energy, in particular solar photovoltaic and wind energy due to transmission congestion, lack of transmission access, and excess supply during low load periods by sending signals in real time to renewable generators via supervisory control and data acquisition (SCADA).
Smart grid components in demand side management	
Advanced Metering Infrastructure	Utility companies are able to implement a variety of load reduction and energy saving programs, reduce cost of providing electricity, and provide significant operational and efficiency improvements. Advanced metering infrastructure comprises smart energy meters that can measure two-way power flow, energy usage with time of use, and other system data; communication networks that transmit meter data to the utility; utility information management systems that process the transmitted data; and features to transmit pricing and energy information from the utility company to the consumer.
Building Energy Management Systems and Factory Management Systems	Building energy management systems are computer-based systems used in managing the electrical appliances and equipment used in commercial buildings. Factory management systems are next-generation energy management systems that manage and control energy in a factory both on the supply and consumption side by maximizing the benefits of distributed cogeneration using renewable and natural gas resources. It also utilizes ICT and sensing technologies for visualizing waste generated by facilities,

	information sharing, and implementing improved productivity through operation-rationalization and labor saving.

Source: Asian Development Bank[1]

3.1.4.2. Various Application of Solar PV Technologies

Palestine has over 3,000 sunshine hours per year and Global Horizontal Irradiance (GHI) over 2,000 kilowatt-hours per meter squared, with the West Bank and Gaza ranking amongst the world's top locations for construction of solar systems[2]. In addition, amongst the available renewable energy sources, solar energy provides Palestine with the opportunity to produce electricity to enhance its energy independence, which decreases its reliance on imported fuels. This makes implementation of solar energy technologies suitable for Palestine. However, the extent of this opportunity will be dependent on access to lands in Area C and implementation of the grid assessment and upgrade. These solar technologies include, solar water heating, efficient irrigation supported by solar water pumps, and solar panels. Currently, solar water heating is already a proven technology in Palestine with wide use of the technology in the residential sector, while limited use in the service and industrial sectors. Additionally, there already exist local manufacturers in Palestine. While solar water heating is highly related to the application of solar technologies, it will be further detailed in a separate section.

In the Palestinian context, the dissemination of small- to medium-scale grid connected photovoltaic power systems present viable short- to medium-term solution to the sustainable development of its energy sector. With Palestine's heavy reliance on imported energy sources from neighboring countries, its economy is burdened due to the electricity insecurity and vulnerability to fluctuating tariffs that this condition brings. At the same time, development of utility-scale solar PV power plants imposes limitations for the Palestinian Authority due to shortage of accessible open land which are mainly in Area C. Under these conditions, the development of grid connected solar PV technologies on available areas such as rooftops of buildings make perfect sense. Rooftop solar PV systems can result in significant savings in cost of electricity for the building implementing the technology and provide lower cost of electricity for distribution utilities by selling excess generated electricity. Nonetheless, the development of larger utility-scale solar power generation plants should remain as a long-term goal for Palestine.

The main components of grid connected solar PV power systems comprise of solar PV modules to absorb sunlight and convert it to electricity, inverters to convert direct current (DC) electricity generated by the PV modules into alternating current (AC) electricity, mounting systems which secures PV modules in place and held at optimal position, and means to monitor and measure system performance.

Solar PV module technologies are commercially available and broadly categorized as crystalline silicon modules and thin film modules. As of 2017, crystalline silicon modules were the most widely used PV technology covering 80 percent of total global market, while thin film modules having a market share of 17 percent, with the remaining 3 percent utilizing more advanced higher efficiency concepts. Table 10 describes commercially available technology options for solar PV modules.

Table 10: Solar PV Module Technologies

Solar PV Cell Technologies	Description
Crystalline Silicon (c-Si) PV Modules	Modules consist of PV cells connected together and encapsulated between a transparent front (usually glass) and a backing material (usually plastic or glass). C-Si provide high-efficiency solar cells. Its commercial efficiency is typically in the range of 13 to 21 percent. Modules are made from cells of

[1] Asian Development Bank. *ADB Sustainable Development Working Paper Series No. 42: Outlook for Increased Adoption of Smart Grid Technologies in ADB Energy Sector Operations*. 2016.
[2] Securing Energy for Development in West Bank and Gaza, World Bank, 2017

	either mono-crystalline or multi-crystalline silicon. • Mono-crystalline silicon (mono-c-Si) wafers are sliced from a large single crystal ingot in a relatively expensive process. • Multi-crystalline silicon (multi-c-Si) wafers are made from a variety of methods and is currently cheaper than mono-c-Si, but is generally not as efficient.
Thin Film PV Modules	Modules are made with thin-film deposition of a semiconductor on a substrate. Thin film cells are typically cheaper in comparison with c-Si due to both materials used and simpler manufacturing process. However, thin film cells are relatively less efficient than c-Si modules. Thin film technology options are as follows: • Amorphous silicon (a-Si) is a well-developed thin-film technology using silicon in its less-ordered, non-crystalline (amorphous) form. A-Si can be deposited on a wide range of both rigid and flexible low-cost substrates. Its low cost makes it suitable for applications where low cost is more important than high efficiency. Efficiency range is about 6 to 9 percent. • Cadmium telluride (CdTe) is a compound of cadmium and tellurium, and consists of a semiconductor film stack deposited on transparent conducting oxide-coated glass. It produces high energy output across a wide range of climatic conditions with good low light response and temperature response coefficients. Efficiency range is about 8 to 16 percent. • Copper Indium (Gallium) Di-Selenide (CIGS/CIS) is a compound of copper, indium, gallium and selenium. Commercial production is in the early stages of development. However, it has the potential to offer the highest conversion efficiency of all the thin film PV module technologies. Efficiency range is about 8 to 14 percent.
Heterojunction with intrinsic thin-film layer (HIT)	Modules are composed of a mono-thin c-Si wafer surrounded by ultra-thin a-Si layers. HIT modules are more efficient than typical crystalline modules, but they are more expensive. Its commercial efficiency range is around 18 to 20 percent.

Source: IFC[3]

Improvements in solar PV module technologies are currently being developed and explored. Improvement approaches are generally focused on improving module efficiency and reducing manufacturing costs. These include incremental improvements on existing technologies such as for c-Si cells and thin film modules, stacking or multi-junction of different cell types for better performance across a wider range of solar spectrum, and other emerging technologies not yet market-ready but could be of commercial interest in the future such as spherical cells, sliver cells and dye-sensitized cells.

Inverters are solid state electronic devices which convert the variable DC electricity generated by the PV modules into a utility frequency AC electricity that can be used to power appliances, lighting, and other electricity-based equipment in buildings and homes. If electricity produced is more than the electricity

[3] International Finance Corporation. *Utility-Scale Solar Photovoltaic Power Plants: A Project Developer's Guide*. 2015.

needed, it can be fed into the grid. Inverters can also perform a variety of functions to maximize the output of the plant. These range from optimizing the voltage across the strings and monitoring string performance to logging data and providing protection and isolation in case of irregularities in the grid or with the PV modules.

Mounting systems for PV modules provide structural support and protection, and ensure optimal orientation for maximized irradiation reception. Technology options for solar PV mounting systems include fixed mounting systems and tracking systems. Fixed mounting systems keep the rows of modules at a fixed tilt angle while facing a fixed angle of orientation. Fixed mounting systems are inexpensive and requires less maintenance compared with tracking systems. Tracking systems on the other hand, employs moving parts which allow solar PV modules to follow the sun as it moves across the sky. This increases the total irradiation that the solar power system receives. Depending on site characteristics, tracking systems may increase the annual energy yield of solar PV systems by up to 27 percent if single-axis tracking is employed, and up to 45 percent for dual-axis tracking. The use of tracking systems entails higher financial and operational costs.

Eventually, solar PV panels will reach the end of its useful life. The average lifetime of solar PV panels is about 30 years,[4] and it is expected that as the market for solar PV grows, proportionate amount of waste should be anticipated from decommissioned solar PV panels. If left unchecked, the growing PV panel waste will present new environmental challenges. Therefore, the end-of-life management of solar PV panels is crucial.

In most countries, decommissioned solar PV panels are classified as general or industrial waste, with the exception of the EU. The EU has pioneered a regulation wherein PV is defined as electronic waste under its Waste Electrical and Electronic Equipment (WEEE) Directive.[5] The WEEE binds all manufacturers of solar PV panels to the EU market, regardless of where they are based, to finance the costs of collecting and recycling end-of-life PV panels put on the market in Europe. This could serve as reference for Palestine in potentially developing its regulatory framework in managing solar PV waste in the long term.

As with most countries, Palestine should consider end-of-life management of solar PV panels linked with its solid waste management approaches, which has its implementation plan as part of this technology roadmap under the solid waste sector. Silicon based solar PV modules typically consist of 76 percent glass, 10 percent plastic, 8 percent aluminum, 5 percent silicon and 1 percent metals. Thin-film based solar PV modules typically consist of 89 percent glass, 6 percent aluminum, 4 percent plastic and 1 percent metals. The inclusion of end-of-life solar PVs under Palestine's solid waste management implementation plan, specifically on waste sorting and recycling, has the potential to serve as new source of raw materials. The recovered materials from solar PV waste could be used to produce new solar PV panels, or other new products, opening the opportunity for a solar PV value chain to be developed.

3.1.4.3. Energy Efficiency Technologies

Achieving energy efficiency in Palestine is extremely important as the country is almost completely dependent on imported energy products. In 2013, Palestinian dependence on Israel constituted 89 percent of total electricity consumption, and to a lesser extent, 4 percent from Egypt and Jordan. In Palestine, buildings consume approximately 43 percent of the total energy consumption per year and this is expected to double by 2020. Additionally, building and construction is the fastest growing sector in Palestine, with 2,585 building licenses issued in the last quarter of 2017 in the West Bank. This highlights the importance in generating and consuming energy efficiently through adopting energy conservation and reducing losses

[4] International Renewable Energy Agency. *End-of-life management: Solar Photovoltaic Panels*. 2016
[5] European Environment Agency. *Waste electrical and electronic equipment (WEEE) Directive 2012/19/EU*. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:EN:PDF

and consumption, which is a key mitigation action for the sector.

Energy efficiency technologies prioritized for Palestine includes the implementation of energy efficiency measures to reduce consumption mainly from commercial and industrial use. This includes building standards on thermal efficiency and energy efficient lighting identified as priority mitigation and adaptation actions under the NDC. There are various energy efficient technologies which are applicable to the building and construction sector of Palestine, including energy efficient heating, ventilation and air conditioning systems, energy efficient insulation such as for walls, windows and doors, efficient lighting, and control systems such as thermostatic valves to allow for more effective thermal balance and IT systems for managing energy consumption. Table 11 describes energy efficiency technology options which could be applied in Palestine's building sector.

Table 11: Energy Efficiency Technologies in the Building Sector

Energy Efficiency Technologies	Description
Efficient Heating, Ventilation and Air Conditioning (HVAC) Systems	Space heating and cooling demands in buildings are usually covered by air-conditioning and heating systems. These include, but not limited to the following. • **Air-sourced heat pump systems** are the commonly used HVAC systems in Palestinian buildings. The system circulates refrigerant between an outdoor unit and an indoor unit (split units) to heat rooms during winter and cool during summer. There is still room for improvement in employing this technology through the use of higher energy efficiency rated equipment and using centralized temperature control systems. • **Ground-sourced heat pump systems**, also known as geothermal heat pumps (not to be confused with geothermal power generation) transfers heat to or from stable, even temperature of the ground or water to provide room air-conditioning or heating. Several pilot projects [6] using this technology has been conducted in Palestine[7], to demonstrate its feasibility. • **Gas (LPG) room heating** is a technology considered under the Palestinian National Energy Efficiency Action Plan for 2020 – 2030 to replace electric room heaters in residential houses and new buildings. The strategy involves the promotion of solar water heater use as far as possible, and promote the use of gas (natural gas or LPG) for central heating to suppress electric room heaters.
Efficient Building Envelope	Refers to the walls, windows, roof and flooring/foundation of a building forming the primary thermal barrier between the interior and exterior environment. It is a key factor on how much energy is required for heating and cooling, as well as influence passive energy efficiency measures such as allowing natural lighting and ventilation. Main technological considerations for building envelope components are as follows. • **Insulation** – heat lost from buildings mostly come through

[6] MENA Geothermal Website, Featured Projects. https://www.menageothermal.com/index.php?TemplateId=2&Lang=en
[7] Khaled Al Sabawi. *First geothermal system in Palestine*. 2009. https://www.eceee.org/static/media/uploads/site-2/library/conference_proceedings/eceee_Summer_Studies/2009/Panel_7/7.047/paper.pdf

	walls, roofs and floors. Proper insulation reduces heat loss during cold weather and prevents excess heat in hot weather maintaining comfortable indoor environment. Commercially available insulation products such as fiberglass and various foams with thermal conductivity greater than 0.02 W/mK have an established market and can be used for retrofits and new buildings. More advanced, higher-performance technologies include aerogel insulation which offers greater benefits for space constrained applications, vacuum-insulated panels achieving high system performance and longer life, and phase change materials integrated with other insulating materials to achieve higher thermal performance. • **Air sealing** – for most buildings requiring heating and cooling, tight air sealing with proper fresh air ventilation is essential in achieving higher energy savings. Air sealing solutions for buildings include sealants, membranes, spray foams and sheathings. • **Windows** – energy efficiency of windows depends on the overall design such as fixed or operable, and individual components including framing material, glazing, coating, and spacers between panes of glass. The main technology used in high-performance windows is the low emissivity (low-e) coating applied to glasses and thin films minimizing the amount of ultraviolet and infrared light passing through the glass without compromising the amount of visible light that is transmitted. Windows can provide higher insulation by using multiple panes and glazing. Although, additional layers of glazing beyond two usually are less cost-effective.
Efficient Lighting	Efficient lighting technologies have matured and have recently been made more affordable. For example, incandescent and halogen light bulbs are being replaced by more efficient lighting technologies. • **Compact fluorescent lighting (CFL)** consumes only about 25 percent of electricity to produce the same amount of illumination as with incandescent bulbs, lasting about 4 times longer. • **Light emitting diode (LED)** lighting technologies increase efficiency further by consuming only around 10 percent of electricity compared with incandescent, lasting even longer at around 25 times. • **Infra-red detectors** can further improve energy efficiency to automatically detect presence in the room and correspondingly switch the lights on when in use and switch off when the room is empty.

Source: Various

3.1.4.4. Solar Water Heating Technologies

Solar water heating systems is already a proven technology in Palestine. It is extensively used in the

residential sector, while limited in the service and industrial sectors. This technology is highly relevant in the Palestinian context as most of the electricity is supplied from external sources which the country has no control of, and thus fetch high costs, the most expensive compared with other countries in the region. As of 2015, solar water heaters are installed in 56.5 percent in households. However, a significant proportion is out of order, about 46 percent of SWH installed[8]. As such, electricity is used as the main source of energy for heating water. With Palestine possessing high potential for solar energy, and the fact that the solar water heating technology is not constrained by the country's limitation on electricity supply, there is high rationale in prioritizing this technology. Additionally, there exist local manufacturers for solar water heating systems in Palestine.

Solar water heater system is a solar thermal technology which collects the sun's energy to heat up water. It can be characterized as either direct wherein the water to be used is heated directly, or indirect wherein other heat transfer fluids are heated instead and heats the water to be used via separate heat exchanger. It can also be categorized as either a passive system wherein heat transfer is facilitated passively without using electric powered pumps to circulate fluid, or an active system which uses electricity to operate mechanical pumps and control systems.

A solar water heating system usually incorporates a solar thermal collector typically mounted on rooftops of buildings connected to a water storage tank through piping system. The solar thermal collector is the integral component of any solar water heating system which concentrates the sun's rays to create heat used to produce hot water. Technological considerations on the different types of commercially available solar thermal collectors are shown in Table 12.

Table 12: Solar Thermal Collector Technologies

Solar Thermal Collector Technologies	Description
Flat Plate	Most common type of solar thermal collector due to its simple design, relatively low cost and easier installation and operation compared with other forms of water heating systems. Solar flat plate thermal collectors usually consist of a heat absorbing plate made of copper or aluminum sheet with blackened surface to absorb more heat, and risers made of copper pipes or tubes aligned parallel and runs the length of the plate where the heat transfer fluid (water or anti-freeze) passes through. The absorber plate and piping are enclosed in insulated box made of metal or wood, and a sheet of glazing material made of glass or plastic which allows the sun's heat to pass through while preventing it from escaping back (greenhouse effect). • **Thermosyphon system** – most common and commercially available passive direct solar water heating system. It is an open-loop system which uses natural force of gravity and convection to circulate water around, and does not need mechanical pumps or control mechanisms to operate. It consists of a solar flat plate collector combined with a storage tank mounted above the collector. The heated water from the collector rises naturally using convection through the pipes and enters the storage tank placed higher than the collector. As the heated water rises and enters the storage tank, cooler water flows downward to the bottom of the collector. This thermosyphon cycle recurs as long as the system is receiving solar radiation. • **Closed-loop system** – an indirect solar water heating system using heat transfer fluid such as anti-freeze solution which is circulated in a closed-loop system instead of water that is to be used. The heat transfer fluid is

[8] *The Palestinian National Energy Efficiency Action Plan for 2020 – 2030*. 2016

	passed through the solar thermal collector which absorbs the heat, to a heat exchanger in the water storage tank which in turn, heats the water. The heat transfer fluid is circulated in the closed-loop system using a mechanical pump. Advantages of this system include higher efficiency compared with thermosyphon system, operates in areas with temperatures below freezing, protection of the system from corrosion from untreated tap water, and storage tank can be placed anywhere (does not need to be higher than the collector). On the other hand, it is dependent on electricity for operation of the circulating pump and the system fetches higher cost.
Evacuated Tube	More modern and efficient solar thermal collector compared with standard flat plate collectors. It consists of rows of parallel transparent glass tubes connected to a header pipe. Each tube consists of a double-walled glass tube with air removed or evacuated from the space in-between creating a vacuum. The vacuum insulates the system significantly reducing heat loss and making the system more efficient, producing higher fluid temperatures for heating water. Another design feature of evacuated tube collector which makes it more efficient is the cylindrical shape of the glass tubes. Due to the cylindrical surface, the angle of sunlight is always perpendicular to the heat absorbing tubes, unlike its flat plate counterpart which only operates at maximum efficiency when the sun is directly perpendicular to the flat surface. This allows the evacuated tube collector to operate at higher efficiency, generate higher temperature, and perform well even when sunlight is low such as during early morning or late afternoon, or when shaded by clouds. Other design variations of evacuated tube collector technologies are as follows: • **Heat pipe evacuated tube collector** – consists of a sealed copper heat pipe attached to a heat absorbing reflector plate within the vacuum sealed tube. The copper heat pipe is evacuated of air creating vacuum, and contains small quantity of low-pressure alcohol liquid (with additives to prevent corrosion or oxidation). The vacuum allows the liquid to vaporize at very low temperatures when solar radiation hits the absorber plate inside the tube. The high temperature gas vapor rises up to the top portion of the heating pipe where it is connected to a heat exchanger which heats up the water or heat transfer fluid flowing through. As the vapor cools during the heat exchange, it condenses back to liquid flowing back down the heat pipe to be reheated. This cycle continues as long as there is solar radiation. Heat pipe evacuated tube collector's design is modular, meaning that individual tubes can be replaced without dismantling the entire system. • **Direct flow evacuated tube collector** – also known as "U" pipe collector. It consists of a copper heat pipe running through the center of the evacuated glass tube forming a U-bend. One end of the pipe acts as the flow pipe while the other end acts as the return pipe. The absorber plate and heat tubes are also vacuum sealed inside the glass tube providing exceptional insulation properties. It is generally considered that direct flow evacuated tube collectors are more energy efficient than heat pipe evacuated tube collectors due its design to direct heat water (without heat exchange of fluids). However, it lacks the flexibility of its heat pipe counterpart wherein if a tube breaks, it cannot be easily replaced.
Integral Collector Storage	Combines the solar collector and storage tank within a single roof-mounted unit. Also known as ICS or batch system, it is very similar in design and operation as with the flat plate collector system. The main difference is that in an ICS, the heat tubes inside the insulated glazed box have significantly larger diameter, functioning as storage tanks integrated within the collector. This design makes ICS one of the simplest solar water

	heating systems as heat collection and water storage is combined in one unit. At the same time, similar to passive flat plate systems, it does not require the use of circulation pumps or electronic control. This makes ICS less expensive compared with other solar water heating systems. However, as ICS and batch systems combine collector and storage together in one system, it forms a large mass of fluid to be heated by the sun which results in lower efficiency, higher heat loss, no freeze protection in cold weathers, and major issues on weight which needs to be taken into consideration.

Source: Alternative Energy Tutorials[9]

3.1.5.Barriers overview

The energy sector faces the following barriers for the dissemination of prioritized technologies in the sector:

Table 13: Barriers in the Energy Sector

Type of barrier	Summary
Political	Lack of access to energy sources / energy generation, limitations in grid integration
Regulatory	Lack of concrete measures related to improving the grid, PETL's capacity in off-taking renewable energy is unknown, no mandatory standards for energy efficiency in buildings and no clear standards for green buildings, no regulations to support integration of solar water heating into buildings
Institutional	Sectoral fragmentation
Technical	Lack of technical capacity and know-how on grid O&M, upgrading assessment, and effectively designing and installing advanced solar water heating systems
Financial	Lack of financial sources, high initial investment costs, perceived risk by investors too high
Geographical	Limitations in land use
Market	Limited market for local producers
Information	Lack of adequate information about potential technologies
Behavioral	Habits and routines may be difficult to change

The introduction of the prioritized technologies in the energy sector is limited by several barriers including political, regulatory, institutional, technical, geographical, financial, market, information, and behavioral. The political barrier is related to access to energy generated, including from renewable energy sources. This limits implementation and connection of electricity produced from renewable energy sources such as solar technologies to the grid connected with the Israel side. This is posed by the Israel Electric Corporation who has high expectation related to the stability of renewable energy and integration to the grid.

On regulatory barrier, there are technology-specific barriers identified including the lack of identification of measures within the existing regulation on how it will achieve the grid system upgrade. For the deployment of various solar PV technologies, PETL is responsible for the offtake of power and providing transmission infrastructure in the West Bank. However, as of 2017, PETL has yet to fulfil either of these roles. For energy efficiency, a barrier exists related to the lack of mandatory building and construction codes and standards for energy efficiency in buildings and green buildings. For solar water heating technologies, although this

[9] http://www.alternative-energy-tutorials.com/solar-hot-water/solar-hot-water.html

can serve as stand-alone projects, there is a lack of regulation which allows for the integration, either voluntarily or mandatorily, of solar water heating technologies in the design, planning and construction of new infrastructures such as buildings.

Institutionally, the current set up is fragmented as responsibilities of electricity distribution differ in Gaza, and the southern and central West Bank from that of northern West Bank.

There is also a lack of technical capacity and know-how for key stakeholders in the sector. Currently, the grid network is maintained poorly due to lack of capital to enhance technical skills, resulting in electricity losses and network outages. This is not limited to regular maintenance but also on performance of pre-assessment and feasibility studies required for the grid upgrade work. For solar water heating technologies, there is a lack of technical capacities for larger and technologically advanced installations in Palestine.

Financially, the implementation of prioritized technologies under the energy sector is associated with high initial investment requirements. Palestine lacks in financial resources and will need external support to finance these technologies. In addition, due to high perceived risks by potential investors, driven by political tension between Palestine and Israeli Occupation, there is little room or interest for private sector involvement.

Geographical barrier is specific to large-scale solar PV technologies. Area C is considered to be the most suitable location to install large-scale solar PV power plants. However, obtaining construction permits for the area is restricted as this requires permission from Israel. Solar PV technologies, such as solar panels, require significant land space.

The current market size is also too small to accommodate and drive enough businesses for technology providers, local manufacturers, service companies, among others, especially for smaller-scale solar technologies such as solar rooftop PVs and solar water heating.

Finally, there is a lack of general awareness and information regarding technologies which could improve the sector's development. In addition, consumers and end users are often poorly informed about market conditions, technology characteristics and their own energy use. This also leads to behavioral barrier in which particular habits and routines make it challenging to change.

3.1.6.Implementation Plan

The successful implementation of the prioritized technologies for the energy sector will help achieve the country's objectives for the sector, meeting its NDC goals, and achieve a low-carbon and sustainable growth. The implementation of a national grid assessment and electricity grid upgrade will greatly contribute to meet the growing demand of Palestine for electricity. It will also allow for the integration of renewable energy sources into the grid system, contributing to meet the country's renewable energy generation mix. The implementation of various solar PV technologies will meet the country's target of 20 - 33 percent of electricity generation coming specifically from solar PV technologies. The implementation of energy efficiency technologies and measures will greatly contribute in achieving the State of Palestine's National Energy Efficiency Action Plan which aims at an annual energy savings of 500 GWh from overall electricity demand. The implementation of solar water heating technologies will likewise contribute to meeting the country's mitigation and adaptation targets in the energy sector relating to conserving energy and efficiently using electricity. Collectively, these prioritized technologies will greatly contribute to meeting Palestine's energy needs and at the same time, contribute to meeting the country's mitigation goal of reducing 24.4 percent of its GHG emissions by 2040 relative to business-as-usual under an independence scenario conditional to receiving international support, or 12.8 percent by 2040 relative to BAU under a status quo scenario.

An increased, more reliable energy supply will have life-altering benefits for women and for Palestinians whose livelihoods - and sometimes even lives – depend on steady electricity supply. It is expected that household chores, normally performed by female members of the family, will be accomplished more

efficiently, leaving time for women and girls to pursue educational, work-related, social or leisure activities. For the infirm, elderly or those requiring urgent medical attention, a steady supply of electricity may be necessary to meet their health needs, possibly also decreasing the burden on their caregivers who would most likely be women. For those whose income depends on electricity – a requirement of most occupations, no matter who they are held by and including the home-based businesses typically owned by women - a strong correlation between a reliable supply and increased productivity and therefore income, would be expected. Additionally, the use of solar and energy efficiency technologies is expected to ease the financial burden on households resulting from the use of more expensive energy sources, possibly enabling families to be more resilient towards climate change.

To achieve these objectives, a roadmap for the deployment of prioritized technologies for the energy sector needs to be developed with actions, measures and timelines defined. The timeline for its implementation should be in line with the country's national priorities and defined targets under its NDC. The implementation action and measures for the energy are proposed as follows:

Action 1.1 – capacity building and awareness raising for grid upgrading

Building the capacity and awareness of the relevant stakeholders such as government institutions, potential investors, developers, end-users, and financial institutions, will enable both short-term and long-term actions to be implemented efficiently. It is crucial that government institutions which have authority over the grid system have in-depth understanding and know-how to be able to develop relevant policies and standards associated with upgrading the grid and its operations. At the same time, stakeholders that would be beneficiaries of the grid upgrade such as power producers (gas and renewable), distribution companies, energy technology providers, and end-users need to have a strong understanding and awareness on the benefits of implementing the upgrade.

Activity 1.1.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions with responsibilities over the national grid, specifically, PETL. This would allow PETL to better and efficiently fulfill their role as the national entity tasked to build, own and operate the Palestinian electricity transmission system. This would also allow them to make informed decisions to design grid and transmission related policies such as regulations and standards to improve market conditions.

Activity 1.1.2 – Technical capacity building – to enhance the technical capacity of relevant government institutions responsible for the transmission and distribution of electricity, specifically, PETL. This would allow them to build technical know-how on the upgrading, operation and maintenance of the grid system. This includes technical understanding of the grid system to allow for the diversification of electricity supply, both from conventional and renewable generation, and from internal and external sources. Increased technical capacity for PETL will lead to reduced losses in the electricity system thereby, improving the overall efficiency in providing electricity services and maximization of energy resources.

Activity 1.1.3 – Awareness raising – to raise energy sector stakeholders and general public awareness. The successful implementation of upgrading the national electricity grid system will establish the enabling environment for the growth of the energy sector. This will pave the way for the mobilization of private sector investments in the sector, making renewable energy power generation a viable and attractive option for investment. It is important that key stakeholders in the energy sector are made aware of the interventions and de-risking measures being undertaken by the government in the form of grid upgrading, to be able to take advantage of the opportunities being presented to them.

Entity-in-charge: The implementing entity for the overall capacity building and awareness raising actions is proposed to be spearheaded by PETL.

Costs: The costs associated with the implementation of this action is estimated at USD 250,000 which involves conducting workshops and trainings, engaging international experts, and deploying public

awareness materials.

Action 1.2 – national grid assessment

A detailed assessment of Palestine's national grid system for its potential upgrading will help identify the current status of the grid system, identify its needs to provide efficient transmission and distribution of electricity in line with the sector's strategies, plans and targets, and identify potential systems and areas suitable for infrastructure upgrade.

Activity 1.2.1 – Feasibility study – to conduct a detailed feasibility study for the practical implementation of electricity grid system upgrade in Palestine. The study will include information on the latest and advanced grid system technologies available which fulfills the need of the Palestinian electricity system to enhance reliability, efficiency and resilience. It will also include detailed design and implementation plan on the system upgrade. This will require significant external support and international expertise.

Activity 1.2.2 – Stakeholders' consultation – results of the detailed feasibility study should undergo several sets of consultations with relevant stakeholders. This will ensure that the proposed technologies fit well under the current circumstance of Palestine, and that all gaps and needs of the stakeholders are addressed.

Entity-in-charge: The implementing entity for conducting the overall assessment of the national grid system is proposed to be spearheaded by PETL.

Costs: The costs associated with the implementation of this action is estimated at USD 250,000 which involves engaging international experts in conducting the study, including detailed technical analysis and recommendations.

Action 1.3 – electricity grid system upgrading

To effectively mainstream a diverse power generation sources such as renewable energy, including solar PV technologies, in Palestine and ensure its sustainability, it is important to create an enabling environment through upgrade of its electricity grid network that would enhance key stakeholder engagement and drive private sector participation.

Activity 1.3.1 – Implementation of grid upgrade – informed by the results of the detailed feasibility study and feedback from key stakeholders. This will follow the roll-out of the upgrade based on the implementation plan. Upgrading of the grid system will require significant external support and therefore, this activity will include securing the necessary financial resources.

Entity-in-charge: The implementing entity for electricity grid system upgrade is proposed to be spearheaded by PETL.

Costs: The costs associated with the implementation of this action is to be estimated during the feasibility study stage.

Action 1.4 – overall capacity building and awareness raising

Building the capacity and raising the awareness of relevant stakeholders such as government institutions, potential investors, developers, end-users, and financial institutions, will enable both short, medium and long-term actions on the deployment for prioritized technologies to be implemented efficiently. On the short-term, this will support the implementation and scaling-up of solar rooftop PV application, solar water heating technologies and energy efficient technologies which represent the least risk among the prioritized technologies. On the long-term, this will support and pave the way for the implementation of large-scale technology applications such as utility-scale solar PV power plants. It will also enable Palestine to identify

new applications which could be introduced in the medium and longer term.

Activity 1.4.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions of the energy sector such as PENRA, PETL and PERC, as well as MOPWH and PEA. This would allow them to make informed decisions to design the required policies such as regulations, standards, fiscal instruments and incentives, among others, to support the implementation and dissemination of various solar PV technologies, solar water heating technologies and energy efficiency technologies and measures.

Activity 1.4.2 – Technical capacity building – to enhance the technical capacity of relevant government institutions responsible in the energy sector for the dissemination of solar PV technologies, solar water heating, and energy efficient technologies. This include PETL responsible for the transmission and distribution of electricity, and PENRA, MOPWH and PEA responsible for promoting energy efficiency in both the energy and building sectors. This would allow them to build technical know-how, to better assess and implement the integration of solar PV generation into the grid, and evaluate available energy efficient technologies and their application in the Palestinian context.

Activity 1.4.3(a) – Capacity building for solar PV developers – for potential project developers to have in-depth understanding which would allow them to make informed decisions in developing various solar PV projects. The private sector in Palestine are expected to be instrumental in delivering solar PV technologies both in the short-term and long-term. Potential project developers will range from the smaller household level, to the larger scale solar PV generation farms. It is important for them to understand the de-risking measures that the Palestinian government has undertaken in terms of regulatory measures and incentives, as well as understand the economic, environmental, and social benefits that such projects bring over other conventional sources of electricity.

Activity 1.4.3(b) – Capacity building for solar water heater system designers, manufacturers and testing facilities – for them to have in-depth understanding on the technological advancements in the field of solar water heating technologies. This would allow them to properly develop assess the necessary systems as required by their market's circumstance. It is also important for them to understand the de-risking measures that the Palestinian government has undertaken in terms of regulatory measures and incentives, to take advantage and benefit from the business opportunity.

Activity 1.4.4 – Capacity building for financing sources – for financial institutions to have general and in-depth understanding of various solar PV technologies, solar water heating technologies, energy efficiency technologies and measures, their applications, the enabling environment that the government has laid out for de-risking, ultimately removing the perceived high risks associated with the technologies. This would allow potential investors and project developers to have better access to financing these prioritized technologies. This can build on and synergize with SUNREF Palestine which provides technical assistance to strengthen capacity of local stakeholders, including banks, for the facilitation of access to green finance for companies and individuals.

Activity 1.4.5 – Awareness raising – to raise general public awareness. The successful dissemination of solar PV technologies, solar water heating technologies and energy efficient technologies and measures cannot be realized without the acceptance, support and participation of end-users from individual Palestinians to large companies. This can be achieved through the dissemination of information regarding benefits of investing in these prioritized technologies, benefiting not only their own economic and financial conditions, but also contributing to the sustainable development of the country.

Entity-in-charge: The implementing entity for the overall capacity building and awareness raising actions is proposed to be spearheaded by PENRA.

Costs: The costs associated with the implementation of this action is estimated at USD 300,000 which

involves conducting workshops and trainings, engaging international experts, and deploying public awareness materials.

Action 1.5 – development of policy, standards and financing schemes

To effectively mainstream solar PV, solar water heating and energy efficient technologies in Palestine and ensure their sustainability, it is important to create an enabling environment that would enhance key stakeholder engagement and drive private sector participation.

Activity 1.5.1 – Policy development and enforcement – to create an enabling environment for the prioritized technologies to be implemented in Palestine. Once capacities of key government institutions have been enhanced through capacity building activities, they will be well-informed to develop the appropriate policies to de-risk and incentivize the off-take of solar PVs, solar water heating and energy efficient technologies, as well as better implement and enforce existing regulations.

For various solar PV technologies, potential de-risking measures include development of standards such as a grid code to ensure grid stability in integrating solar PV generation, implementing the feed-in-tariff for solar PV generated electricity, and developing a streamlined licensing and approval procedures for solar PV energy producers and their interconnection with the grid.

For solar water heating technologies, to control the quality and performance of solar water heating systems, standards need to be established to ensure that materials being used to manufacture the systems are effective and reliable, and that providers of the technology such as manufacturers, system designers and installers meet these standards. At the same time, a certification and labelling system needs to be developed in order to have assurance that technology providers meet the set standards, and that customers and end-users are informed and assured that the technology that they are investing in come from reliable and certified sources.

For energy efficient technologies and measures, this includes the development of a green building code and construction code.

Activity 1.5.2 – Financing scheme development – to design an attractive incentive mechanism to mobilize private sector investments. The private sector will be the main driving force for the deployment of these prioritized technologies in Palestine. To kick-start the market for the private sector, external financing resources could fund part of the financing scheme.

Entity-in-charge: The implementing entity for the development of relevant policies, standards and financing schemes is proposed to be spearheaded by PENRA.

Costs: The costs associated with the implementation of this action are estimated at USD 200,000 which involves engagement of international and national consultants to support the formulation and development of policy measures, and to conduct the necessary workshops, trainings and consultations.

Action 1.6 – dissemination of solar rooftop PVs

The main driver behind the dissemination of solar rooftop PVs is the development of a household-led demand, which will lead to the development of a market attractive enough for the private sector. This can be achieved on the short-term with few inputs, given the current support to the sector. This will require the following measures:

Activity 1.6.1 – Diffusion of solar rooftop PVs – considered as a solution that could be implemented with the least amount of de-risking measures. The diffusion of solar rooftop PVs will be focused at the household level and medium-scale commercial level. The scale of projects associated with solar rooftop PV application results in reduced dependency of end-users on electricity imports without having to deal

with issues associated with larger scale applications such as the use of land area and grid stability concerns. Further scaling up of the technology's diffusion into Palestine is expected upon enhancement of its market through the development of the policy environment and incentives as part of government actions earlier mentioned, as well as better access to financing through financial products developed by engaged and capacitated financial institutions.

Entity-in-charge: The diffusion of solar rooftop PV technology will mainly be private sector driven with PENRA being the government representative lead.

Costs: The implementation of this action is expected to leverage around USD 125 million (USD 1.25 million per MW of installed capacity) from the private sector.

Action 1.7 – Development of larger scale solar PV and other renewable energy technologies

Larger scale solar PV technologies such as utility scale solar power generation plants, as well as other renewable energy sources such as wind and waste-to-energy technologies, will require significant investments and negotiations related to land use with Israel.

Activity 1.7.1 – Deployment of larger scale solar PV and other renewable energy technologies – once the enabling environment is established through the implementation of de-risking measures and actions, it is expected that investments in various solar PV and other renewable energy technologies would make business sense and drive public and private sector investments.

Activity 1.7.2 – Negotiations – in particular, under the status quo scenario and until independence is achieved by the State of Palestine, continuous negotiations with Israel will need to be conducted. This will aim to de-risk implementation of larger solar PV power plants and other renewable energy generation plants, which would need to use land under Area C.

Entity-in-charge: The diffusion of large-scale solar PV technology and other renewable energy technologies will mainly be private sector driven, with potential for public-private partnership between local governments mainly represented by PENRA and independent power producers.

Costs: The implementation of this action is expected to leverage around USD 300 million (USD one million per MW of installed solar PV capacity) from the private sector.

Action 1.8 – dissemination of solar water heating technologies

The main driver behind the dissemination of solar water heating technologies will be the private sector. The dissemination of this technology can be achieved on the short-term with few de-risking measures.

Activity 1.8.1 – Diffusion of solar water heating technologies – considered as a solution that could be implemented with few de-risking measures. The diffusion of solar water heating technologies will be focused at the household level and medium-scale commercial level. This technology already exists in Palestine. Therefore, further scaling up of the technology's diffusion is expected upon enhancement of its market through the development of standards and certification system as part of government actions, and better access to financing through financial products developed by engaged and capacitated financial institutions.

Entity-in-charge: The diffusion of solar water heating technology will mainly be private sector driven.

Costs: The implementation of this action is expected to leverage investments from the private sector, estimated to total around USD 3,165,000,000 (USD 400 – 700 for a residential system and around USD 20,000 – 40,000 for an industrial scale system).

Action 1.9 – deployment of energy efficient technologies

The dissemination of energy efficient technologies will mainly be private sector driven given the demand resulting from the enabling environment established.

Activity 1.9.1 – Construction of new green buildings – Once the enabling environment has been established and market for energy efficiency technologies and measures developed, it is expected that investments in developing new green buildings utilizing these technologies and measures would commence.

Activity 1.9.2 – Retrofit of older buildings – similarly, the enabling environment established under earlier actions for the sector is expected to result into the mobilization of investments to retrofit older buildings to incorporate energy efficiency technologies and measures. Most of the existing buildings in Palestine have been built without adhering to any energy efficiency standards and therefore, have high potential to apply energy efficiency technologies and measures.

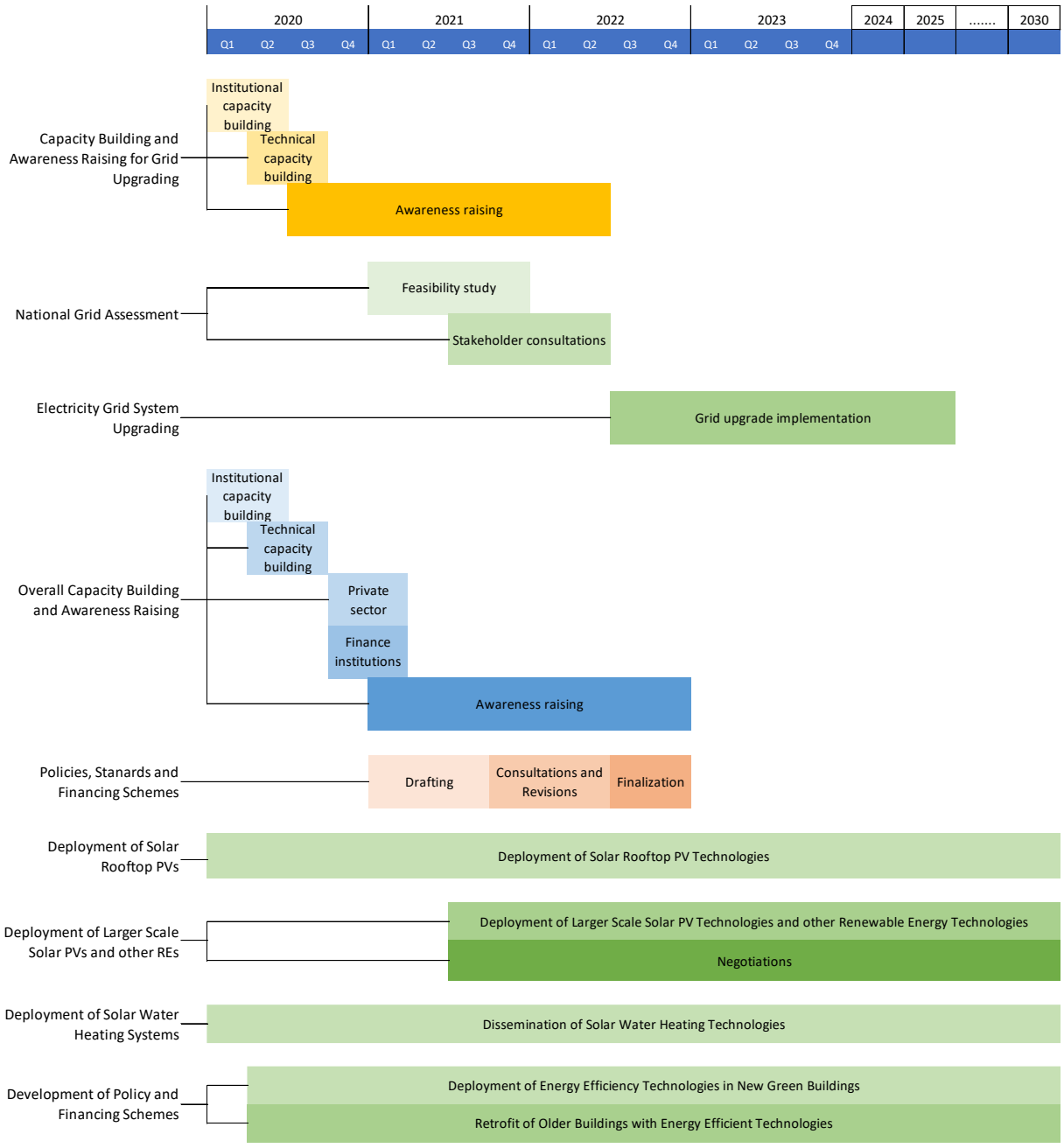
Entity-in-charge: The diffusion of energy efficient technologies will mainly be private sector driven.

Costs: The implementation of this action is expected to leverage around USD 30,000,000 from private sector investments.

3.1.7. Implementation Timeline

Figure 2 shows the overall timeline for the implementation of the energy sector prioritized technologies in Palestine.

Figure 2: Energy Sector Implementation Timeline



3.1.8. Expected Impacts

The upgrade of the national grid system, including rehabilitation and upgrade of existing electricity distribution systems will result in enhanced adaptive capacity of its infrastructure and increase in its efficiency. This translates to more efficient electricity distribution with reduced losses, increased integration of electricity generated from renewable sources, and resilience to extreme weather events and shocks. This will greatly contribute to meeting the country's adaptation and mitigation targets.

Palestine's NDC indicates solar PV technologies as one of the mitigation actions to be implemented conditional on receiving international support. It targets the generation of up to 33 percent of electricity using solar PV by 2040. It is assumed that the electricity demand is projected to be 26,940 GWh by 2040 based on a 6 percent annual growth. If full implementation of solar PV technologies is achieved by 2040 and meets the solar generation target of 33 percent, it is estimated that around 5 billion tons of carbon dioxide equivalent annually in greenhouse gas emissions can be reduced.[10]

Palestine's NDC also indicates solar water heating technologies as one of the mitigation actions to be implemented conditional on receiving international support. The implementation of this technology will lead to reduced dependence on electricity use as well as fossil fuel-based resources such as gas and diesel, resulting in savings on conventional energy use and consequently reducing greenhouse gas emissions.

The implementation of energy efficiency technologies and measures will bring significant impact to the energy sector. The expected reduction of Palestine's overall energy use in adopting this technology will result in reduction in greenhouse gas emissions associated with fossil fuel-based electricity generation, cost savings from energy consumption, and improved energy security.

3.1.9.Potential financing

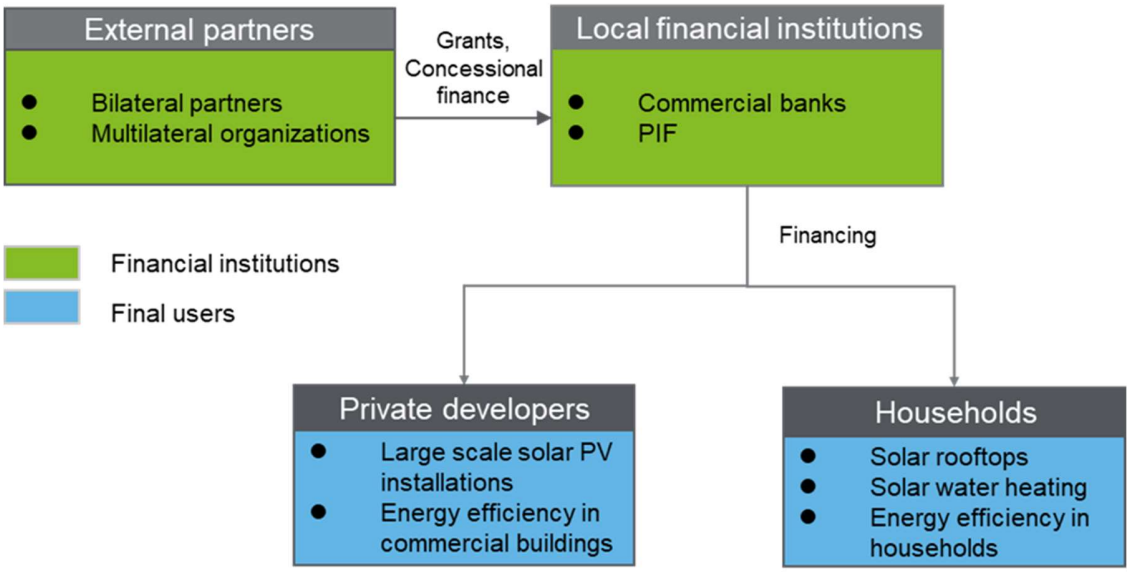
The overall approach to financing for the roadmap is detailed in Annex 2: approach to financing. In the energy sector, there are significant opportunities for the private sector, as projects involve clearly defined revenue streams and / or cost decreases.

The financing approach therefore aims at leveraging external support, in the form of grants and concessional finance, in order to develop bankable and sustainable business models and conditions for private sector engagement. As much as possible, the implementation roadmap will aim at leveraging Palestine's budget and donors' support to encourage private sector participation, which is an important partner in the energy sector, both at household level, on the short term, and at utility level, on the longer term.

It is important to consider the different stakeholders involved and potential models for the energy sector. Some potential models include the following:

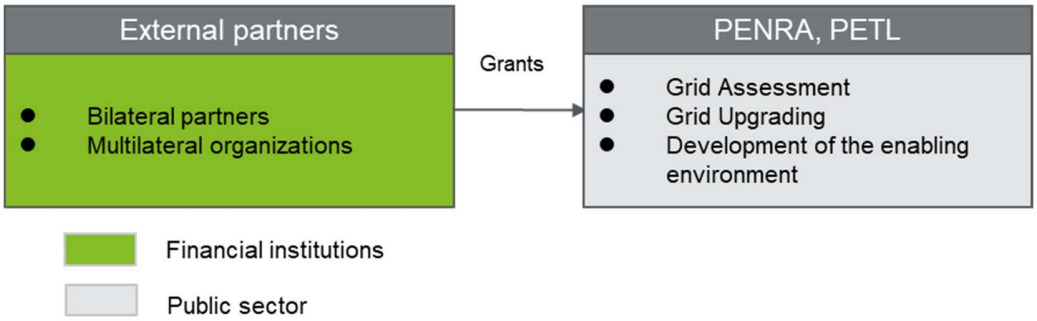
[10] Calculated on assumption that grid emission factor is based on IEC power generation.

Figure 3: Potential Financing Options for the Energy Sector



Other actions which are to be led by the public sector will be mainly financed by grants, provided by international partners.

Figure 4: Potential Financing Options for the Energy Sector, Public Sector Led



Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in Table 14.

Table 14: Financing for Energy Sector Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 1.1 – capacity building and awareness raising for grid upgrading	Technical assistance	250,000	Grant	Bilateral donor / International organization
Action 1.2 – national grid assessment	Assessment / F/S	250,000	Grant	Bilateral donor / International organization

Action 1.3 – electricity grid system upgrading	Infrastructure development	To be estimated during feasibility study	Grant / Concessional loan	Bilateral donor / International organization
Action 1.4 – overall capacity building and awareness raising	Technical assistance	300,000	Grant / Domestic resources	Bilateral donor / International organization
Action 1.5 – Development of policy, standards and financing schemes	Technical assistance	200,000	Grant	Bilateral donor / International organization / Domestic resources
Action 1.6 – Dissemination of solar rooftop PVs	Infrastructure development	125,000,000	Private sector led	Local financial institutions, households, developers
Action 1.7 – Development of larger scale solar PV technologies	Infrastructure development	300,000,000	Private sector led Potentially blended finance	International organization / Developers / Sponsors
Action 1.8 – dissemination of solar water heating technologies	Infrastructure development	3,165,000,000	Private sector led	Local financial institutions, households, developers
Action 1.9 – deployment of energy efficient technologies	Infrastructure development	30,000,000	Private sector led Potentially blended finance	International organization / Local financial institutions, households, developers

Indirect costs and financing

Other actions, that may stem from the measures undertaken under the implementation roadmap, include the implementation of the policies developed under the roadmap. For example, the costs associated to the implementation of measures such as feed-in-tariffs, certifications for energy efficient buildings and solar water heating technologies, as those have not been identified yet. Most of these costs, however, will be borne by the public sector. It is expected that feed-in-tariffs, for example, could be covered under the National budget or any alternative dedicated fund to enhance such approaches.

External financing

Requests for external financing will focus on measures that cannot be financed by Palestine and which are of high priority to the country. As mentioned above, the energy sector should seek private sector engagement, as it has the potential to support bridging the financing gap for the sector. External financing

will therefore be requested for preparing the enabling environment for private sector participation.

The first set of priority measures to be financed by external resources is therefore grid upgrading. This is a prerequisite to the introduction of renewable energy in Palestine at utility scale. The use of grants or of highly concessional financing is crucial to achieve this objective.

The use of concessional financing from international partners will also be considered for supporting private sector engagement in energy efficiency and infrastructure development for large scale solar PV plants. It is expected that concessional financing comes as a co-financing source for traditional financing, in order to cover some of the risks experienced by private sector developers.

Potential sources of financing include the GCF, GEF as well as international organizations, such as the World Bank, and bilateral donors. UNDP has also been very active in the development of projects related to energy efficiency, for example as an Accredited Entity to the GCF.

3.2. Agriculture Sector

3.2.1. Current status of the sector

The Palestinian agriculture sector is diverse in terms of agricultural production. It is highly vulnerable to climatic change and variations in Palestine. In 2014, the value of agricultural production at constant prices was US$ 540 million. The sector is in continuous decline since 2011, which recorded the highest value of agricultural production, up to US$ 721.5 million.[11]

In Palestine, holdings are usually small, with a majority owned by the household. More than 70 percent focus on plant production, while a minority, less than 10 percent, are livestock producers.[12] Olive tree cultivation covers the largest agricultural area in the West Bank. The agricultural sector is an important provider of jobs for Palestinians, with 10.4 percent of the total workforce employed in agriculture in 2014.[13]

In terms of geographies, 90 percent of agricultural lands are located in the West Bank, while only 10 percent is located in the Gaza Strip. The majority of the Palestinian territory in the West Bank, including agricultural land, are still under full Israeli control, as 62.9 percent of West Bank area is classified as Area C.[14] Access to water is extremely limited throughout Palestine, due to the control of Israel over water resources, and groundwater remains the main water source for agricultural production. Restriction over water management and the rehabilitation of water sources are significant barriers for the development of an irrigated agriculture in Palestine.[15]

In order to understand the impacts of climate change on the agricultural sector in Palestine and how potential technologies can contribute to support the resilience of the sector, it is important to understand the current climatic conditions in Palestine. Palestine is located between the Mediterranean and arid, tropical zones. Rainfall and temperature vary per location, season and with the altitude. The West Bank is therefore relatively arid, with more than 50 per cent experiencing less than 500 mm of rainfalls per year.

[11] National Agricultural Sector Strategy (2017 2022)
[12] Ibid
[13] Ibid
[14] Ibid
[15] Ibid

There are five major climate zones in Palestine.[16]

Table 15: Climate Zones in Palestine

Climate zones	Average rainfall / year	Other characteristics
Jordan valley	100 to 200 mm	400 meters below sea level to 90 meters above sea level Soil and water salinization is a major issue
Eastern slopes	150 to 300 mm	N/A
Central highlands	400 to 700 mm	400 to 1,000 meters above sea level
Semi-coastal region	400 to 700 mm	100 to 300 meters above sea level
Coastal plain (Gaza strip)	200 to 350 mm	N/A

Climate change poses a major and growing threat to water and food security. In Palestine, changing rainfall patterns, drought, flooding and other results of climate change have direct impact on agricultural production. Water scarcity is expected to become even more severe, which will make it more difficult for local livestock producers to produce their own fodder and to rely on grazing resources, which will decrease over time. This will lead livestock producers to increasingly rely on imported animal feed.

Rain-fed agriculture is dominant in Palestine, representing 81 per cent of the total area used for agriculture, against 19 percent for irrigated areas.[17] In rain-fed areas, changes in rainfall patterns are expected to lead to increased variations in soil moisture. Irrigated areas will need to increasingly rely on storage systems to respond to the decreasing availability of water. In order to support the development of the sector and adapt to the impacts of climate change, it is therefore crucial for Palestine to introduce a number of technologies, which will support achieving better productivity with less inputs, including water, and ensure the availability of inputs for production, such as animal feed.

3.2.2.Institutional arrangements

The implementation and scaling up of technologies related to resilient and low-carbon agriculture in Palestine involves the engagement and participation of key government institutions from the agricultural sector. The following key government institutions were identified which would play the leading role:

Table 16: Key Government Institutions in the Agriculture Sector

Lead Institution	Description
Ministry of Agriculture	The Ministry of Agriculture (MOA) is the governmental body that leads agricultural development and is responsible for the formation of partnerships related to agriculture under which civil society and international institutions work. MOA is responsible for setting up the legal, institutional, economic and financial framework of the agricultural sector development. MOA will have a key role in setting up the enabling

[16] FAO Aquastat (2008), Occupied Palestinian Territory, http://www.fao.org/nr/water/aquastat/countries_regions/PSE/index.stm, adapted based on information from Ministry of Agriculture

[17] National Agricultural Sector Strategy (2017 2022)

	environment for private sector engagement and farmer engagement.
Palestinian Water Authority (PWA)	The Palestinian Water Authority (PWA) was established in April 1995 as the institution responsible for policy-making and regulation of the water sector. PWA will have a key role in technologies which are related with the use of water.

The following key stakeholders were also identified which would play major roles in the implementation of prioritized technologies under the agricultural sector, as well as supporting lead institutions:

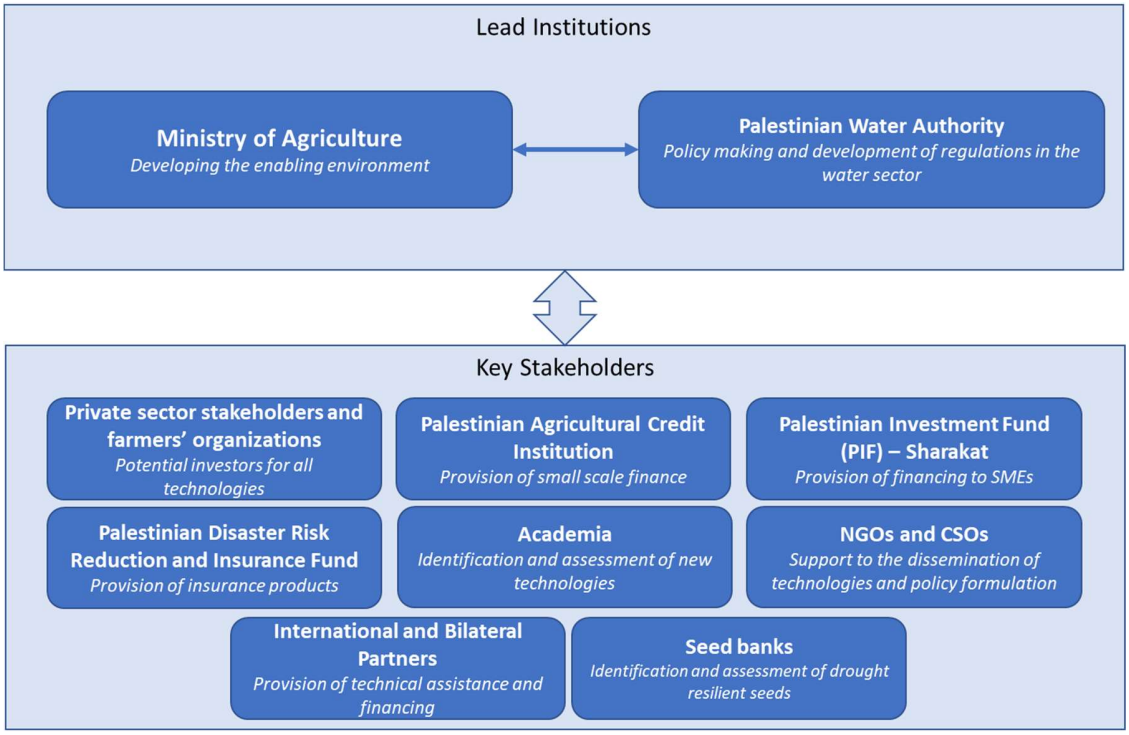
Table 17: Key Stakeholders in the Agriculture Sector

Key Stakeholders	Description
Private sector stakeholders and farmers' organizations	There is a significant number of private sector stakeholders involved in the agricultural sector. While some of them, such as the Palestinian Food Industry Union and PalTrade focus on food industry and exportation, others, such as the Union of Agricultural Cooperative Associations, farmers' organizations and commodity councils, provide services related to agricultural inputs and production. These organizations will be key in diffusing the technologies to smallholders. The Milk Council, Sheep Council and the Palestinian Livestock Cooperatives Union, regulate activities and provide services in the livestock sector. These organizations will be key in diffusing technologies related to animal feed to the whole sector. Larger companies involved in food production may also be led by Chambers of Commerce and other organizations.
Palestinian Agricultural Credit Institution	The Palestinian Agricultural Credit Institution (PACI) is a governmental tool and mechanism that helps Palestinian farmers and agricultural companies to obtain loans for the development of agricultural projects, as well as agricultural production. It has been established by the Decree law no. 8 of 2015. One of the missions of PACI is to stimulate and create an investment environment in the agricultural sector through the financing of agricultural projects. PACI will play an important role in supporting the financing of projects where the smallholders can be involved, such as precision agriculture and conservation agriculture, among others.
Palestinian Investment Fund (PIF) - Sharakat	The Palestine Investment Fund (PIF) is Palestine's sovereign wealth fund. PIF seeks to maximize impact through innovation by investing and partnering in cutting-edge strategic projects in under-developed and vital sectors. Sharakat is PIF's impact arm for agriculture, technology, and human development. Sharakat invests for impact in Palestinian SMEs to strengthen food self-sufficiency, enhance the technology offer, and accelerate human development through health and education. Established in 2013, Sharakat is a fully-owned subsidiary of the Palestine Investment Fund. All technologies prioritized under the agricultural sector fall under the mandate of Sharakat, as it they are both related to sustainable agriculture and technology. Sharakat will be involved in the financing or co-financing of private led businesses.
Palestinian Disaster Risk Reduction and Insurance Fund (PDRRIF)	PADRRIF's mission is to create a secure agricultural environment for Palestinian farmers by supporting and protecting them from various natural and unnatural disasters through agriculture insurance and compensation, investment. PADRRIF will be key in providing products and services which will enable farmers and the private sector to be more economically secure and stable.
NGOs and CSOs	Non-governmental organizations and civil society organizations relevant to the agriculture sector in Palestine will be key to the implementation of

	prioritized technologies. Their engagement and participation will be important for activities in the implementation plan such as policy formulation, awareness and sometimes project implementation, including financing.
Academia	Academia will play an important role in the identification and assessment of new technologies for agriculture. Academia, will also be able to contribute to the ex-post assessment of the efficiency of the technologies introduced as part of the roadmap, as well as of their impact on farmers.
Seed Banks	Seeds banks may also be leveraged during the course of the implementation of the roadmap. Seeds banks may provide the support in the identification and assessment of drought resilient seeds, among others.
International and Bilateral Partners	Plays a key role as partners to the Palestinian government in providing support in consideration of the country's limited resources. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the agriculture sector is illustrated in Figure 5.

Figure 5: Agriculture Sector Institutional Framework



3.2.3. Objectives and goals of the sector

Agriculture is identified as a highly vulnerable sector under the NDC and the NAP. Palestine, through its NDC, NAP and Agricultural Sector Climate Change Adaptation Action Plan 2018-2020,[18] aims at introducing

[18] Ministry of Agriculture / GIZ, Agricultural Sector Climate Change Adaptation Action Plan 2018-2020, 2018

climate-smart agriculture, improve water-use efficiency and decrease the cost of agricultural production. In its NDC, Palestine aims at introducing climate-smart agriculture in at least 50 percent of the farms in Palestine by 2040. By 2025, Palestine will aim to achieving climate smart agriculture in at least 10 percent of the farms and at least 25 percent by 2030.

It is important that the roadmap contributes to achieving the objectives and goals of the agricultural sector in terms of climate change adaptation and mitigation as defined in Palestine's NDC. Introducing the technologies will also contribute, directly or indirectly, to sectoral goals, as developed under the National Agricultural Sector Strategy (2017 2022) and the Livestock Sector Strategy 2015-2019.

In the agriculture sector, the technology roadmap will focus on a climate smart approach, which will cover all technologies prioritized under the sector.

The technology roadmap will therefore contribute in strengthening the resilience of the sector and by supporting the introduction of climate smart agriculture in Palestine. The introduction of precision agriculture, efficient irrigation, conservation agriculture, water harvesting and resilient fodder production will contribute to mitigate the impacts of climate change on food production. Resilient fodder will contribute to improving resilience of livestock production as well as decreasing dependence on imported fodder.

Some technologies, such as precision agriculture and conservation agriculture, will also contribute to reduce agricultural GHG emissions, therefore contributing to meet Palestine mitigation objectives.

3.2.4. Current status of technologies and technology overview

The technologies prioritized under this sector are climate smart agriculture, including on precision agriculture, efficient irrigation, conservation agriculture, water harvesting and resilient fodder production. All technologies are expected to enhance the resilience of the sector by increasing water use efficiency, providing alternative sources of water and / or improving food production.

3.2.4.1. Climate smart agriculture (Precision agriculture)

The Food and Agriculture Organization (FAO) defines climate-smart agriculture as "an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate". Climate smart agriculture aims to contribute to sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible.

Climate smart agriculture is an approach which involves a range of elements which have to be embedded in local contexts. It relates to measures both on-form and beyond the farm. Some practices of climate smart agriculture relevant to the Palestinian context are detailed in Table 18.

Table 18: Climate-Smart Agriculture Practices

Climate smart agriculture practices	Description
Crop production and soil management	Crop production needs to become more resilient to the impact of climate change. Climate smart crop production practices provide options which support sustainable food production, while at the same time, reducing negative impacts on climate change. This is heavily linked with the concept of sustainable crop production intensification (SCPI) refers to an ecosystem approach that capitalizes on natural inputs and processes. SCPI aims at maintaining healthy soils, cultivating a wider range of species in association or rotation and managing water efficiently. Most of these practices aim at preventing soil damage and promoting soil

	and water conservation, which will in turn increase productivity. Some of the practices the most relevant to Palestine are detailed below: • Conservation agriculture, detailed below • Soil moisture conservation: mulching and conservation: Soil moisture conservation enhances the productive capacity by minimizing the amount of water lost from the soils. Mulching is a simple technique that buffers soil temperature and helps the soil-crop system reduce evaporation and the mineralization of organic matter. Mulching also counteracts the nutrient loss. Conservation tillage, which is also included in conservation agriculture practices, aims at reducing the tillage to increase the soil capacity to absorb and retain water. • Precise management of nitrogen: Nitrogen is a nutriment crucial to the production of most crops. However, over-application of fertilizers may lead to the mineralization of nitrogen, therefore threatening food and water security. The precise management of nitrogen involves to deliver nutrients to the plant in times of peak demand, in order to avoid using too much mineral fertilizers, which will reduce productivity of the soils. This might be supported by the use of nitrogen-fixing crops. Nitrogen management is also facilitated by conservation agriculture and precision agriculture technologies. • Crop diversification: Crop diversification consists in growing different types of crops by season. Good practices include the rotation of deep-rooted and shallow-rooted crops. This allows plants to draw water from different depths within the soil, therefore enabling moisture regeneration. • Use of precision technologies for crop management (precision agriculture): Recording technologies and reacting technologies can support crop management, such as moisture and yield management. For example, soil mapping, soil moisture mapping, canopy mapping, yield mapping may be drawn from data gathered from sensors mounted on ground-based stations, rolling, airborne or satellite platforms, and gathering spatial information. Technologies can also support the application at a variable rate of water (via irrigation), and other inputs, such as seeds, fertilizers and pesticides, therefore contributing to the management of nutriments and soil moisture conservation. Recording technologies can be used as a standalone system, while reacting technologies require data recording to be used. Both require Global Navigation Satellite Systems as a prerequisite.
Water management	Options for the adaptation to climate change in water management in the agriculture sector include water storage and irrigation schemes, among

	others. • Water harvesting, detailed below. • Efficient irrigation technologies, developed below. • Supplemental irrigation: Supplemental irrigation refers to adding limited amounts of water to rain-fed crops to stabilize yields when rainfall is not sufficient. This practice is especially adapted to drylands, where annual rainfall is between 300 and 500 mm. It is usually paired with the setting-up of a reservoir to meet the water demand in stress periods. • Deficit irrigation: Refers to a practice where water supply is reduced below maximum levels and mild stress is allowed with minimal effects on yield. It is expected that water savings will offset losses in production. The water saved can then be used for other crops.
Use of genetic resources for food production	The use of genetic resources for food production is essential to cope with climate change. While the use of better quality seeds and crops is crucial in order to secure better yields and nutritional contents, specific traits can be used to adapt to climate change. In Palestine, drought and saline tolerant varieties are especially important. • Development of drought resilient varieties (seeds): The introduction of drought resilient varieties may allow for a sustained production, even in the context of decreasing rainfalls.
Energy management	Within the context of CSA, energy management aims at decreasing agriculture and food production's dependence on fossil fuels. In Palestine, the introduction of low carbon solutions for food value chains can also contribute to food security. Some of the technologies identified include: • Solar pumps: The introduction of solar pumps would allow to replace fossil fuel based generators with solar generation based generators. Technologies used for solar pumps are similar to those described in the energy sector for solar PV cells. • Low carbon cold chain; Cold chains allow to better conserve agricultural produce and food on a longer span. A cold chain is a temperature-controlled supply chain. It enables to maintain a desired low-temperature range over a series of activities, which can cover production, storage and distribution. Conventional technologies such as dry ice and transportation via refrigerated trucks are energy intensive. Low-carbon technologies include the combination of refrigerant plates and insulation boxes. The combination of refrigerant plates and insulation boxes allows to adapt the temperature depending on the needs of the product. Some systems can be integrated in trucks, thus becoming less energy intensive.
Livestock production	Smart agriculture practices in livestock production are mainly related to grazing and pasture management, as well as feed management. Related technologies are developed below.

The practices described in Table 18 are interlinked. Some of the technologies and practices are further detailed in the sections below, such as for efficient irrigation and conservation agriculture, among others.

In Palestine, agriculture is linked with water availability and with soil quality. Precision agriculture is heavily related to minimizing the use of water and stress on soils, therefore improving their quality. Precision agriculture and climate smart practices offer solutions to optimize agriculture inputs while mitigating the impact of climate change or on climate change. FAO defines precision agriculture as farming guided by detailed environmental information so as to minimize the use of water, agrochemicals and labour. Precision agriculture covers several areas of climate smart agriculture, such as efficient irrigation, conservation agriculture and solar pumps, among others.

Efficient irrigation and conservation agriculture are detailed in sections 3.2.4.2 and 3.2.4.3 respectively. Precision agriculture also refers to whole-farm management approaches using information technologies, such as remote sensing and satellite positioning data.

Table 19: Precision Agriculture Technologies

Precision agriculture technologies	Description
In-field sensors	Many in-field sensors are available and used for data collection. In-field sensors enable to analyze the status of the soil, weather information and the physiological status of crops. These sensors include: • Analyzing soil status: electrical conductivity (ECa) sensors, gamma-radiometric soil sensors, and soil moisture devices can be used to analyze the status of the soils. ECa sensors provide information on the soil electrical conductivity, which provides indications on its texture and water holding capacity. The detailed soil texture needs to be analyzed in labs. It enables to inform farmers on soil salinization and compaction, and therefore inform the use of fertilizers. Soil moisture sensors are directly linked with the use of irrigation in fields. In advanced systems, they can inform irrigation systems on when to provide water to specific areas, thus leading to major savings in water use. • Weather information sensors: Real-time weather monitoring systems enable farmers to better manage their crops. It allows to measure the temperature, humidity, light, wind speed, and their influence on soil temperature and moisture, among others. This can inform water management (irrigation) as well as the provision of fertilizers. Weather information systems are formed by a weather stations, the transmitter node, a receiver node, which allows to receive data from several stations, and data analysis solutions. • Physiological sensors: Those sensors enable farmers to control the level of nitrogen provided to the crops, and therefore avoid a lack of or an oversupply of nitrogen, It is linked with techniques for nitrogen management.
Remote sensing via airborne	Another option for remote sensing is using multispectral and hyperspectral cameras on board airborne and satellite platforms, which will provide data

and satellite platforms	across several wavelengths and provide information on the crop condition, such as chlorophyll content and stress level. These technologies rely on the availability of satellite platforms, or lighter vehicles, such as unmade aerial vehicles (drones).
Data analysis	Data analysis is paramount in order to understand and use the data collected. It is usually done through Geographic Information Systems (GIS), where the data collected by the sensors is georeferenced into maps to provide information on the soil and crop status. The interpretation of the results and data, and its practical use in farms either requires advanced trainings, access to dedicated software, or to advisory services.
Variable rate nutrient application	This refers to the application of seeding, fertilizing and spraying according to accurate mapping of soil and plant information. This enables to manage areas with variable levels of production. This can be done by applying a prescription map which is designed based on the data received from the field using in-field sensors or airborne platforms. Spinner spreaders or pneumatic applicators are usually used. Spinner spreaders enable to control the application rate by adjusting the speed of the conveyor, while in pneumatic applicators the material is spread using an adjustable air stream.

It is important to emphasize that precision agriculture technologies vary in cost and complexity. Depending on the size of the farms, the choice of the technology and of the integration of precision agriculture will vary. For example, it may not be easy to introduce practices based on remote sensing and satellite positioning data, while more basic and affordable technologies, such as efficient irrigation and conservation agriculture, require only a few inputs for their introduction.

3.2.4.2. Efficient irrigation

Irrigation is the prime means of intensification for agriculture and food production. It will remain a crucial factor in securing stable yields under climate change and in the face of added water scarcity. Improving irrigation efficiency, and therefore management, on farm is therefore crucial to secure agricultural productivity. Improving application efficiency through technological and management innovation mainly aims at determining the optimal proportion of water that should be applied to a crop depending on soil characteristics.

Surface irrigation techniques, which have lower efficiencies than overhead irrigation and micro-irrigation, have been widely developed. Techniques such as furrow and bed irrigation, surge flow and cutback are available for water to reduce the time taken for water to cover the field and thus improve uniformity and reduce water losses. In Palestine, surface irrigation systems are mainly used in areas irrigated by natural springs or for irrigating citrus trees, using basins or furrows.[19] These techniques make the most sense where soils have high clay contents or where drainage ability may be impeded. However, it is important to note that these technologies are only applicable for very limited areas and crops in Palestine.

Sprinklers, rain-guns, centre pivots and other pressurized systems can be efficient when properly designed to ensure that runoff is limited. Micro-irrigation systems deliver controlled amounts of water through drippers, drip-tape or micro-sprinklers. They supply daily water needs without saturating the soil. Micro systems usually require significant capital and operating costs, as extensive piping is required. Sprinklers and micro-sprinklers are already used in Palestine to irrigate potatoes, onions, carrots, radishes, spinach and citrus trees. Specific systems related to sprinkler irrigation and which may be adapted to the specific context of agriculture in Palestine are detailed in Table 20.

[19] Irrigation in the Middle East region in figures – AQUASTAT Survey 2008

Table 20: Sprinkler Irrigation Systems

Sprinkler and localized irrigation technologies	Description[20]
Periodic move systems	Periodic move sprinkler irrigation systems are moved to an appropriate position and operated for a specified length of time with the aim of applying a required depth of water. The laterals, pipes and/or sprinkler are then advanced to the next set position. Periodic move systems are adaptable to most soils and crops, but are not the best solution for precise irrigation scheduling. They also require pressurized water, which is energy intensive.
Solid set systems	A fixed or solid set sprinkler irrigation system can irrigate an area without the need to move pipes, laterals or sprinklers. As for periodic move systems, solid set systems are adaptable to most soils and crops. They require pressurized water, which is energy intensive.
Low energy precision application (LEPA) systems	LEPA is a low energy precision water application system that supplies water at the point of use. This system combines a self-moving mechanical device (centre pivot or linear move) along with water and soil management procedures that aim to retain and make efficient use of the water received as precipitation and irrigation. LEPA systems distribute water directly onto or very near the ground surface, using drop tubes fitted with low pressure application devices. LEPA are best adapted to large flat fields and to crops for which rain already meets a significant part of crop water requirements. LEPA systems have the ability to make frequent small applications of water and fertilizer, in some cases to supplement precipitation. As a consequence, LEPA systems are more resilient than many others because they require less energy and less water.
Localized irrigation systems	Localized irrigation is the broad classification of frequent, low volume, low pressure application of water on or beneath the soil surface by drippers, drip emitters, spaghetti tube, subsurface or surface drip tube, basin bubblers, and spray or mini sprinkler systems. Localized irrigation is also referred to as drip and trickle irrigation. This is best suitable for row crops, such vegetables. Systems are relatively easy to automate and irrigation scheduling can be based on, for example, soil moisture sensors. The net result is that scheduling can maintain soil moisture conditions and produce high yields and good quality outputs. Typically, however, localized irrigation systems use more energy than surface irrigation systems, though less energy than sprinkler irrigation systems.

However, the adoption of a 'better' technology does not guarantee a saving of water. It is also crucial to prevent water leakages from end-to-end, from the water basin to the farm. In order to guarantee the best use of water, to reduce leakage and to make sure that farms do not use more water with efficient systems than with surface irrigation techniques, it is important to encourage water management and efficient design

[20] FAO, Compendium, Climate smart irrigation

and policy-making.

Finally, irrigation is heavily linked with the availability of water. The use of alternative sources, such as water harvesting or wastewater need to be explored. Both technologies will be detailed in further sections.

3.2.4.3. Conservation agriculture

Conservation agriculture is a response to sustainable land management, environmental protection and climate change adaptation and mitigation. In many cases, conservation agriculture has been proven to reduce farming systems' greenhouse gas emissions and enhance their role as carbon sinks. Conservation agriculture is not only a climate change mitigation measure. The purpose of conservation agriculture is to stabilize production and increase soil fertility, by improving soil structure, water conservation and therefore yields. Adopting conservation agriculture therefore leads to more resilience to changes in climate, temperature and water scarcity.

As defined by the FAO in 2008, conservation agriculture has three main principles:

- Minimum soil disturbance: this means no-till seeding and weeding. Under this type of practice, no soil distortion and mechanical tilling is done. Sowing is done with equipment enabled to plant on the residues on the previous cropping season.

- Soil protection by vegetation cover: this means to maintain crop residues and stubble in arable crops and to preserve groundcovers between rows of trees in permanent crops.

- Crop rotation and plant association: this can be done through rotations, sequences and associations of crops.

Since conservation agriculture avoids tillage, it is necessary to have the adequate tools and equipment to establish the crops in the relevant conditions. One of the main technologies required for conservation agriculture are the direct seeders, or no-till drills, which allow farmer to plant the crops successfully without tilling.

The main technology of no-till drills allowing minimum-disturbance is the opener. Minimum-disturbance no-tillage openers disturb the surface of the ground as little as possible for tillage. They retain at least 70 per cent of the surface residues evenly distributed over the surface of the ground. Some of the technologies used for openers include double and triple discs, a disc version of winged openers and narrow knife openers operating in low-residue conditions,

Other design considerations and characteristics for no-till drills are also important. The first consideration should be provided to adopting a large scale machine or a small scale equipment. Larger scale machines answer to the needs of larger farms, while small scale are more adapted to smaller scale and less expensive.

For larger scale machinery, it is important to consider the following (Table 21) design considerations.

Table 21: Design Considerations for Large Scale Machinery

Design considerations	Large scale equipment
Operation width	No-tillage machines only cover the field once and can therefore afford to operate at a slower rate of ground coverage than conventional tillers. Large scale machinery tends to be narrower than conventional

	drills.
Surface smoothness	The opportunity to smooth the ground prior to drilling is lost under a no-tillage regime. Thus, the drill or planter openers need to be able to faithfully follow significant changes in the surface of the soil without detriment to drilling depths or functions.
Power requirements	No-tillage drillers require more power than conventional drills. Typical power requirements are 3 to 9 tractor engine kilowatts (kW) (4 to 12 horsepower (hp)) per opener[21]
Downforce application	Each design of no-tillage opener requires a different downforce to obtain its target seeding depth. Required downforce is determined by soil strength, soil moisture, presence of stones and plants, and decay stage of roots, among others.
Transport consideration	Transportation needs to take into account potential compaction of the soil in no tillage.
Matching to available power	It is important to correctly match the tractor to the power needs of the drills. Conventional drills are often less power intensive than no-till drills.

Smaller scale technologies are usually characterized by small field sizes and limited availability of energy, often also accompanied by limited financial resources. Most small-scale planters sow fertilizer and seed simultaneously in separate slots. There is a wide range of small-scale no-tillage seeding equipment available, each suited to different sources of power and field conditions.

Table 22: Small Scale No Tillage Seeding Equipment

Equipment	Details
Hand-jab planters	Hand-jab planters do not require access to power and are low-cost. They are easy to operate and often used in small scale farms. Their small size makes them suitable for hilly, stony and stumpy areas as well as for intercropping.
Row-type planters	The operation of row-type platers is similar as for larger machines. Most of them use discs, which are applied with downforce, via the application of weights.
Planters adapted from power tillers	Power tillers are normally used for conventional tillage. By eliminating some of the powered blades to till narrow strips and leave the ground between the rows untilled, it is possible to adapt them to no-tillage seeding.

[21] FAO, No-tillage Seeding in Conservation Agriculture, 2007

Other options, such as tractor-based drills, widely used in South-East Asia, also exist.

Despite the use of added crop diversity, rotation and enhanced biodiversity, some application of crop protection products may be required. Herbicides therefore remain an important factor in conservation agriculture.

3.2.4.4. Resilient animal fodder

Livestock feed security is a major limitation to livestock production in semi-arid lands. Climate change has significant impacts on livestock in the West Bank. Recurring droughts, as well as overgrazing, have resulted in reduced access to grazing land and increased dependency on imported fodder. Decreasing rainfalls are likely to increase this pattern and further impact livestock in the West Bank. It is therefore crucial for herders to gain access to sustainable, affordable animal feed. The sector has, therefore, identified the development of initiatives and national policies to reduce cost of production inputs, especially prices of fodders, fertilizers and pesticides as one of priority policies.

Potential technologies to increase animal fodder resilience include the introduction of drought-tolerant species, building large-scale grain storage silos, the introduction of alternative fodder, such as feed blocks, improved pasture management and alternative cropping systems, among others.

Table 23: Technologies to Increase Animal Fodder Resilience

Technology	Details
Drought tolerant species	Drought tolerant species in forage crops, suitable for animal feed, include rye, triticale, wheat, barley and oats, among others. While rye and triticale are the most resistant to droughts, they are not cultivated throughout the region. Wheat, barley and oats are already cultivated throughout the region and have some tolerance to droughts. Further research and technology transfers are required for the crops to become more resilient in Palestine.
Storage silos	There are several types of silos available around the world. The most common type is the concrete stave silos. Concrete stave silos allow to store plant grain crop such as corn and sorghum. Oxygen limiting silos are made of steel panels. They are used to store low moisture hay crop silages and high moisture grain. Other technologies, such as plastic bag silos, are also available, but remain expensive.
Feed blocks	Feed blocks are made of a mixture of one or multiple agricultural by-products, which are then aggregated with a binder. Feed blocks can be prepared from a number of by-products, such as straws and fruit waste, and differ in nutritional value depending on their contents.
Hydroponics (Aquaponics)	Hydroponics is a soilless method of growing plants and crops. Plants can be grown in an inert substrate, such as sand and gravel, or in an aqueous medium. Hydroponic fodder production can provide an alternative source for fodder production, it has already been tested in the West Bank.[22] Hydroponic

[22] FAO, Alternative fodder production for vulnerable herder in the West Bank, 2015

	fodder production could in theory be used as part of an aquaponics system, in which it would be combined with fish farming within a closed system that uses wastewater from the fish tank as a fertilizer. However, this requires to be piloted.

3.2.4.5. Water harvesting

Water harvesting is the accumulation and storage of water / rainwater runoff for reuse before it reaches the aquifer or evaporates. The water can then be use to grow crops and to support livestock. Rainwater conservation and harvesting for agriculture use provides opportunities to reduce the high risk of yield losses associated with low rainfall and uneven distribution throughout the season. Rainwater harvested for agriculture can be collected from a number of surfaces, including roofs, soil surfaces, road surfaces, concrete and plastic surfaces, among others. Natural surfaces, such as trees and others can also be used.

Rainwater harvesting for agricultural use is highly relevant to the Palestinian context. In Palestine, traditional water harvesting techniques include in-soil profile, family cisterns, small and medium collection dams, and have been used for several decades to capture rooftop runoff for many purposes, including cooking, washing, and in some cases irrigation. Climate change offers additional stress to already limited precipitation in the region, as it is expected that there will be a decrease in winter rainfall and an increase in mean annual temperature. However, the extent of the opportunity offered by water harvesting will be dependent on access to lands in Area C, especially for larger scale infrastructure.

Under this roadmap, small scale water harvesting for agricultural purposes will cover cisterns of at least 100 m^3. Larger scale systems, such as dams, will also be considered.

3.2.5.Barriers overview for the sector and specific to technologies

The agricultural sector faces the following common barriers for the introduction of the technologies.

Table 24: Barriers in the Agriculture Sector

Type of barrier	Summary
Financial	Significant initial investment required especially for large scale structures
Cultural	Resistance towards changing traditional agricultural practices
Geographical, access to water and equipment	Limitations in terms of access to land, water, and tools and equipment

The introduction of climate smart agriculture technologies is limited by a significant financial barrier. For small scale technologies, such as precision agriculture, conservation agriculture and water harvesting, significant investment is required from smallholder farmers for equipment. This requires support for the provision of adequate finance, technology transfer and capacity building. Financing is critical for incentivizing farmers and communities, public institutions and private sectors to invest in introducing these technologies.

Financing is also critical to the introduction of larger scale technologies, such as large silos for resilient fodder. This will not only require financing for the private sector through incentives, but also support from external resources and development of adequate schemes for public private partnerships.

Culturally, it is important to emphasize that changing practices for farmers, which may have used similar techniques over a number of generations, may be challenging. Access to land and water remains limited and will have to be taken into account for the introduction of the all technologies. Access to tools and

equipment may also constitute a significant barrier, which needs to be handled for the introduction and diffusion of the technologies.

3.2.6. Implementation Plan

It is crucial to determine which technologies will contribute on the short, medium and long term to achieving higher agricultural resilience and to mitigate the impacts of climate change on food production. Although it is possible to consider each of the technologies identified in a separate action plan, there are significant synergies with one another, which suggest that transversal measures for the introduction of the technologies, as well as individual measures for each technology, should be identified.

Transversal measures to each of the technologies, such as institutional capacity building, will benefit all technologies and allow for the development of medium to longer-term measures. The implementation plan details transversal and individual actions required to ensure their diffusion.

The implementation plan will adopt a climate-smart agriculture approach, to which all technologies will contribute. Given Palestine's constraints in terms of land use, it would be preferable to focus on applying climate smart agriculture on existing agricultural land. This would enable Palestine to start diffusing some technologies on the short term. It would also be preferable to focus, on the short term, on affordable technologies, which require limited inputs and infrastructure to be implemented.

On a longer term, Palestine could consider the diffusion of these technologies to other areas throughout the West Bank and Gaza Strip, as well as the development and technologies requiring significant investment, technology transfers or the development of an enabling environment.

Women's contributions on family farms are often underestimated and therefore underrepresented. They often have less access to technology and resources than men. At the household level, women are often the decision makers regarding food management and rationing. For a multitude of reasons, female-headed households bear the brunt of food insecurity. For these reasons, building on the knowledge of women regarding sustainable home gardening and farming practices and developing their capacity on relevant agricultural technologies will directly impact the ability of families – particularly those most vulnerable - and farms to maintain or improve food security. Building the capacity of female-owned or female-led farms may lead to increased production and therefore increased income, offering women farmers greater resilience towards climate change.

The NDC aims at introducing climate-smart agriculture in more than 50 percent of farms by 2040. By 2025, Palestine will aim to achieving climate smart agriculture in at least 10 percent of the farms by 2025 and at least 25 percent by 2030. The timeline for the implementation plan should therefore be in line with these objectives, by adopting similar objectives on the short-term (2025) and the medium-term (2030).

Action 2.1 – overall capacity building and awareness raising

Building the capacity and raising the awareness of the relevant stakeholders such as government institutions, potential investors, developers, end-users, farmers and local communities, and financial institutions, will enable both short-term and long-term actions to be implemented efficiently. On the short-term, this will support the implementation and scaling-up of climate smart agriculture technologies, such as solar pumps, efficient irrigation and introduction of climate resilient varieties.

It will also enable Palestine to prepare the next steps in order to introduce and disseminate more complex technologies, such as remote sensing and digital advisory services, and to develop the enabling environment to introduce or scale-up technologies such water harvesting and resilient fodder.

Activity 2.1.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions of the agricultural sector such as MOA, PACI and PIF. This would allow them to make

informed decisions to design the required policies such as regulations, standards, fiscal instruments and incentives, among others, to support the implementation and dissemination of climate-smart agriculture. This is especially required for PACI and PIF, which could leverage significant investments from the private sector in climate smart technologies. Capacity building will also be provided to PWA for technologies related to water harvesting and irrigation.

Activity 2.1.2 Technical capacity building and partnership building – to enhance the technical capacity of relevant government institutions responsible for agricultural development, seed development and research as well as data management. This action will aim at preparing Palestine for medium to longer-term actions which require technical knowledge. Those will include the introduction of new seeds, the introduction of resilient fodder, remote sensing, and the introduction of alternative fodder, such as fodder trees and feed blocks and alternative cropping systems, among others. It will include capacity building to MOA, to the Ministry of Telecom and Information Technology and to seed banks, such as the seed bank established by the Union of Agricultural Work Committees in 2008 as an example.

Activity 2.1.3 – Awareness raising – to raise farmers' awareness. The successful implementation of climate smart agriculture technologies cannot be realized without the acceptance, support and participation of smallholder farmers regarding the benefits of using these technologies instead of traditional practices. MOA already has experience in raising awareness towards smallholder farmers. Farmer's associations, The Milk Council, Sheep Council and the Palestinian Livestock Cooperatives Union should also be leveraged. This can be achieved through demonstration farming, knowledge dissemination, workshop development and other similar activities.

Entity-in-charge: The implementing entity for the overall capacity building and awareness raising actions is proposed to be spearheaded by MOA.

Costs: The costs associated with the implementation of this action is estimated at USD 400,000 which involves conducting workshops and trainings, engaging international experts, and deploying public awareness materials.

Action 2.2 –Development of the enabling environment for private sector engagement in climate-smart agriculture

Most of the measures will be mainly driven by smallholder farmers or by larger private sector stakeholders. It is therefore important to develop the enabling environment to encourage them to take-up climate-smart agriculture technologies. The enabling environment will include the development of a regulatory environment, guideline development, support to design and provision of adequate financing, among others.

Activity 2.2.1 – Policy development and enforcement – to create an enabling environment for climate-smart technologies to be implemented in Palestine. Policies supporting one technology could also support another, directly or indirectly. Policies need to emphasize the role of water in agriculture and to incentivize both efficient irrigation and using of alternative water resources.

It will be important for MOA and PWA to develop the appropriate policies to incentivize the off-take of efficient irrigation techniques and technologies. Potential policy measures include the development of standards related to water leakage and to irrigation technologies encouraged or allowed depending on the cropping system and soil and the development of additional measures to prevent the overuse of water, among others.

Policy development related to developing alternative water resources for irrigation will also be extremely important. Although water harvesting is already a priority in a number of policies in Palestine, it will be important for MOA and PWA to develop the appropriate policies to incentivize the off-take of water harvesting in Palestine. Potential policy measures include the development of incentives for smallholder farmers interested in the technology, such as tax breaks and comprehensive support in setting-up an

irrigation system in coordination with water harvesting.

Activity 2.2.2 – Guideline development for the development of irrigation systems – to provide the required guidance to the private sector to implement efficient irrigation in Palestine. Guidelines will follow policy development and enforcement. They will guide the WUAs, the private sector and farmers on the type of irrigation system, technology and techniques that fit their production site. It will also provide guidance to WUAs on the development of water management rules and tariffs if required, in order to prevent the overuse of water.

Activity 2.2.3 – Potential mapping for water harvesting – to identify and map potential locations to set-up water harvesting infrastructure in Palestine for climate smart irrigation. Mapping potential locations will support producers if their farm can accommodate water harvesting. It will also support a number of communities in understanding how to best invest in the technology. For example, setting-up a cistern for several producers could be an option in some communities, which have limited needs in water for irrigation.

Activity 2.2.4 – Capacity building to the private sector and service providers related to irrigation diagnostic and design – considered as a solution that could be implemented with a minimal amount of de-risking measures. The diffusion of efficient irrigation technologies and techniques will require designing irrigation systems that are adapted to the soil and cropping systems. While drip-irrigation may be relevant for some soils, it may be counterproductive depending on the cropping system and on how the field is organized. Capacity building will be provided to the private sector, following the guidelines prepared during the policy development phase. It would be preferable to involve service providers or extension services, which can then provide their expertise to smallholders, rather than training to a limited number of farmers.

Activity 2.2.5 – Securing land, water and energy – to secure the required resources to implement the technologies. Most of the locations for water harvesting and irrigation are expected to be located in Area C. Under the current situation, building water harvesting infrastructure and irrigation bears significant risks for smallholder producers if they do not obtain permits. Supporting this process will be crucial in de-risking investments in these technologies.

Large scale silos, alternative cropping technologies, such as hydroponics, require access to land, water and / or energy. Securing access to these is crucial for the technologies to be introduced in Palestine.

Activity 2.2.6 – Provision of adequate financing – to provide adequate financing to farmers to invest in climate smart agriculture technologies, especially related to water harvesting and irrigation. While water harvesting technologies are affordable, smallholder producers will still require support for financing up-front costs. Irrigation technologies, such as drip irrigation, also require significant up-front support. Under this measure, PACI will develop adequate financing measures for climate-smart agriculture technologies which meet the needs of smallholder producers and can be provided at affordable rates.

Larger investments will require different financing schemes. For example, large scale silos or alternative cropping can be interesting for the private sector. However, these require significant up-front investments. Public Private Partnerships could be a way to involve the private sector in investing in these technologies. Concretely, up-front costs would be covered by grants from international resources or by the private sector, who would then receive payments from the State of Palestine for the provision of services to producers, such as stocking grain or fodder production. This type of arrangement could be developed by Palestine to attract the private sector for such large-scale investments.

Entity-in-charge: The implementing entity for the development and enforcement of relevant policies is proposed to be spearheaded by MOA as lead agency and PWA as a partner agency.

Costs: The costs associated with the implementation of this action is estimated at USD 750,000 which

involves conducting engaging national and international experts to support the formulation and development of policy measures as well as of the mapping, and conduct the necessary workshops, trainings and consultations.

Action 2.3 – dissemination of conservation agriculture practices

Disseminating conservation agriculture practices will require the development of a demand led by farmers or farmers' associations, which will lead to the development of a market led by the private sector for equipment and inputs related to the practice. Achieving wide-spread adoption of the practice can be achieved with the relevant actions and measures:

Activity 2.3.1 – Diffusion of direct seeders and other inputs – considered as a solution that could be implemented with a minimal amount of de-risking measures. The diffusion of direct seeders and other inputs, such as herbicides, is crucial for farmers to off-take the technology. Direct seeders will enable farmers to work with no-till. Low-cost seeders cost between USD 1,500 and USD 6,000 in the region, in countries such as Syria or Iraq[23]. The initial cost of the technology may therefore be a significant barrier for individual farmers. The diffusion of direct seeders will therefore be focused at farmers' association level. Financing may be provided by PACI.

Entity-in-charge: The diffusion of direct seeders will mainly be supported by internal resources and / or private sector driven. Farmers associations and MOA will be closely associated to the measure.

Costs: The implementation of this action is expected to leverage around USD 5,000,000 from international support and the private sector, at approximatively USD 5,000 per seeder.

Action 2.4 – dissemination of efficient climate-smart irrigation, solar water pumps and climate-smart water management

Disseminating these technologies will require the development of a demand led by farmers or farmers' associations, which will lead to the development of a market led by the private sector. Solar pumps present significant mitigation impact. If the technology is applied on coordination with climate-smart water management practices and efficient irrigation, it can also contribute to climate adaptation. While this can be achieved on the short-term, it requires the following actions and measures:

Activity 2.4.1 – Diffusion of efficient, climate-smart irrigation technologies – considered as a solution that could be implemented with a minimal amount of de-risking measures. Depending on the diagnostic conducted as part of the capacity building, private sector stakeholders, through WUAs or farmers' associations will be encouraged to introduce efficient and climate-smart irrigation technologies which are adapted to their fields and cropping systems. The initial costs of the technologies are among the major barriers to adopting efficient and climate-smart irrigation systems, such as for drip-irrigation, which requires extensive piping. Their diffusion will therefore be focused at farmers' association level, in close association with Water Users Associations (WUA). WUAs in Palestine organize the distribution of irrigation water among users. Although installing irrigation systems can be prohibitive for a single user, it is affordable for multiple users under WUAs. Providing incentives to farmers and WUAs to install efficient and climate-smart irrigation systems will be done as part of the development of the policy environment and incentives mentioned earlier. Financing may be provided by PACI.

The implementation plan will target 25 percent of the irrigated lands in Palestine, or currently approximatively 20 percent of land used in agriculture[24]. This represents 60,000 dunums.

[23] ICARDA, conservation agriculture: opportunities for intensified farming and environmental conservation in dry areas, 2012

[24] National Agricultural Sector Strategy, (2017 2022)

Activity 2.4.2 – Diffusion of solar water pumps – considered as a solution that could be implemented with a minimal amount of de-risking measures. The diffusion of solar water pumps that lift well water to irrigation systems present significant benefits. The initial cost of solar technology coupled with the established maturity of electric and diesel are among the major barriers to solar water pump adoption. The diffusion of solar water pumps will therefore be focused at farmers' association level, in close association with Water Users Associations (WUA). WUAs in Palestine organize the distribution of irrigation water among users. Although buying solar water pumps can be prohibitive for a single user, it is affordable for WUAs. Providing incentives to farmers and WUAs to buy solar water pumps will be done as part of the development of the policy environment and incentives mentioned earlier. Financing may be provided by PACI or international support.

Activity 2.4.3 – Diffusion of climate-smart water management practices – considered as a solution that could be implemented with a minimal amount of de-risking measures. The adoption of climate-smart water management practices is extremely important to ensure that the use of solar pumps does not lead to the overuse of water resources in Palestine. While water management practices can be supported by technology, such as water use monitoring devices and efficient irrigation (see next section), it also corresponds to a set of practices which can be used to enhance efficiency, such as water allocation, scheduling and distribution, water saving techniques and adopting less water intensive crops, among others. This will be promoted at farmer level through the development of knowledge material and demonstration farming. It would be preferable to target farmers who use solar pumps and efficient irrigation to achieve maximum impact, both in terms of mitigation and adaptation.

Entity-in-charge: The diffusion of solar pumps will mainly be private sector driven under the support of external resources, while the adoption of water management practices will be done at farmers' level. WUAs, farmers associations and MOA will be closely associated to the effort, especially in terms of capacity building.

Costs: The implementation of this action is expected to leverage around USD 11,000,000 from the private sector, at approximatively USD 5,000 per solar pump. Costs related to efficient irrigation are estimated at USD 3,000 to 10,000 per 10 dunums (one ha) (lower end for sprinklers and higher end for drip irrigation),[25] depending on the system, or approximatively USD 48,000,000. Costs related to capacity building for the diffusion of climate-smart water management practices are estimated at USD 200,000.

Action 2.5 – Technology transfers

The enabling environment for climate-smart agriculture, will include measures related to conducting research. Some technologies, such as resilient fodder, require extensive research on which technologies might be applicable to Palestine. Although some technologies, such as alternate cropping systems or large-scale silos, are straightforward, other require extensive research to understand if they will be applicable to the local conditions. The development of the enabling environment will therefore focus on research as well as on developing policies and regulations to support private sector engagement for other technologies on a shorter term.

Activity 2.5.1 – Research and technology transfers for climate resilient species – considered as a solution that will require significant external support. Identifying relevant seeds to Palestine soil and climate will require research and development. While Palestine can rely on research conducted in similar countries, it is important to have seeds adapted to local conditions, which will require additional research. This will require significant support from external sources, either in terms of technical assistance or financial resources.

Palestine could also consider introducing seeds which have been developed for similar conditions,

[25] FAO, Irrigation Techniques for Small-scale Farmers: Key Practices for DRR Implementers, 2014

without having been adapted to Palestine's local conditions. This would enable Palestine to introduce climate resilient seeds on a shorter timeline. Seeds would have to be tested beforehand, which would still require support in terms of technical assistance or financial resources.

Activity 2.5.2 – Research and technology transfers for resilient fodder – to identify technologies adapted to local conditions to introduce and disseminate resilient fodder. There are several options for Palestine in order to further explore the technologies available and their adaptation to local conditions. Palestine can rely on internal research. It can also rely on international technology transfers. For example, drought-tolerant species, alternative fodder, such as feed blocks, among others, may be introduced by benefiting from technology transfers. Fodder trees and feed blocks are used in arid climates in East Africa and other countries as well. This step is essential to successfully choose the optimal technology for Palestine.

Entity-in-charge: The implementing entity for the development and enforcement of relevant policies is proposed to be spearheaded by MOA.

Costs: The costs associated with the implementation of this action is estimated at USD 500,000 which involves conducting engaging national and international experts to support the formulation and development of policy measures as well as to support technology transfers.

Action 2.6 – dissemination of water harvesting technologies

Disseminating water harvesting technologies will require the development of a demand driven by farmers and farmers' associations, which will lead to the development of a market driven by the private sector.

Activity 2.6.1 – Diffusion of water harvesting technologies – considered as a solution that could be implemented with a minimal amount of de-risking measures. The diffusion of water harvesting technologies will be encouraged by the provision of an enabling environment. This action will be focused on leveraging investment from private stakeholders supported by climate finance instruments. The Ministry of Agriculture has identified a sector target of achieving 10 million cubic meters of water harvested by 2030. Hence, the implementation plan will aim to achieve this for the introduction of water harvesting technologies for climate-smart agriculture purposes, in line with MOA's target. This number will be adjusted after the potential mapping for water harvesting has been implemented.

Entity-in-charge: The diffusion of efficient irrigation technologies and techniques will mainly be private sector driven with MOA engagement as a sector lead.

Costs: The implementation of this action is expected to leverage around USD 30,000,000 from the private sector, at approximatively USD 30,000 per 10,000 m^3 collection system (small dam)

Action 2.7 – Introduction of alternative cropping technologies

Introducing alternative cropping technologies will require the support of external financing through grant financing, as well as the involvement of the private sector. Hydroponics / aquaponics could be used to produce fodder in a closed environment, thus supporting its continuous production. However, land, access to water and energy are required.

Activity 2.7.1 – Introduction of hydroponic / aquaponic farming – considered as a solution that could be implemented with external support and significant de-risking measures. The introduction of hydroponic / aquaponic farming would require technology transfers, as well as support from the provision of an enabling environment. These would be provided as part of the measures related to developing the enabling environment. This action will be focused on leveraging investment from private stakeholders. It is expected that early adopters may invest in hydroponic / aquaponic farming for limited areas. Under the implementation plan, targets for hydroponic farming will be set at least at 100 dunums, or 10 ha per

year, targeting at least 700 dunums.

Entity-in-charge: The introduction of hydroponic farming will mainly be MOA with private sector sector engagement.

Costs: The implementation of this action is expected to leverage around USD 6,125,000 from the private sector, at USD 35,000[26] per 4 dunums.

Action 2.8 – Introduction of large-scale silos

Introducing large-scale silos seems feasible if land is secured. It would enable Palestine to store grain for longer periods and be more resilient to droughts and / or market fluctuation.

Activity 2.8.1 – Introduction of large scale silos – considered as a solution that could be implemented with external support and de-risking measures. The introduction of large-scale silos technologies will be encouraged by the provision of an enabling environment. This action will be focused on public engagement. The State of Palestine, supported by external resources, will invest and may provide services to producers. Income streams will be provided by the services paid by the producer to store grain.

Entity-in-charge: The introduction of large-scale silos will mainly be public sector driven, led by Ministry of National Economy.

Costs: The implementation of this action is expected to leverage around USD 9,000,000 from the international resources.

Action 2.9 – Introduction of climate resilient seeds

Introducing climate resilient seeds will require the development and adoption of seeds resilient to drought, heat or salinity for crops cultivated in Palestine. Resilient crops will offer direct adaptation benefits, by improving productivity in conditions which would not be favorable to productivity otherwise, such as increased temperatures, drought and salinity. Climate resilient crops can also consume/ require less water, which is a significant benefit for Palestine. The introduction of climate resilient seeds requires the following actions and measures:

Activity 2.9.1 – Introduction of climate resilient seeds – considered as a solution that could be implemented with a minimal amount of de-risking measures, with external support to some extent. The introduction of new seeds will be led at farmers' level. Similar to other new practices, introducing new seeds can be a disruptive / unwelcomed practice compared to the farmers' habits. It is therefore crucial to raise awareness on the benefits of climate resilient seeds, by developing knowledge documents and setting-up demonstration farming.

Entity-in-charge: Introducing the seeds into farming practices, will be done at farmers' level in close collaboration with farmers associations and MOA.

Costs: The implementation of this action will be estimated as part of action 2.5.1.

Action 2.10 – Introduction of technologies for soil and crop monitoring and management, including remote sensing

By deploying sensors and mapping fields, farmers can begin to understand their crops at a micro scale,

[26] https://www.greentechmedia.com/articles/read/the-farm-of-the-future-will-grow-plants-vertically-and-hydroponically#gs.ohwqkr

conserve resources, and reduce impacts on the environment. Soil and crop monitoring can be achieved through remote sensing, either by using small drones or ground based remote sensor.

> Activity 2.10.1 – Introduction technologies for soil and crop monitoring – considered as a solution that could be implemented in the long-term, with significant de-risking and external support. The introduction of technologies for soil / crop monitoring may include ground based remote sensors, remote sensing using imagery equipped drones or other high-end technologies using satellite-based data imagery. Imagery-equipped drones are often technically and financially affordable for small farmer communities. Ground based sensors can be more expensive but may provide additional data compared to drones. The diffusion of drones and technologies can therefore be implemented at farmers' association level. Some technologies are linked with easy-to-use software, which does not require high-end technical understanding. However, introducing these technologies may require importation permits from Israel, which will limit their diffusion.

Entity-in-charge: The diffusion of soil and crop monitoring will mainly be private sector driven, either by large farms or farmers' associations. MoA will lead negotiations with Israel for importation permits for the material. The technology will target at least 1 per cent of lands used for agricultural purposes (1 per cent of 1.2 million dunums).

Costs: The implementation of this action is expected to leverage around USD 500,000[27] from the private sector. Costs related to capacity building for the diffusion of the technology are estimated at USD 100,000.

Action 2.11 – Introduction of other technologies

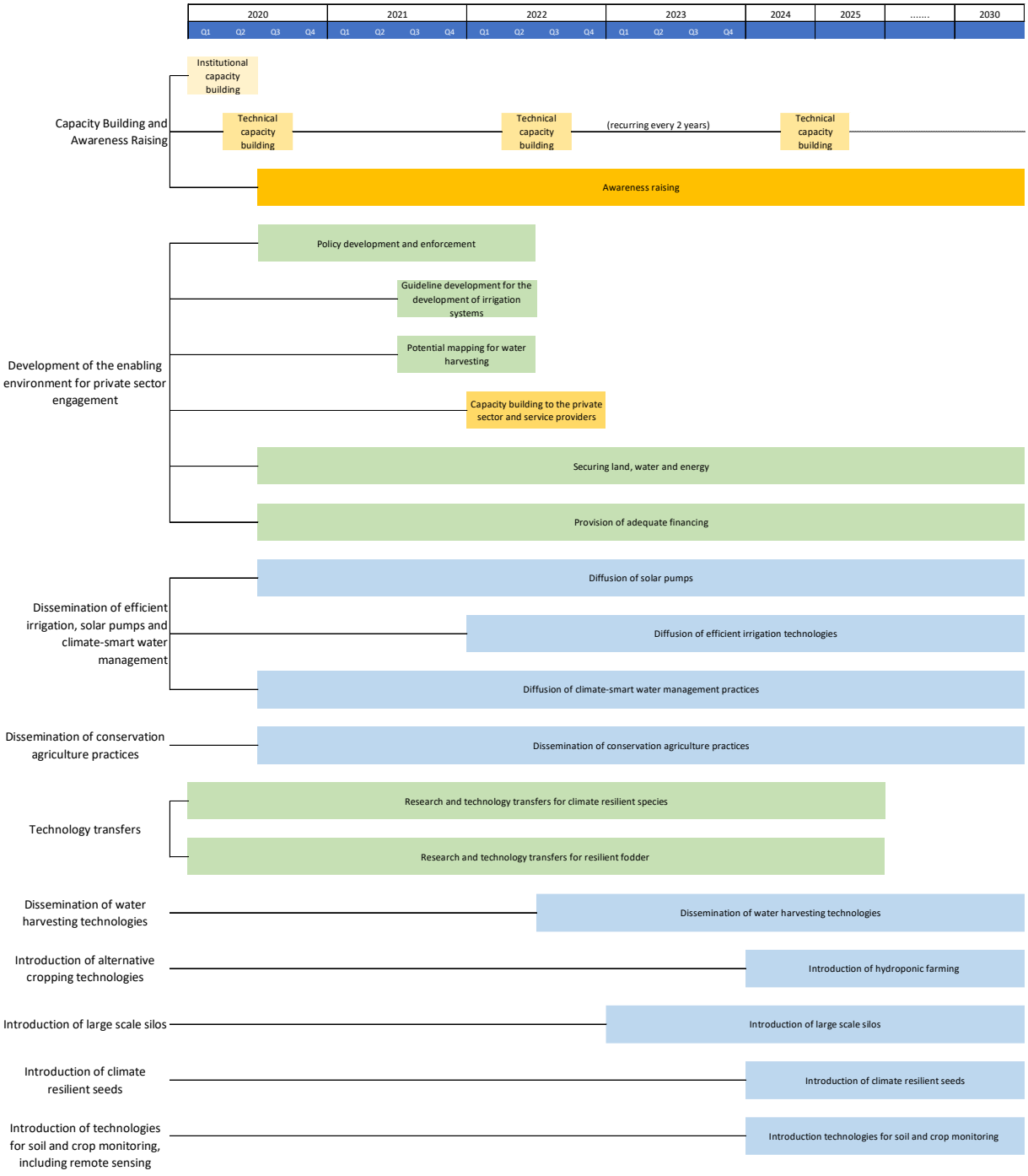
Technologies transferred will be introduced as part of this action. The cost and entity in charge depend on the technology and will be detailed at a later stage.

3.2.7. Timeline

Figure 6 shows the overall timeline for the implementation of technologies related to agriculture in Palestine. The implementation timeline for setting up the enabling environment is planned to be completed within three years. After which, it is planned that technologies requiring little de-risking, such as irrigation, solar pumps and climate smart water management, as well as conservation agriculture practices, are disseminated quickly and continuously. Longer term de-risking measures such as technology transfers, will enable other technologies to be introduced on a longer term.

[27] Approximatively USD 26 / ha per year in 2005 for soil sampling and field mapping, estimated in The Journal of Terrestrial Observation, On-Farm Profitability of Remote Sensing in Agriculture, 2008.

Figure 6: Agriculture Sector Implementation Timeline



3.2.8.Expected impacts

The successful diffusion of technologies related to agriculture and climate change mitigation in Palestine will result in direct impacts on food production and security. Agriculture will be more resilient to water scarcity, which will lead to less damage in food production. Better practices in water management and efficient irrigation will lead to a more efficient use of water, which will greatly contribute to climate change adaptation in Palestine

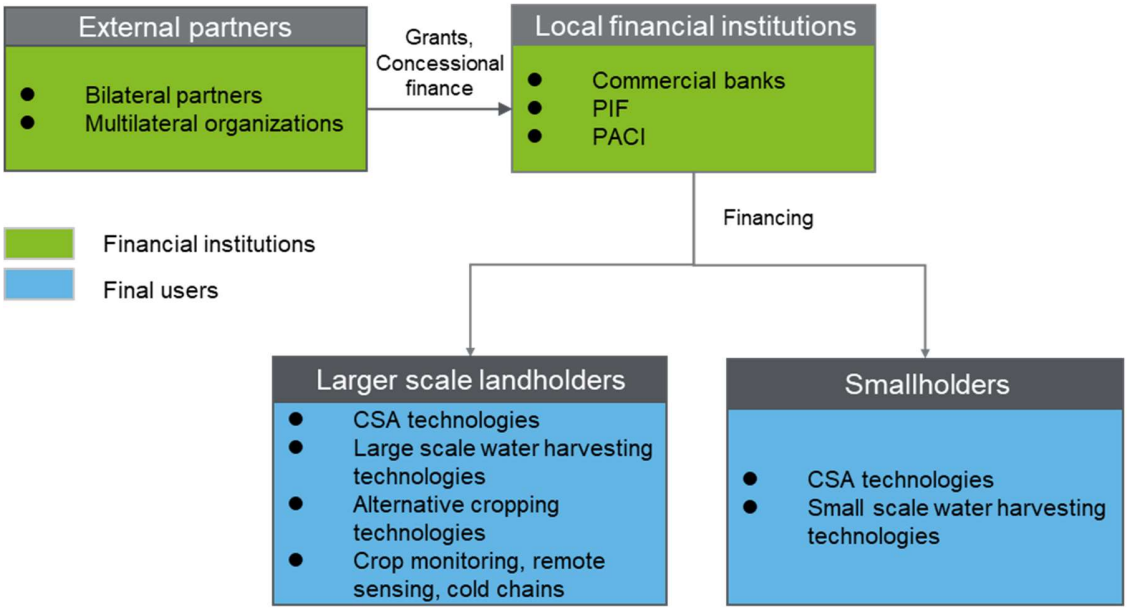
3.2.9.Financing

The overall approach to financing for the roadmap is detailed in Annex 2: approach to financing. In the agriculture sector, the main users of the technologies are private sector smallholders and, more rarely, larger scale landholders. It will therefore be crucial to provide the right financing conditions/ schemes to trigger private sector investments from smallholders for the introduction of new technologies.

Under this approach, Palestine and international partners will mainly provide grant financing related to technical assistance. Activities financed will not only include technical assistance towards the public sector, but also support to awareness activities, mapping for water harvesting and capacity building to the private sector and service providers related to irrigation diagnostic and design as well as support to demonstration farming, when required.

Based on the result of the technical assistance, the private sector will provide financing pertaining to the direct implementation of the activities. The financing approach therefore aims at leveraging external support, in the form of grants and concessional finance, in order to develop bankable and sustainable business models and conditions for private sector engagement. It is expected that smallholders will be important stakeholders in the financing of the implementation plan, by introducing the technologies on their own funds or by being supported by WUAs and local financial institutions. Some potential models include the following:

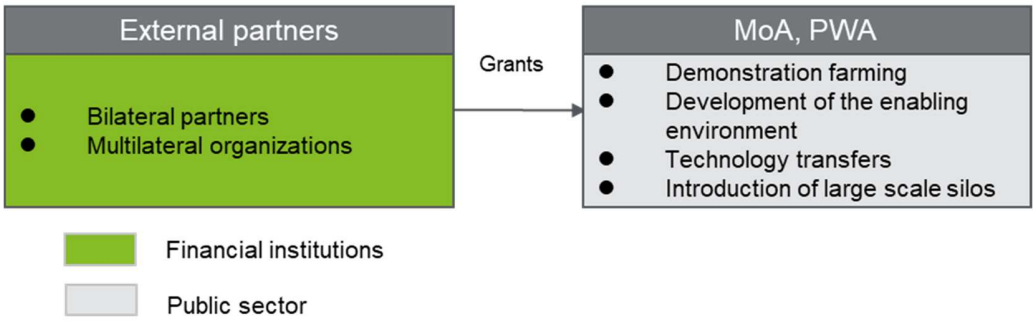
Figure 7: Potential Financing Options for the Agriculture Sector



Other large infrastructure development, in case it is led by the public sector, will be supported by grant

financing.

Figure 8: Potential Financing Options for the Agriculture Sector, Public Sector Led



Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in Table 25.

Table 25: Financing for Agriculture Sector Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 2.1 – overall capacity building and awareness raising	Technical assistance	400,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 2.2 –Development of the enabling environment for private sector engagement in climate-smart agriculture	Technical assistance	750,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 2.3 – dissemination of conservation agriculture practices	Equipment	5,000,000 (5,000 per seeder)	Private sector led	Local financial institutions, producers
Action 2.4 – dissemination of efficient climate-smart irrigation, solar water pumps and climate-smart water management	Equipment	59,000,000	Private sector led	Local financial institutions, producers, WUAs
	Technical assistance	200,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 2.5 – Technology transfers	Technical assistance	500,000	Grant	Bilateral donor / International organization
Action 2.6 – dissemination of water harvesting	Equipment	30,000,000	Private sector	Local financial institutions,

technologies			led	producers, WUAs
Action 2.7 – Introduction of alternative cropping technologies	Equipment	6,125,000	Private sector led	Local financial institutions, producers
Action 2.8 – Introduction of large scale silos	Equipment	9,000,000	Private sector led	Local financial institutions, large private sector stakeholders
Action 2.9 – Introduction of climate resilient seeds	Technical assistance	To be determined based on 2.5	Grant	Bilateral donor / International organization / Domestic resources
Action 2.10 – Introduction of technologies for soil and crop monitoring, including remote sensing	Equipment	500,000	Private sector led	Local financial institutions, large private sector stakeholders
	Technical assistance	100,000	Grant	Bilateral donor / International organization / Domestic resources

Indirect costs and financing

Other actions, that may stem from the measures undertaken under the implementation roadmap, include the implementation of the policies developed under the roadmap. For example, the costs associated to the introduction of longer-term technologies through technology transfers, costs related to securing land and energy, and costs related to financing arrangements have not been included.

External financing

Requests for external financing will focus on measures which are of high priority to the country and enable Palestine to implement its ambitious NDC. This takes into consideration that Palestine's NDC is mostly conditional on receiving support in the form of finance, capacity building and technology transfer. As mentioned above, the agriculture sector is based on a number of smallholder producers. Smallholder producers will need to be at the center of the financing strategy for the introduction of all technologies related to water harvesting, irrigation and technologies directly related to production. External financing will therefore be requested for preparing the enabling environment for their participation and implementation of the prioritized technologies.

The first set of priority measures to be financed by external resources is therefore the development of the enabling environment for private sector engagement in climate-smart agriculture. This is the first step in order for smallholders to aim at introducing all technologies related to climate-smart agriculture.

Grants and concessional financing may also be used for blended finance, in order to support local financial institutions in provide financial products which are relevant to the needs of the private sector.

Longer term actions may also be supported by international partners, such as the introduction of climate resilient seeds or introduction of technologies for soil and crop monitoring, including remote sensing. These require significant resources and require capacity building. It is expected that grants or concessional financing supports the introduction and implementation of these technologies, while additional financing supports capacity building to the private sector, in order to cover most of the risks perceived by the private sector.

Potential sources of financing include the GCF, GEF, Adaptation Fund, as well as international organizations, international financing institutions and multilateral development banks such as the World Bank, and bilateral donors. FAO has spearheaded the introduction of climate-smart technologies in emerging economies and is very active in Palestine and may be a relevant partner for the introduction of some of these technologies. The Adaptation Fund may also be a source of financing. The adaptation fund has also supported a number of projects related to the resilience of agriculture sector to climate change as well as scaling up climate-smart agriculture.

3.3. Water and wastewater sectors

3.3.1. Current status of sectors

Sustainable management of water resources is vital to Palestinian's long-term prosperity. Water is essential for human and other life and crucial for the development of agriculture and industry, as every sector depends on secure and sustainable access to water. For Palestine, the sustainable management of water resources is not easy as the ongoing Israeli occupation and control over the vast majority of water resources limits Palestine's access to its water resources. Palestine also suffers from poor sanitation system. Current statistics show that only 60 percent of the generated wastewater quantity is collected. Regarding the wastewater networks coverage in Palestine, almost all areas of Gaza Strip are connected to wastewater networks while for West Bank, this is limited to only in main cities with partial coverage in most cases, which makes wastewater treatment infrastructure incapable of dealing with all collected wastewater quantities[28]. Therefore, improving the sewage collection infrastructure is a crucial component of the wastewater sector and a prerequisite for an integrated system that includes treatment and reuse. In addition, the lack of sanitation system and availability of these systems within Palestine, which is a result of Israel's policies towards Palestine's wastewater sector, is currently resulting in discharged wastewater to flow to Israel, where it is treated for reuse by Israel and the cost of treatment is deducted from Palestinian tax money which is collected by Israel for goods imported by Palestinians through Israeli controlled borders. This benefits Israel with access and sales of treated wastewater.

For the overall supply of water, Palestine is mostly reliant on groundwater where the majority of Palestinian water supply comes from either by wells or by springs.[29] There are more than 5,000 water wells in Palestine, most of which are for agriculture purposes with an average depth of 40-70 meters. However, abstraction of water already far exceeds natural recharge, placing additional pressure to the already limited water resource in Palestine. Since water resources are scarce (as a result of Israeli control of the available resources) and there is an increasing demand for water, the Palestinian Government has started to focus on developing non-conventional resources such as desalinated water and reuse of treated wastewater.[30]

3.3.2. Institutional arrangements

The implementation and scaling up of technologies in the water and wastewater sector in Palestine involves the engagement and participation of key government institutions. The following key government institutions

[28] State of Palestine (2016). National Water Sector Strategic Plan and Action Plan (2017 – 2022).

[29] ibid.

[30] ibid.

were identified which would play the leading role:

Table 26: Key Government Institutions in the Water and Wastewater Sector

Lead Institution	Description
Palestinian Water Authority	The Palestinian Water Authority (PWA), established in 1995 under Presidential Decree No. 90, is responsible for the overall management of water resources. It aims to protect water suppliers, carries out tasks related to planning, regulation and evaluation of water resources management in terms of economic and social feasibility, and monitoring the implementation of water and wastewater projects. PWA promotes private sector participating in the water sector in coordination with relevant authorities. PWA plays a key role in setting up the enabling environment for the implementation of water security technologies as well as private sector investments and participation. Mainly, PWA is responsible for ensuring that Palestinian people have access to quantity and quality water resources.
Water Sector Regulatory Council	The Water Sector Regulatory Council (WSRC), established under the Water Law 2014, is a legal independent entity responsible for water service providers' monitoring and regulation. Thus, it plays a critical role in ensuring the implementation of water security technologies by local government units, who are responsible for providing water services, through the WSRC.
Ministry of Local Government	The Ministry of Local Government (MOLG) is responsible for ensuring that local government units have the ability and tools to take actions in meeting strategic objectives. MOLG will play a critical role in ensuring that local governments have the resources necessary, financially and technically, to implement and disseminate water security technologies. In addition, in the West Bank, the wastewater treatment and collection service is the responsibility of the local authorities, which emphasizes the important role MOLG plays in the implementation of technologies related to wastewater management.
Ministry of Agriculture	The Ministry of Agriculture (MOA) is responsible for agricultural development in Palestine. It is the leading authority responsible for implementing priority technologies in the agriculture sector, which includes water harvesting technology that supports increasing water availability in Palestine for use in irrigation. It will play a key role in setting up the enabling environment for private sector and farmer engagement for supporting the introduction of water resources technologies for the agriculture sector.
Ministry of Health	The Ministry of Health (MOH) is an institution responsible for the development and management of the health sector in Palestine. It is responsible for monitoring and testing of water quality for the water and wastewater sector as well as for the agriculture sector. It will play an important role in supporting the introduction of technology related to water quality monitoring in this sector.
Environment Quality Authority	The Environment Quality Authority (EQA) aims to promote sustainable environmental development in Palestine. It is responsible for protecting the environment with all elements and preventing environmental hazards threatening all living things. It is the umbrella for all activities and studies related to environmental planning, protection, monitoring and control. It will play a key role in supporting the introduction of technology related to water quality and monitoring in this sector.

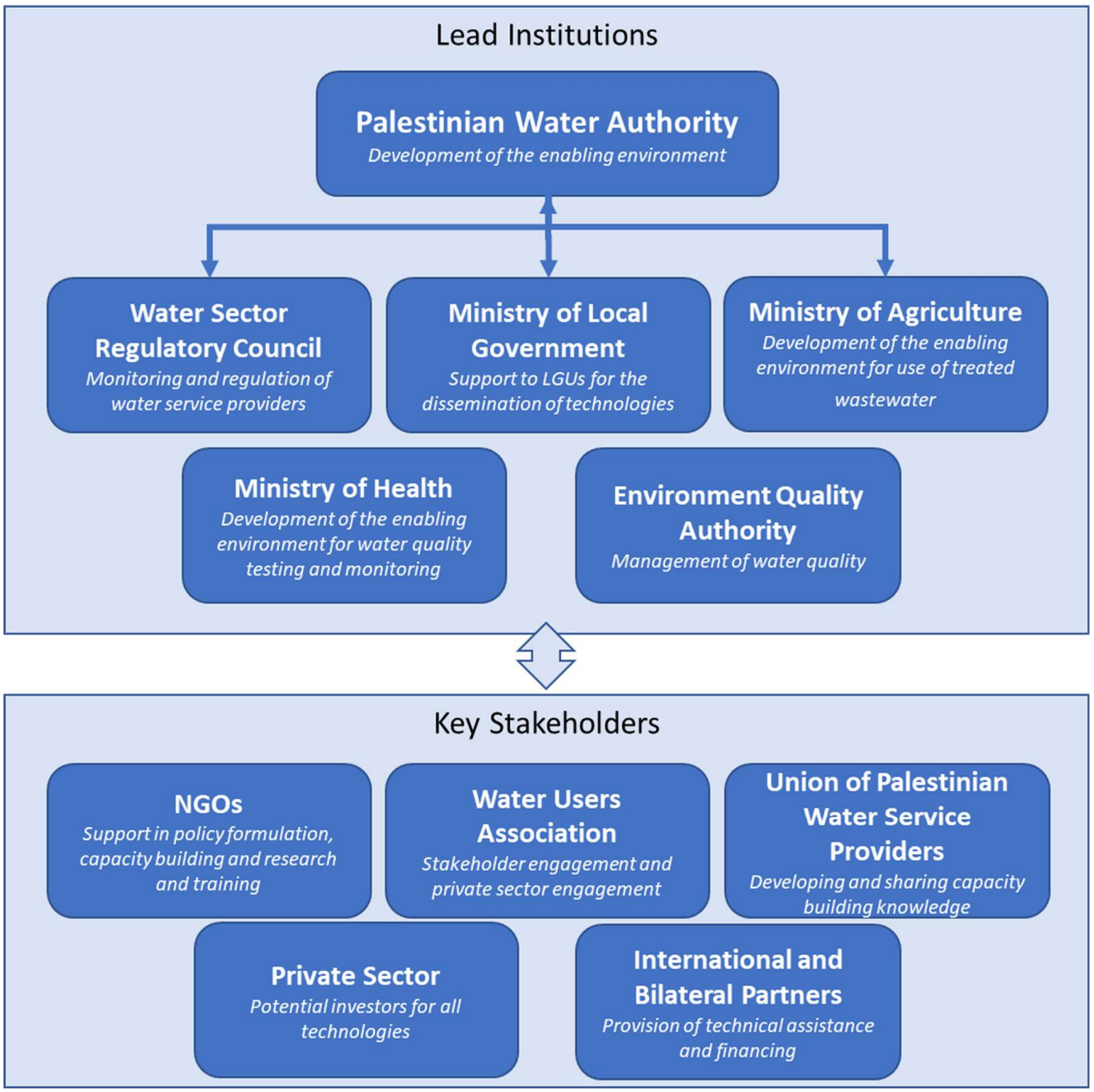
The following key stakeholders were also identified as playing major roles in the implementation of prioritized technologies in the water and wastewater sector, as well as supporting lead institutions:

Table 27: Key Stakeholders in the Water and Wastewater Sector

Key Stakeholders	Description
NGOs	Non-governmental organizations specialized in the water and wastewater sector in Palestine will be key to the implementation of prioritized technologies. Their engagement and participation will be important for activities in the implementation plan such as policy formulation, capacity-building and research, and training. They also may provide financial resources for the implementation of activities under the roadmap.
Water Users Association	The Water Users Association (WUA) in Palestine is an active body established to organize the distribution of irrigation water (both fresh water and treated wastewater) among the users. It also provides direct feedback to decision-makers regarding water-user requirements and concerns. WUA will play a key role in achieving PWA's objective to increase water availability in Palestine, both quality and quantity, from both conventional and unconventional sources. It is also expected that WUA will serve as the platform for stakeholder engagement and private sector engagement.
Union of Palestinian Water Service Providers	The Union of Palestinian Water Service Providers (UPWSP), established in 2007 under the initiative of main water service providers in Palestine, focuses on the institutional development of the Union and ensuring its financial sustainability, development of technical and institutional capacities of its members, development of regulatory framework for the water sector, and integration of small water service providers. It will play a key role in providing and sharing capacity building knowledge for its members and supporting in the development of an enabling environment.
Private Sector	Private sector actors in the water and wastewater sector includes potential investors in small- to large-scale rainwater harvesting technologies and on-site wastewater collection and treatment plants. These stakeholders play an important role in improving the water and wastewater sector, and will be instrumental in the implementation of the prioritized technologies and their dissemination.
International and Bilateral Partners	International and bilateral partners play a key role as partners to the Palestinian government in providing support in consideration of the country's limited resources. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the water and wastewater sector is illustrated in Figure 9.

Figure 9: Water and Wastewater Sector Institutional Framework



3.3.3. Objectives and goals of sectors

It is important that the Technology Roadmap contributes to achieving objectives and goals of the water and wastewater sector objectives as defined in Palestine's NDC. The introduction of prioritized technologies for the sector will greatly contribute to securing water availability and resources in Palestine. PWA's strategic plan identifies increasing the availability of water, both quantitatively and qualitatively, from both conventional and non-conventional water resources as one of its key objectives. This also relates to monitoring of quantity and quality of water resources in Palestine. In addition, the reuse of reclaimed wastewater has become an increasing interest to Palestine and it has become a major priority for the country, as confirmed by the Palestinian Water Policy adopted by the PWA and the Ministry of Agriculture. Thus, the reuse of treated wastewater provides an appealing solution to lower the burden and pressure on

Palestine's water resources.[31]

In addition, increasing water availability and improving water management in Palestine are identified as key climate adaptation actions in its NDC. The Technology Roadmap for this sector will therefore focus on increasing and management of water resources from both conventional and non-conventional resources.

3.3.4. Technologies overview

The prioritized technologies for this sector are rainwater harvesting, water resources monitoring technologies, and wastewater collection and treatment plants and advanced wastewater treatment technologies.

3.3.4.1. Rainwater harvesting

In Palestine, water supply is limited due to the control placed by Israeli occupation. Water use is significantly limited, in which a large number of Palestinians suffer from shortages of drinking and agricultural water. In addition, the rapidly growing population is placing extra pressure on the already limited supply of water in the region.

Rainwater harvesting is a type of water harvesting techniques that induce, collect, store and conserve local surface runoff (rain or surface water flow that occurs when soil is infiltrated to full capacity[32]. In Palestine, rainwater is a principal water resource that had been adopted since ancient times. This is similar to the rainwater harvesting technology proposed for use in the agriculture sector specifically for irrigation purposes, under the overall water harvesting umbrella. The technology for the water and wastewater sector will focus on securing water supply access for population in Palestine using rainwater as a water resource mainly for domestic use. A number of researches on the assessment of rainwater harvesting for domestic water supply in Palestine has been conducted and suggests that harvested rainwater is a viable resource that can contribute considerably to minimizing water shortage. Different types of rainwater harvesting technologies are described in Table 28

Table 28: Rainwater Harvesting Technologies

Technologies	Description
Rooftop	Water from rainfall is collected in vessels at the edge of the roof or channeled to a storage system via gutters and pipes. Roofs can be constructed with a range of materials including galvanized corrugated iron, aluminum, cement sheets, and titles and slates. Rooftop collection is suitable for household level application and can provide freshwater for domestic purposes and small-scale farming.
Ground surface	Water flowing along the ground during the rain is diverted toward a tank below the surface. There is a greater possibility of water loss when using this method compared to the rooftop system due to infiltration to the ground. In addition, the water is generally of lower quality than that collected directly from rainfall. This method is suitable for low topographic areas and is suitable for large-scale agriculture production as it allows for in-situ storage and usage of fresh water for irrigation.
Rock surface	Rock surface can also be used to collect rainfalls. Bedrock surfaces found within rocky top slopes or exposed rock outputs in lowlands often have natural hollows or valleys which can be turned into water reservoirs by building a dam. Similar to ground surface catchments, water is generally of

[31] Prospects of efficient wastewater management and water reuse in Palestine, Country Study, the Water studies Institute (WSI).

[32] Rainwater Harvesting. Climate Technology Centre and Network. Accessed from: https://www.ctc-n.org/technologies/rainwater-harvesting

	lower quality than that of direct collection of rainfall.

Source: CTCN[33]

3.3.4.2. Water resources monitoring technologies

Water is a critical resource in Palestine in which withdrawal is restricted by Israel. With growing population, coupled with expected impacts of climate change, securing water as a resource is an important adaptation action for Palestine. The West Bank and Gaza are facing significant and growing shortfalls in the water supply available for domestic use, and it is thus primordial to assure water security in Palestine. Implementing water resources monitoring systems will allow Palestine to effectively manage freshwater resources, collect essential information in characterizing the physical, chemical and biological status of water resources, and determine trends and changes over time. This technology will allow for monitoring of different water resources, both quantitatively and qualitatively, including violations. This allows for efficient management of water resources in Palestine. Examples of application of water monitoring technology are described in Table 29.

Table 29: Applications of Water Monitoring Technologies

Technologies	Description
Monitoring of water levels	Automatic monitoring of water levels, both for surface water levels and groundwater levels
Monitoring of open channel flow	Velocity-area method is the most commonly used monitoring technology for open channel flow
Monitoring of pipe flow	Types of popular instruments used for the monitoring of industrial and domestic pipe flow, and irrigation water include the electromagnetic flow meter, acoustic flow meter and water meter
Monitoring of water quality	Water quality monitoring can generally be divided into two kinds, one is the manual monitoring, and the other is automatic measurement. Manual monitoring can be combined with laboratory analysis
Monitoring of precipitation, evaporation and water storage	Automatic monitoring of water levels will allow for efficient monitoring of water storage capacity of reservoirs and other water bodies generally obtained through the water level-volumetric correlations. In addition, automatic monitoring can also be achieved for monitoring of precipitation. Monitoring of evaluation is generally conducted manually

Source: Ning, D., Wang, G., Wu. M. & Yang J. (2016)[34]

3.3.4.3. Wastewater collection and treatment plants and advanced wastewater treatment technologies

Palestine experiences severe limitation to access water. This is due to the control placed by Israel. Currently, the use of cesspits remains as the most widespread collection method of wastewater in the West Bank. This is significantly dangerous as a wide range of water pollutants can slowly reach the groundwater sources in which almost all of West Bank communities rely on as source of drinking water. In addition, a high percentage of water is discharged into the open water without any treatment, leading to water pollution

[33] ibid.

[34] Ning, D., Wang, G., Wu. M. & Yang J. (2016). "A tentative discussion on the monitoring of water resources in China." Water Resources Assessment and Seasonal Prediction, International Association of Hydrological Sciences

in Palestine, especially in Gaza in which more than 50 percent of raw sewage is discharged untreated into the sea.[35] Wastewater collection and treatment technologies reduces environmental impact caused by the sewage to the environment. They also provide opportunities to increase the amount of water available for use by Palestinians and are important adaptation measures for Palestine. Currently, there are four wastewater treatment plants in Gaza and five wastewater treatment plants in the West Bank. For rural communities in the West Bank where the dispersed pattern of houses in rural areas make it economically unfeasible to construct wastewater treatment plants, onsite small-scale wastewater treatment plants have been established for single house or building.[36] While this has not been successful due to lack of funding to continue supporting the project, this is still considered as an important technology at the household level. Further implementation of this technology in Palestine will focus on securing private sector involvement. These small-scale treatment plants also provide benefit of generating water resource that can be utilized for irrigation purposes. The use of treated wastewater in agriculture is currently being explored within the agricultural sector in Palestine. This offers an appealing option to the already constrained water availability in Palestine.

Table 30: Wastewater Treatment Process and Technologies

Technologies	Description
Preliminary treatment	The preliminary treatment process removes coarse solids and other large materials often found in raw wastewater. Removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units. Preliminary treatment operations typically include coarse screening, grit removal and, in some cases, comminution of large objects. In grit chambers, the velocity of the water through the chamber is maintained sufficiently high, or air is used, so as to prevent the settling of most organic solids. Grit removal is not included as a preliminary treatment step in most small wastewater treatment plants. Comminutors are sometimes adopted to supplement coarse screening and serve to reduce the size of large particles so that they will be removed in the form of a sludge in subsequent treatment processes. Flow measurement devices, often standing-wave flumes, are always included at the preliminary treatment stage.[37]
Primary treatment	The primary treatment removes organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming. During this process, approximately 20 – 50 percent of the incoming biochemical oxygen demand (BOD_5), 50 – 70 percent of the total suspended solids (SS), and 65 percent of the oil and grease are removed. Some organic nitrogen, organic phosphorus, and heavy metals associated with solids are also removed during primary sedimentation but colloidal and dissolved constituents are not affected. The effluent from primary sedimentation units is referred to as primary effluent.
Secondary treatment	The secondary treatment performs further treatment of the effluent from primary treatment to remove the residual organics and suspended solids. In most cases, secondary treatment follows primary treatment and involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms

[35] "Al-Safady, M.Y.M. (2012). "Physio-Chemical and Microbiological Characteristics of Seawater in Northern Part of Gaza Strip, Palestine." Al-Azhar University-Gaza.

[36] Status of the Environment in the State of Palestine, Applied Research Institute – Jerusalem (2015).

[37] Food and Agriculture Organization of the United Nations. "3. Wastewater treatment". Accessed from http://www.fao.org/3/t0551e/t0551e05.htm

		(principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3, and H_2O). There are several aerobic biological processes used for secondary treatment differing primarily in the manner in which oxygen is supplied to the microorganisms and in the rate at which organisms metabolize the organic matter. The microorganisms must be separated from the treated wastewater by sedimentation to produce clarified secondary effluent. The biological solids removed during secondary sedimentation, called secondary or biological sludge, are normally combined with primary sludge for sludge processing.[38]
(i)	**Anaerobic Digestion**	In large sewage treatment plants (> 7600 m^3/d in the US), primary sludge is most commonly processed biologically by anaerobic digestion. In the digestion process, anaerobic and facultative bacteria metabolize the organic material in sludge, thereby reducing the volume requiring ultimate disposal, making the sludge stable and improving its dewatering characteristics. Digestion is carried out in covered tanks (anaerobic digesters), typically 7 to 14 m deep. The residence time in a digester may vary from a minimum of about 10 days of high-rate digesters (well-mixed and heated) to 60 days or more in standard-rate digesters. Gas containing about 60 to 65 percent methane is produced during digestion and can be recovered as an energy source. In small sewage treatment plants, sludge is processed in a variety of ways including: aerobic digestion, storage in sludge lagoons, direct application to sludge drying beds, in-process storage (as in stabilization ponds), and land application.[39]
(ii)	**Activated sludge**	In the activated sludge process, the dispersed-growth reactor is an aeration tank or basin containing a suspension of the wastewater and microorganisms, the mixed liquor. The contents of the aeration tank are mixed vigorously by aeration devices, which also supply oxygen to the biological suspension. Aeration devices commonly used include submerged diffusers that release compressed air and mechanical surface aerators that introduce air by agitating the liquid surface. Following the aeration step, the microorganisms are separated from the liquid by sedimentation and the clarified liquid is secondary effluent. A portion of the biological sludge is recycled to the aeration basin to maintain a high mixed-liquor suspended solids (MLSS) level. The remainder is removed from the process and sent to sludge processing to maintain a relatively constant concentration of microorganisms in the system.[40]
(iii)	**Trickling filters**	A trickling filter or bio-filter consists of a basin or tower filled with support media such as stones, plastic shapes, or wooden slats. Wastewater is applied intermittently, or sometimes continuously, over the media. Microorganisms become attached to the media and form a biological layer or fixed film. Organic matter in the wastewater diffuses into the film, where it is metabolized. Oxygen is normally supplied to the film by the natural flow of air either up or down through the media, depending on the relative temperatures of the wastewater and ambient air. The thickness of the biofilm increases as new organisms grow. The sloughed material is separated from the liquid in a secondary clarifier and discharged to sludge processing. Clarified liquid from the secondary clarifier is the secondary

[38] ibid.

[39] Food and Agriculture Organization of the United Nations. "3. Wastewater treatment". Accessed from http://www.fao.org/3/t0551e/t0551e05.htm

[40] ibid.

	effluent and a portion is often recycled to the bio-filter to improve hydraulic distribution of the wastewater over the filter.[41]
(iv) Rotating Biological Contactors	Rotating biological contactors (RBCs) are fixed-film reactors similar to bio-filters in which organisms are attached to support media. Under the rotating biological contactors, the support media are slowly rotating discs that are partially submerged in flowing wastewater in the reactor. Oxygen is supplied to the attached biofilm from the air when the film is out of the water and from the liquid when submerged, since oxygen is transferred to the wastewater by surface turbulence created by the discs' rotation.[42]
Tertiary and/or advanced treatment	Tertiary and/or advanced wastewater treatment is applied when specific wastewater constituents, which cannot be removed by secondary treatment, must be removed. Because advanced treatment usually follows high-rate secondary treatment, it is often referred to as tertiary treatment. Under this treatment, effluent from primary clarifiers flows to the biological reactor, which is physically divided into five zones by baffles and weird. In sequence these zones are: (i) anaerobic fermentation zone (characterized by very low dissolved oxygen levels and the absence of nitrates); (ii) anoxic zone (low dissolved oxygen levels but nitrates present); (iii) aerobic zone (aerated); (iv) secondary anoxic zone; and (v) final aeration zone. The function of the first zone is to condition the group of bacteria responsible for phosphorous removal by stressing them under low oxidation-reduction conditions, which results in a release of phosphorus equilibrium in the cells of the bacteria. On subsequent exposure to an adequate supply of oxygen and phosphorus in the aerated zones, these cells rapidly accumulate phosphorus considerably in excess of their normal metabolic requirements. Phosphorus is removed from the system with the waste activated sludge.[43]
Disinfection	Disinfection normally involves the injection of a chlorine solution at the head end of a chlorine contact basin. The chlorine dosage depends upon the strength of the wastewater and other factors, but dosages of 5 to 15 mg/l are common. Ozone and ultra violet (UV) irradiation can also be used for disinfection but these methods of disinfection are not in common use.[44]

Source: FAO[45]

3.3.4.4. Desalination (including renewable energy application)

As one of the options to increase alternative sources of potable water in Palestine, use of desalination is recognized as a suitable solution, especially for Gaza. In Gaza, the availability of fresh water is amongst the lowest in the world. Currently, two million Palestinians in Gaza rely almost exclusively on the coastal aquifer as a source of freshwater. However, this is inadequate in meeting the growing demand of water, both qualitatively and quantitatively, with expected domestic water demand projected to increase from 103 million cubic meters in 2015 to more than 140 cubic meters in 2035.[46] In addition to meeting the growing demands for water, the use of desalination technology for brackish and seawater in the region provides

[41] ibid.

[42] Food and Agriculture Organization of the United Nations. "3. Wastewater treatment". Accessed from http://www.fao.org/3/t0551e/t0551e05.htm

[43] ibid.

[44] ibid.

[45] ibid.

[46] Gaza Central Desalination Plant and Associated Works Program: Donor Information Handbook. Palestinian Water Authority (2018)

protection to its coastal aquifer from either depletion or becoming saline.[47] The desalination process will reduce economic burden and health hazards on households, resulting in positive socio-economic and environmental impact.[48]

In this context, constructing large-scale desalination plants has been identified as the preferred option for Gaza to stabilize the aquifer and secure its water supply. A new construction of the desalination plant in Gaza, the Gaza Central Desalination Plants, has already been proposed for the region. Conventional desalination plants require a considerable amount of energy which can lead to negative economic impact. Therefore, the newly proposed desalination plan will include renewable energy application in the form of solar PV and wind turbines available both on-site and off-site.

Table 31: Renewable Energy Applications for Desalination Plants

Technologies	Description
Solar thermal desalination plant	Solar thermal desalination plan, also referred to as the concentrating solar power (CSP) plant, is most widely used desalination plant with renewable energy application. It collects solar radiation and provides high temperature heat for electricity generation. The CSP plant is very often combined with thermal storage system or with conventional desalination plant to extend operation even when the solar radiation is not available. This technology is most suited for medium to large-scale desalination plants, in region with high direct solar irradiance.
Wind power desalination plant	Similar to the photovoltaic desalination, the wind turbines are directly connected to the desalination plant, and power generated is used to power the desalination plant. This technology is best suited for seawater desalination, especially in coastal areas with high wind potential.

3.3.5.Barriers overview for sectors and specific to technologies

The water and wastewater sector face the following common barriers for the dissemination of prioritized technologies in the sector.

Table 32: Barriers in the Water and Wastewater Sector

Type of barrier	Summary
Political	Required to apply for construction and rehabilitation permit with Israel in many cases
Institutional	Lack of appropriate institutional capacity resulting from governance gap in the water sector which further results in lack of clarity on roles and responsibilities of involved entities, including implementation of prioritized technologies
Technical	Lack of adequately trained human resources and limited technical capacity
Financial	Lack of financial sources; high construction cost expected in remote areas
Geographical	Limitations in land use
Awareness	Lack of awareness on risks of water contamination

[47] Assaf, S.A. (2001). "Existing and the future planned desalination facilities in the Gaza Strip of Palestine and their socio-economic and environmental impact." Desalination 138 (1-3), pg. 17 – 28

[48] United Nations Office for the Coordination of Human Affairs (2017). "Largest seawater desalination plant opened in Gaza". The Monthly Humanitarian Bulletin. Accessed from: < https://www.ochaopt.org/content/largest-seawater-desalination-plant-opened-gaza>

Access to energy	Lack of electricity and fuel to support proper operation of the technology

The introduction of prioritized technologies in the water and wastewater sector is limited by a number of barriers including political, institutional, technical, financial, geographical, awareness and access to energy. The political barrier is related to the need for Palestine to apply for and obtain from Israel the necessary construction and rehabilitation permit that would allow for the introduction of prioritized technologies at a large-scale. In addition, implementation of these technologies, specifically the water monitoring technologies, may be of concern to Israel as these will allow for monitoring of water resources within Palestine.

Institutionally, the water and wastewater sector currently experience a lack of clarity on roles and responsibilities of key authorities involved in the sector. This results in lack of clarity on which authority will be responsible for the overall implementation of prioritized technologies in the sector.

Technically, the introduction of these prioritized technologies requires strong technical capacity, especially related to operation and maintenance of these technologies. However, the sector lacks in adequately trained and skilled human resources to support this need.

Financially, implementation of these technologies requires high investment cost. In addition, required construction in remote areas will also result in higher construction cost. For Palestine, who is already limited in its resources, this is an additional barrier and will require external financial support.

Geographically, the installation of these technologies will also require additional land, especially in Area C, which is currently limited in access. Not having access to the land in Area C will be a barrier for the sector. This is especially applicable to construction of wastewater treatment plants. In regards to access to energy, the operationalized plant in Gaza is currently experiencing challenges related to accessing electricity and fuel, which are affecting the overall operation of the plant. This is also a barrier for desalination plants with renewable energy application as the plant will require stable supply of energy.

In regards to awareness, there is currently a lack of awareness about water contamination risks among the population, which will need to be addressed through knowledge sharing and awareness raising.

3.3.6. Implementation Plan

The successful implementation of prioritized technologies in the water and wastewater sector will greatly contribute to securing water availability and resources in Palestine. PWA's strategic plan identifies increasing the availability of water, both quantitatively and qualitatively, from both conventional and non-conventional water sources as one of its objectives.

In order to achieve this objective, it is important to determine which actions will be main drivers to ensure their dissemination. In the short-term, the implementation plan will focus on diffusion of small-scale technologies, such as the rooftop rainwater harvesting technology and on-site wastewater treatment collection and treatment plants while also focusing on capacity building at the institution and technical – level, and awareness raising. Short-term actions will also include policy development and enforcement.

In the medium-term, the focus will be on identification of applicable water resources monitoring technologies for use in Palestine. This is related to technology transfer to Palestine and related activities will include conducting feasibility studies.

The implementation plan, for the long-term, will focus on introduction of prioritized technologies at a large scale, such as construction of large-scale utility rainwater harvesting technology and wastewater collection and treatment plants. These activities will require additional land and construction permits from Israel for

access to land in Area C for development purposes. Therefore, this will require developing a platform for having a dialogue with Israel to obtain the necessary permit and approval.

Improved water supply and knowledge of disease prevention from contaminated water is expected to decrease household spending on health services and medicament and increase school attendance, health and hygiene, particularly in impoverished families. At the household level, women are decision-makers regarding water use. Increased water security will directly affect their ability to effectively and efficiently manage water and wastewater, as well as influence other members of the family to do the same. It will allow women and girls to meet their personal hygiene needs.

As the primary caregivers in families, improved water supply will help women and girls to more efficiently undertake basic domestic chores and secure the needs of children, persons with disabilities, the elderly, the chronically ill and themselves. Likewise, knowledge and enforcement of disease prevention practices will have a direct effect on decreasing their domestic burden.

Although the timeline for the implementation of these water security technologies should be in line with the country's national priorities and defined targets under its NDC, there is no clear timeline defined for the implementation of adaptation components under the NDC and the NAP. For the purpose of this project and as a result of consultations with stakeholders during the third mission, a time frame of 2019- 2030 will be used, with dissemination of these technologies to be completed by 2030. This timeline also aligns with Palestine's National Water Sector Strategic Plan and Action Plan.

Action 3.1 – Overall capacity building and awareness raising

Capacity building and raising awareness for relevant government institutions is important to allow for informed decision-making and engagement of stakeholders.

Activity 3.1.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions of the water and wastewater sector. This is important in clarifying which authority is responsible for the overall implementation of prioritized technologies in the sector.

Activity 3.1.2 – Technical capacity building – to enhance the technical capacity of relevant government institutions as well as service providers. This will be focused significantly on the operation and maintenance of applicable technologies, including rainwater harvesting, wastewater collection and treatment plants, and desalination plan. Technical capacity building activities will allow authorities and service providers involved to build technical know-how to better manage and operate prioritized technologies. This will also support in transferring water monitoring technologies in Palestine by assessing and identifying applicable water resources monitoring technology for implementation in Palestine. Technical capacity building activities will be provided on a recurring basis throughout the implementation period to ensure that technical knowledge is frequently updated and maintained for efficient operation and maintenance of technologies.

Activity 3.1.3 – Awareness raising – to raise general awareness regarding disease preventions to address water contamination issue. This will be delivered through dissemination of information regarding disease prevention measures that would help protect the public. This is also important to enhance the understanding of current and future state of water resources and the environment in Palestine. Activities related to awareness raising will be provided continuously throughout the implementation period.

Entity in-charge: The implementation entity for the overall capacity building and awareness raising is proposed to be led by PWA with the support of relevant national NGOs.

Costs: The cost associated with the implementation of this action is estimated at USD 400,000 for conducting workshops and trainings, engaging international expert, and preparing public awareness

material on maintenance and operation, as well as on overall benefits of the technology.

Action 3.2 – Development of the enabling environment

To effectively implement prioritized technologies for the sector, especially on water resources monitoring technologies and wastewater collection and treatment plants, it is important to create an enabling environment that would enhance stakeholder engagement.

Activity 3.2.1 – Policy development and enforcement – to create an enabling environment for the implementation of water resources monitoring technologies and wastewater collection and treatment plants. For the water resources monitoring technologies, even though measurement of water resources is identified as a key policy intervention for the sector, there is still a need to develop specific policy that would support the implementation of water resources monitoring technologies. For the wastewater collection and treatment plants, this will include defining mandatory use of treated water, development of PPP schemes, among others. This is an important as PPP can be used to promote wastewater treatment at an initial low cost. In addition, setting up mandatory use of treated wastewater, such as in irrigation for agriculture, will encourage water resilience and offer a revenue stream to wastewater treatment plants and the government. This will be possible once the relevant government institutions' capacities are enhanced to be able to make informed decision as well as to identify specific measures that are needed.

Activity 3.2.2 – Mapping of potential locations for rainwater harvesting and small-scale wastewater collection and treatment plants – to identify and map potential locations in setting-up rainwater harvesting and wastewater collection and treatment infrastructure in Palestine. The mapping process will cover for both small-scale and large-scale set-up of technologies. For small-scale, this will focus on identifying and mapping potential locations for rooftop rainwater harvesting and onsite wastewater collection and treatment plants in rural areas. For large-scale, this will focus on large utility-level rainwater harvesting and wastewater collection and treatment plants. Mapping potential locations will support producers in identifying infrastructure needs to support both rainwater harvesting and wastewater collection and treatment plants. It will also support a number of communities in understanding how to best invest in the technology.

Entity in-charge: The implementing entity for the development and enforcement of relevant policies is proposed to be led by PWA and MOLG.

Costs: The associated cost for the implementation of this action is estimated at USD 250,000 to engage international consultants to support in the development of policy measures and to conduct necessary workshops, trainings and consultations.

Action 3.3 – Dissemination of rooftop rainwater harvesting technologies

In order to support the dissemination of rooftop rainwater harvesting technology and onsite small-scale wastewater treatment plants, there is a need to develop demand from the household level, resulting in the creation of favorable market for private sector entry.

Activity 3.3.1 – Diffusion of rooftop rainwater harvesting technology – considered as a solution that could be implemented with the least amount of de-risking measures. The diffusion of rooftop rainwater harvesting technology will focus at the household level which would result in the creation of favorable market for private sector entry. In addition, this technology will use the already existing roof water tanks for the primary storage of the collected water. This will significantly reduce the cost for the installation of the technology as the storage tank is usually the most expensive component of the rainwater

harvesting system.[49]

Entity in-charge: The diffusion of rooftop rainwater harvesting technologies will mainly be demand-driven and expected to be financed by households and owners of buildings with PWA being the government representative lead.

Costs: The implementation of this action is expected to cost around USD 597,000,000 (USD 3,000 per unit of rooftop rainwater harvesting system for an average sized household).[50]

Action 3.4 – Dissemination of onsite small-scale wastewater treatment plants

In order to support the dissemination of onsite small-scale wastewater treatment plants, there is a need to develop demand and creation of favorable market for private sector entry.

Activity 3.4.1 – Diffusion of onsite small-scale wastewater treatment plants – two types of onsite small-scale treatment plants were implemented on a pilot basis in the West Bank for rural communities without access to wastewater treatment plants. The diffusion of this technology amongst single houses or buildings, will eliminate the need to negotiate for additional land space with Israel and will allow for the implementation of this technology in small-scale in short-term in Palestine.

Entity in-charge: The diffusion of onsite small-scale wastewater treatment technologies will mainly be demand-driven and expected to be financed by households and owners of buildings with PWA being the government representative lead.

Costs: The implementation of this action is expected to cost around USD 398,000,000 (USD 4,000 per unit for the onsite small-scale wastewater treatment plants for each household).[51]

Action 3.5 – Technology transfer of relevant water resources monitoring technology applicable for Palestine

There is a need to transfer technology to Palestine related to water resources monitoring technologies.

Activity 3.5.1 – Research – to assess available technologies and identify the one that is applicable for use in Palestine and to transfer technology to Palestine. It is also important that this step account for the needs of other data that needs to be monitored, such as violations and contamination. This activity will resume once capacities have been built, both at the institutional and technical level.

Activity 3.5.2 – Pilot and deployment of water monitoring technologies – to implement pilot project on wells within the currently Palestinian territory using the identified water monitoring technology. Once technologies are tested and proven, deployment follows. This will ensure that the selected technology is tracking and monitoring data that is needed for Palestine.

Entity in-charge: The implementation of this action will be led by PWA.

Cost: The associated cost for the implementation is expected to be USD 150,000 for research, and around USD 880,000 for deployment of water monitoring technologies in at least 100 wells (USD 4,000 – 13,600

[49] Traboulsi, H. and Traboulsi, M. (2017). "Rooftop level rainwater harvesting system." Applied Water Science 7, 769-775.
[50] The Renewable Energy Hub UK. *Cost of Installing Rainwater Harvesting System*. Accessed from: https://www.renewableenergyhub.co.uk/main/rainwater-harvesting-information/cost-of-installing-rainwater-harvesting-system/
[51] The Applied Research Institute – Jerusalem/Society. "2. Small scale wastewater treatment unit". Accessed from: <http://www.arij.ps/component/content/article/146-get-involved/526-small-scale-wastewater-treatment-unit.html>

per unit cost).[52]

Action 3.6 – Deployment of large-scale rainwater harvesting technologies

Large-scale rainwater harvesting projects will provide additional water resource, increasing the overall availability of water in Palestine.

Activity 3.6.1 – Deployment of commercial and industry-scale rainwater harvesting – as the enabling environment is set up through de-risking measures and actions, it is expected that investments in commercial and industry-scale rainwater harvesting technology will provide business benefit to drive public sector investments.

Entity in-charge: The diffusion of large-scale rainwater harvesting technology projects will remain with the public sector, with potential public and private partnership between local governments, as well as engagement of WSRC and PWA.

Costs: Costs associated with the implementation of the deployment of large-scale rainwater harvesting technologies is estimated at USD 154,770,000.

Action 3.7 – Deployment of large-scale wastewater collection and treatment plants

Large-scale wastewater collection and treatment projects will expand the potential of using treated wastewater for domestic, commercial and industrial use, increasing the overall availability of water in Palestine.

Activity 3.7.1 – Deployment of large-scale wastewater collection and treatment plants – as the enabling environment is set up through de-risking measures and actions, it is expected that investments in large-scale wastewater collection networks and treatment plants will provide business benefit to drive sector investments.

Entity in-charge: The diffusion of large-scale wastewater collection and treatment technology projects will remain with the public sector, with potential public and private partnership between local governments, as well as engagement of WSRC and PWA.

Costs: Costs associated with the implementation of the deployment of large-scale wastewater collection and treatment plants is estimated at USD 58 million.

Action 3.8 – Negotiations for Area C land use for large-scale projects

Large-scale projects will require significant investments and negotiations related to access of land in Area C with Israel, as well as approval for the implementation of water monitoring technologies in wells and dams.

Activity 3.8.1 – Negotiations – under the status quo scenario, Palestine will need to negotiate with Israel to obtain approval and permits for construction in Area C for the implementation of commercial and industry scale rainwater harvesting projects, large-scale wastewater collection and treatment facilities, as well as implementation of water monitoring technologies.

Entity in-charge: Implementation of this activity will be led by PWA.

[52] Radhakrishnan, V. and Wu, W. (2018). "IoT technology for smart water system." 2018 IEEE 20th International Conference on High Performance Computing and Communications; IEEE 16th International Conference on Smart City; IEEE 4th Intl. Conference on Data Science and Systems.

Action 3.9 – Development of desalination plants in Gaza

Activity 3.9.1 – Desalination plants in Gaza – construction of large-scale desalination plants has been identified as the preferred option for Gaza to stabilize the aquifer and secure its water supply. It will include the application of renewable energy technologies such as solar PV and wind turbines as part of its design.

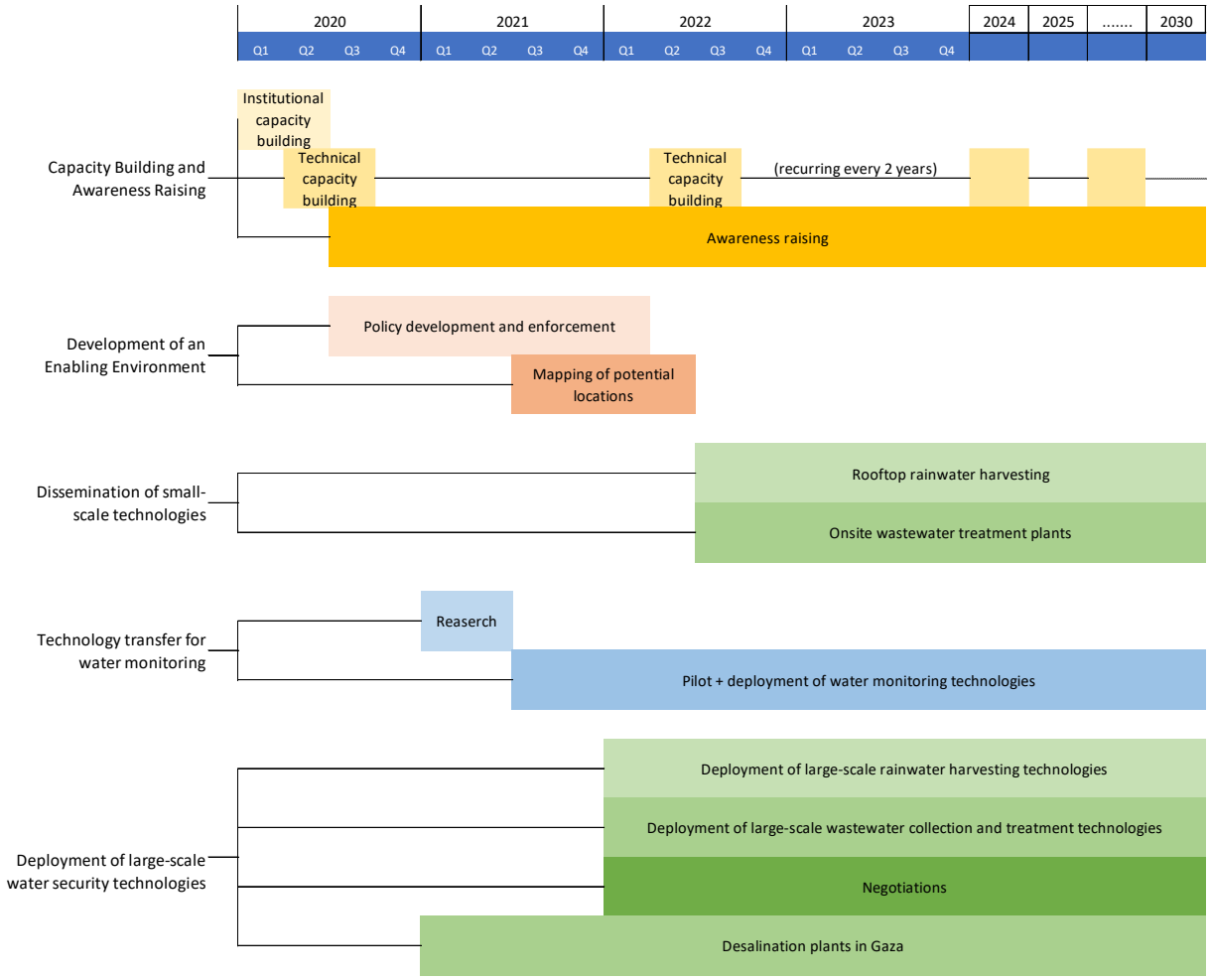
Entity in-charge: The implementation of this activity will be led by PWA.

Costs: Costs associated with the implementation of this action is estimated at USD 510 million.

3.3.7. Timeline

Figure 10 presents the overall timeline for the implementation of water security technologies. Implementation actions are to be completed by 2030, with short-term actions to be implemented by 2025, including technology transfer of applicable water monitoring technologies.

Figure 10: Water and Wastewater Sector Implementation Timeline



3.3.8. Expected impacts

Palestine's NDC indicates that increasing water availability is an important climate adaptation action. Implementation of these technologies will contribute to long-term water security for Palestine. It will provide enhancement in food production and improve living conditions of Palestinians. Water monitoring technologies will also enhance the management of water resources, such as identification of violations, to protect this resource. At the same time, desalination technologies will increase alternative sources of potable water in the country.

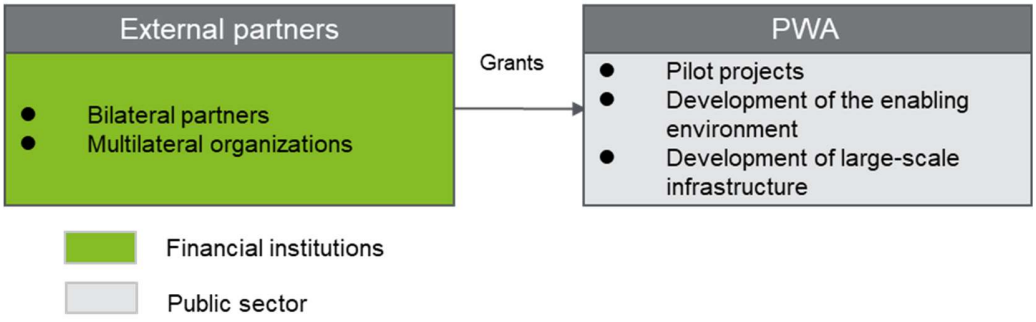
3.3.9. Potential financing

The overall approach to financing for the roadmap is detailed in Annex 2: approach to financing. In the water and wastewater sector, the financing approach will aim at attracting international climate finance for implementing large-scale projects in the form of grants as well as driving household demand for alternative technologies and trigger private sector investments in larger technologies by developing the enabling environment for the introduction of new technologies.

Under this approach, Palestine and international partners will mainly provide direct financing related to technical assistance and for the implementation of the projects on the ground. Activities financed will not only include technical assistance towards the public sector, but also support to awareness activities, mapping for water harvesting and development of pilot projects, when required.

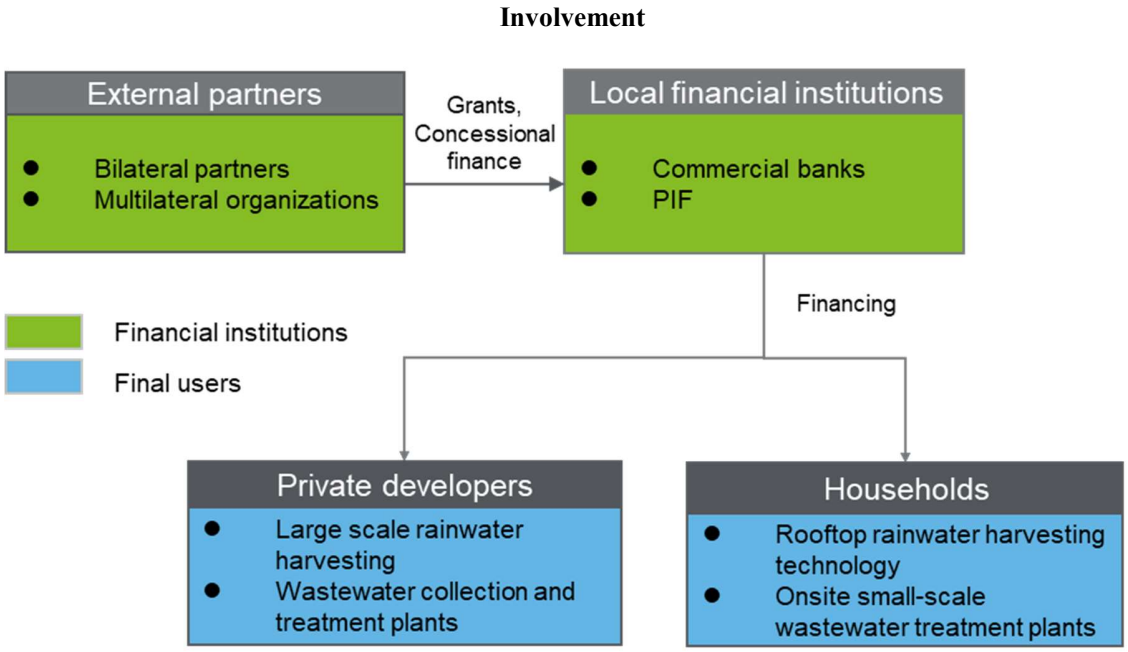
An important aspect of the financing strategy will be to support households in investing in rooftop rainwater harvesting technology and onsite small-scale wastewater treatment plant. This will be done by providing adequate financing options to households through local financial institutions.

Figure 11: Potential Financing Options for the Water and Wastewater Sector



Additionally, the private sector will play a leading role in financing large scale infrastructure on the long-term. This will be encouraged by the provision of financing at better rates, such as with concessional loans or through blended finance, in order to cover some of the risks experienced by the private sector. It will also be important for the private sector to be sure that stable revenue streams are available for the management of these. Revenue streams will be provided through the national budget, for water provision and wastewater treatment.

Figure 12: Potential Financing Options for the Water and Wastewater Sector, Private Sector



Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in Table 33.

Table 33: Financing for Water and Wastewater Sector Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 3.1 – Overall capacity building and awareness raising	Technical assistance	400,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 3.2 – Development of an enabling environment	Technical assistance	250,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 3.3 – Dissemination of rooftop rainwater harvesting technologies	Infrastructure and equipment	597,000,000	Private sector led	Local financial institutions, households and communities, developers
Action 3.4 – Dissemination of onsite	Infrastructure	398,000,000	Private sector	Local financial institutions,

small-scale wastewater treatment plants	and equipment		led	households and communities, developers
Action 3.5 – Technology transfer of relevant water resources monitoring technology applicable for Palestine	Technical assistance and equipment	150,000 for research 880,000 for water monitoring technologies	Grant	Bilateral donor / International organization
Action 3.6 – Deployment of large-scale rainwater harvesting technologies	Infrastructure and equipment	154,770,000	International climate finance Grants, private sector led Potentially blended finance / PPP	International organization / Local financial institutions, developers
Action 3.7 – Deployment of large-scale wastewater collection and treatment plants	Infrastructure and equipment	58,000,000	International climate finance Grants, private sector led Potentially blended finance / PPP	International organization / Local financial institutions, developers
Action 3.8 – Negotiations for Area C land use for large-scale projects	Negotiations	N/A	Domestic resources	Domestic resources
Action 3.9 – Development of desalination plants in Gaza	Infrastructure and equipment	510,000,000	International climate finance Grants, private sector led Potentially blended finance / PPP	International organization / Local financial institutions, developers

Indirect costs and financing

Other actions, that may stem from the measures undertaken under the implementation roadmap, include the implementation of the policies developed under the roadmap. For example, the costs associated to the introduction of longer-term technologies through Public-Private-Partnerships have not been included. This will involve costs related to concession fees and others.

External financing

Requests for external financing will focus on measures that cannot be financed by Palestine and which are of high priority to the country. Palestine's NDC is mostly conditional on receiving appropriate support in order to be able to implement these technologies. As mentioned above, the water and wastewater sector has significant potential for agriculture use and remote households. Larger scale infrastructure will enable Palestine to be more independent in terms of water resources and are also of high importance in the longer term. External financing will therefore be requested for preparing the enabling environment for both measures.

The first set of priority measures to be financed by external resources is therefore the development of the enabling environment for households and communities to invest in rooftop rainwater harvesting technology and onsite small-scale wastewater treatment plants. This is an immediate action which can support the development of other technologies and sectors, such as in agriculture.

Grants and concessional financing may also be used for blended finance, in order to support local financial institutions in providing financial products which are relevant to the needs of the private sector, especially for households.

As mentioned above, the development of larger scale infrastructure in water and wastewater treatment will enable Palestine to be more resilient . However, the investments required are significant and will require support from international organizations, such as the provision of grants and possibly concessional loans to Palestine or private developers, or through blended finance.

Potential sources of financing include the GCF, GEF as well as international organizations, such as the World Bank, and bilateral donors. A similar approach has been taken by Caribbean countries with GEF's support in the "integrated approach to water and wastewater management using innovative solutions and promoting financing mechanisms in the Wider Caribbean Region" project.

3.4. Transport sector

3.4.1. Current status of the sector

Road networks in Palestine are weak and inefficient. Despite the Palestinian Government's effort to lead major developments to improve existent road networks and new networks after the establishment of the Palestinian National Authority, Israeli occupation has obstructed further development of the sector. In Palestine, under the Ottoman rule, transport networks developed in the 19th century from primitive roads and lanes to paved roads. Later, roads connecting Palestinian cities, towns and villages were constructed. In 1978, the West Bank was separated from the Gaza Strip and Israel had constructed settler's bypass roads. Therefore, roads throughout the Palestinian territory have neither built on economically feasible grounds, nor account for the shortest distance between residential areas. This has resulted in inefficient road networks in Palestine.[53]

[53] Transport Sector Strategy 2011-2013, Ministry of Transport, Palestine. Accessed from: http://www.lacs.ps/documentsShow.aspx?ATT_ID=4812

According to 2018 statistics provided by the Ministry of Transport, there were total of 254,502 licensed vehicles in the West Bank (no data for Gaza). Data also showed that private vehicles comprise the highest percentage of all the licensed vehicles amounting to 88 percent (in the West Bank, no data for Gaza). Public transportation sector suffers from several predicaments, including an outdated bus fleet, in which service provision is yet inefficient and irregular. Besides fragmenting the Palestinian territory, Israeli military checkpoints double travel time and cost.[54]

Measures to improve the transport sector are important climate mitigation actions for Palestine. Currently, the sector faces challenges such as lack of and inefficient road networks that are resulting in inefficient flow of traffic inside and outside of cities. This causes traffic congestions, which, couple of with operation of outdated vehicles, result in higher GHG emissions and pollution. Therefore, introducing a number of technologies within this sector will support in meeting Palestine's climate change objective and, overall, improve lives of Palestinians.

3.4.2. Institutional arrangements

The implementation and scaling up of technologies related to low-carbon transportation in Palestine involves the engagement and participation of key government institutions from the transport sector. The following key government institutions were identified:

Table 34: Key Government Institutions in the Transport Sector

Lead Institution	Description
Ministry of Transport	The Ministry of Transport (MOT) is mainly responsible for preparing laws and regulations to modernize, develop and organize the transport sector, monitoring implementation and developing road networks. The Ministry is also responsible for creating safe traffic environment in Palestine. The Ministry will play a critical role in ensuring necessary policies and regulation are implemented that would support effective implementation of technologies to support the sector.
Ministry of Public Works and Housing	The Ministry of Public Works and Housing (MPWH) is responsible for the maintenance of roads and road networks in Palestine. MPWH will play a key role specific to technologies which involves infrastructure development such as BRT. In general, maintenance of roads will support further implementation of modal shift options.
Ministry of Local Government	The Ministry of Local Government (MOLG) is responsible for ensuring that local government units have the ability and tools to take actions in meeting strategic objectives. MOLG will play a critical role in ensuring that local governments have the resources necessary, financially and technically, to implement and disseminate modal shift to public transportation and upgrading of existing vehicle fleet.
Palestinian Energy and Natural Resources Authority	The Palestinian Energy and Natural Resources Authority (PENRA) is the main institution responsible for the energy and electricity sector in Palestine. PENRA will play a critical role in setting up the enabling environment for private sector participation, especially in the development of charging stations for electric vehicles (EVs) as part of upgrading of the existing vehicle fleet and use of EVs in public transportation services.
Environment Quality Authority	The Environment Quality Authority (EQA) aims to promote sustainable environmental development in Palestine. It is responsible for protecting the environment with all elements and preventing environmental hazards threatening all living things. It is the umbrella for all activities and studies

[54] Transport Sector Strategy 2011-2013, Ministry of Transport, Palestine. Accessed from: http://www.lacs.ps/documentsShow.aspx?ATT_ID=4812

	related to environmental planning, protection, monitoring and control. It will play a key role in supporting the introduction of prioritized technologies for the transport sector in relation to GHG emission and air quality measurement.

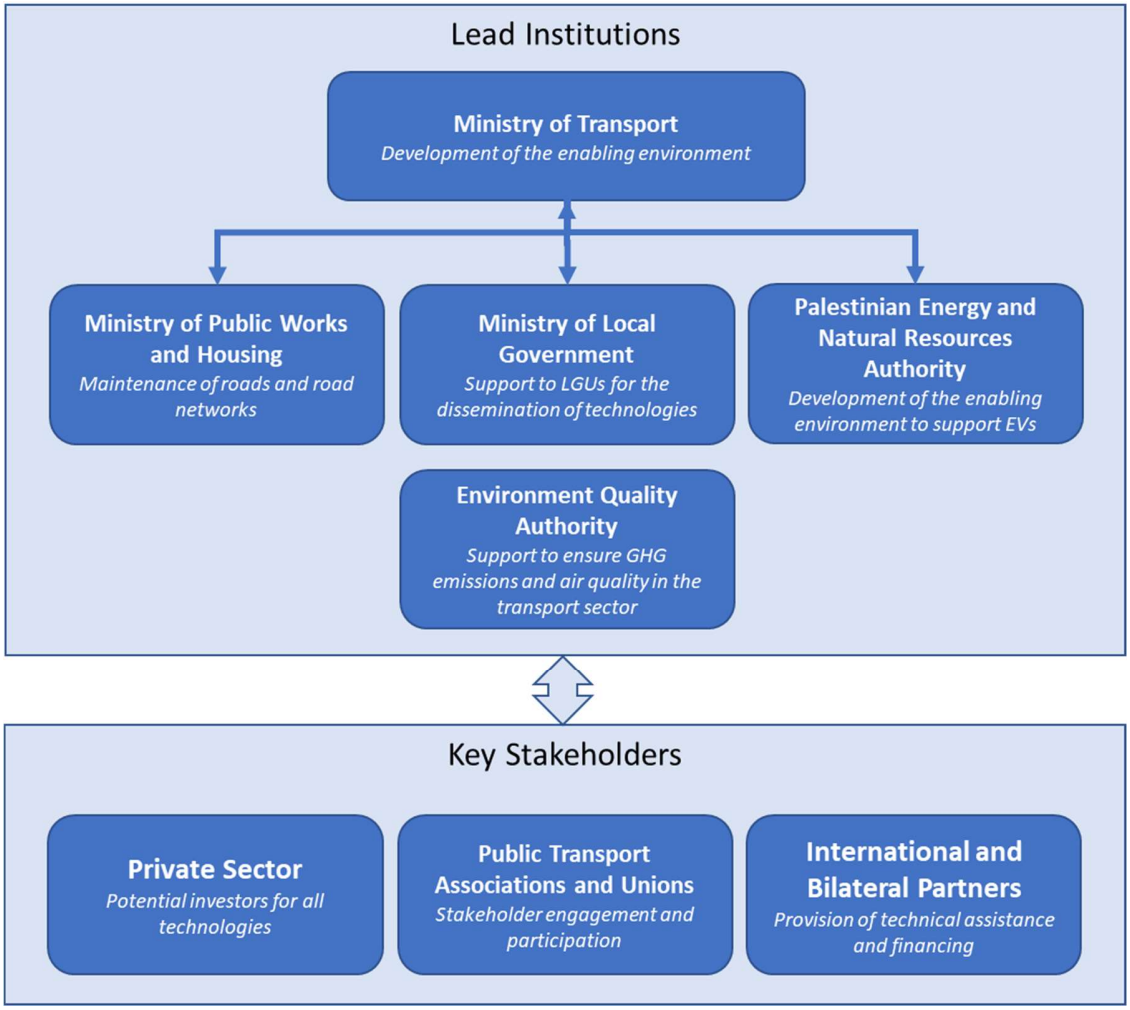
The following key stakeholders were also identified which would play major roles in the implementation of prioritized technologies under the transport sector, as well as supporting lead institutions:

Table 35: Key Stakeholders in the Transport Sector

Key Stakeholders	Description
Private Sector	Private sector actors in the transport sector includes potential investors for EV providers, along with EV charging stations. It will be important to include the private sector as they are currently leading the introduction of EV and construction of related charging stations in Palestine.
Public Transport Associations and Unions (public buses and taxis)	Associations and unions of public buses and taxis plays a key role in the successful implementation of modal shift to public transportation in Palestine. Their engagement and participation will be important to achieve the objectives and goal for this activity.
International and Bilateral Partners	International and bilateral partners play a key role in providing support to Palestine given the context of Palestine related to its limited resources. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the transport sector is illustrated in Figure 13.

Figure 13: Transport Sector Institutional Framework



3.4.3. Objectives and goals of the sector

The Palestinian transport sector is one of the most influential sectors in local economy. It serves citizens by providing their transportation needs between Palestinian lands and goods transportation. Moreover, this sector offers many investment and job opportunities.

In Palestine's NDC, climate mitigation actions such as promoting modal shift to public transportation, improving the efficiency of road vehicles by updating the vehicle fleet, disposing of old vehicles, and promoting and encouraging the use of efficient vehicles are identified as measures to reduce GHG emissions. Palestine's goal is to achieve 25 percent shift to public transportation by 2030 as per the NDC.

For the purpose of the Technology Roadmap, the sector target is to eliminate vehicles older than 10 years from operating on roads by 2030, with specific focus on taxis rather than private vehicles as they are on the road more frequently and are easier to regulate. The introduction of these technologies will also contribute to meeting strategic objectives of the sector identified in the transport sector 2017-2022 strategy.

The Technology Roadmap for the sector will therefore focus on reducing of GHG emissions by supporting the introduction of modal shift to public transportation and upgrade of existing vehicles. Modal shift will reduce GHG emissions by moving towards use of public transportation and upgrade of existing vehicles will move towards adoption of low-carbon technologies. These technologies will significantly contribute to reducing the number of on-road and outdated vehicles. Improving the current state of public transportation will also contribute to improved living environment for Palestinians by providing efficient transportation option for travels inside and outside of Palestinian cities.

3.4.4. Technologies overview

Technologies prioritized under this sector are modal shift to public transportation and upgrade of existing vehicle fleets. These technologies can contribute to the development of the sector that mitigate impacts of climate change by reducing GHG emissions, and will provide alternative transportation mode for improved travel experience for Palestinians. For modal shift to public transportation, the technology will incorporate components such as contracts, fare systems and incentives, and improved passenger information. For upgrade of the existing vehicle fleet, the technology will include components such as better vehicles and maintenance, fuel standards, and vehicle inspection process.

3.4.4.1. Public transportation (modal shift)

Poor accessibility to public transportation has resulted in private vehicles becoming the most common mode of daily travel. This is one effect of the poor accessibility of public transportation. In Palestine, traffic jams have become one of the major challenges in the road network, both inside and outside of cities. This is mainly due to lack of proper road networks in place. In addition, according to statistics from the Ministry of Transport, 51.19 percent of licensed vehicles operate on diesel and 47.46 percent operate on gasoline, including on-road taxis, contributing to GHG emissions and air pollution. The proposed model will help in reducing the number of cars on the road, thus, reducing GHG emissions. The model considered for the Technology Roadmap is on inter-city transportation and will focus on providing bus rapid transit service between cities in Palestine. The MOT's focus is to restructure this deteriorated passenger transportation sector in Palestine to positively impact both citizens and service providers. Under the prioritized technology, the sector will also consider updating existing vehicle fleet of buses to newer vehicles, with organized timetable and schedule of operation.

Table 36: Modal Shift to Public Transportation Model

Technologies	Description
Intercity bus transportation	Intercity bus transportation is part of the overall surface transport network and holds particular importance for small communities and rural areas[55]. Intercity buses provide links among smaller communities within a region and, importantly, to larger urban areas that offer services and opportunities not available in less-populated regions of the country. Intercity bus transportation provides a particularly critical role for smaller communities in which air or passenger rail travel options are not available.

3.4.4.2. Upgrade of the existing vehicle fleet

According to the Ministry of Transport, 68 percent of registered vehicles in Palestine are 20-30 years old, including 11 percent above 20 years and 21 percent above ten years.[56] This means maintenance cost is high and spare parts are no longer available. Many respective companies that provide spare parts are not

[55] National Research Council (2002). *Effective Approaches to Meeting Rural Intercity Bus Transportation Needs*. Transit Cooperative Research Program. Transportation Research Board, 184.

[56] Transport Sector Strategy 2011-2013. Accessed from < http://www.lacs.ps/documentsShow.aspx?ATT_ID=4812>

in existence either. Gas emissions of such old and outdated vehicles are high and cause hazardous environment pollution. Therefore, upgrading a large number of the existing vehicle fleet to newer vehicles that emit less GHG in the short-term and introducing EVs and hybrid vehicles in the long-term, appear to be one of the potential solutions to tackle the pollution issue in Palestine. In supporting the long-term vision of the sector, the introduction of EVs will require ensuring that necessary power networks are also available and in place in Palestine to support the upgrading of vehicles to EVs.

Table 37: Vehicle Upgrade Technologies

Technologies	Description
Newer vehicles	Newer vehicles are more efficient in relation to GHG and air emissions. It contributes to reduction in these emissions and thus provide more environmentally-friendly options to vehicle users.
Electric (EVs) and hybrid vehicles	Electricity driven vehicles are more efficient than the traditional combustion process in a car. Electricity for use for these vehicles can be generated through renewable sources, such as hydroelectric, wind, solar, and biomass. Hybrid vehicles use both an internal combustion engine and an electric motor to drive the vehicle in which the fuel consumption can be significantly reduced compared to conventional gasoline engine-powered vehicles[57].

3.4.5. Barriers overview for the sector and specific to technologies

The transport sector faces the following common barriers for the dissemination of prioritized technologies:

Table 38: Barriers in the Transport Sector

Type of barrier	Summary
Financial	(1) Meeting infrastructure requirements will require significant investments; and (2) Alternative income source for current taxi drivers will be required to promote the shift to use of public transportation.
Geographical	Limitations in land use for the development of new road networks and new infrastructure for EVs, such as charging stations.
Information	Insufficient information provided to the general population related to prioritized technologies and on general challenge on climate change
Infrastructure	(1) Lack of infrastructure to support public transportation (e.g. new road networks); and (2) Introduction of EVs at a large scale requires the implementation of infrastructure specific to hybrid/electric cars

The introduction of these technologies to mitigate climate change will require significant financial resource. This is needed for meeting infrastructure requirements and investments. Updated and new road networks will be required to support public transportation, such as construction of bus priority lanes. In addition, income from providing transportation services is the only source of income for majority of current taxi drivers

[57] Masrur, M.A. & Mi, C. (2017). *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*. John Wiley & Sons.

in Palestine. Alternative income source for them will need to be offered in order to effectively support the modal shift to public transportation.

Geographically, to support the development of new road networks and infrastructure for public transportation, additional land is required, in which access to Area C is in need. In addition, introduction of EVs at a large scale requires the implementation of infrastructure specific to hybrid/electric cars, which includes the setting up of charging station. This will further require development of power networks throughout cities.

As both technologies relate to behavior change of users, and market availability to support such behavior change, accessibility to information is critically important. Currently, there is insufficient information available on both benefits of public transportation and use of EVs, and willingness of the population to use public transportation, as well as general information on the challenge of climate change and how these technologies will help mitigate related impacts.

3.4.6. Implementation Plan

For the successful implementation of the Technology Roadmap, in the short-term, the implementation plan will focus on capacity-building and awareness raising activities and the development of an enabling environment. This will include standards, incentives and processes. In the medium-term, the implementation plan will focus on data collection that will support in measuring progress in meeting the target and provide opportunity for any modification in target set. This will be conducted through vehicle inspection. For the long-term, the implementation plan will focus on the construction of the infrastructure, such as road networks and charging stations, for dissemination of these technologies

Improved roads and clean, efficient public transportation services will have a direct impact on all segments of the Palestinian population. Women and youth, who are often more likely than others to use public transport services for education, work and social – related travel will see their mobility and access to employment opportunities increased. They will be able to better manage their travel time (important for women due to childcare and domestic responsibilities) and have access to safe vehicles and roads. In case of a climatic event, improved transport services and infrastructure will support vulnerable communities to receive help or to evacuate, possibly limiting the number of resulting in casualties and deaths.

It is recommended that all plans regarding transport be designed with a disability perspective to make the services as inclusive as possible, including for persons with disabilities and the elderly. It is also important that public transportation services remain affordable for all segments of the population.

The NDC aims to achieve 25 percent shift from private vehicle to public bus by 2030, therefore the implementation timeline will bet set for 2030 to align with Palestine's climate objective. For upgrading of existing vehicles, the implementation plan will enforce policy to remove taxis older than 10 years in 2030.

Action 4.1 – Overall capacity building and awareness raising

It will be significantly important to develop the capacity and awareness of relevant government institutions, potential investors, end-users and financial institutions. This will ensure that short, medium and long-term actions are implementable. In the short-term, this will support the implementation of policies and standards for the development of the necessary enabling environment. In the medium term, this will support the behavior change to support the shift in the sector, and in the long-term, this will support in achieving the total upgrade of existing vehicles in Palestine and in shifting the modal to public transportation.

Activity 4.1.1(a) – Institutional capacity building (modal shift) – to strengthen the capacity of MOT, MPWH and PENRA. This will allow these government institutions to make informed decisions on programme components and incentives that would promote modal shift to public transportation for inter-city transportation.

Activity 4.1.1(b) – Institutional capacity building (upgrade of existing vehicle fleet) – to strengthen the capacity of MOT, MPWH, and PENRA. This will allow these government institutions to make informed decision on incentives for taxis to upgrade their fleet to newer vehicles, and in the introduction of advanced vehicles, such as hybrid and electric, in the medium term, and on the development of necessary infrastructure, such as new roads and road networks, in the long-term.

Activity 4.1.2 – Capacity building for financing sources (modal shift) – to strengthen the understanding of financial institutions on the enabling environment that the government has provided for de-risking to provide access to finances for end users and developers.

Activity 4.1.3 – Capacity and skills building for taxi drivers (modal shift) – to strengthen and provide opportunity in finding alternative income source for current taxi drivers. It is critically important that this group of population is considered through the process of the implementation of the technology for a sustainable sector development. This capacity building could focus on transitioning these taxi drivers to bus drivers, as a potential new job, jobs related to upgrade of the fleet, such as for maintenance and verification of related vehicles, and access to ownership of buses to be operated, for some drivers.

Activity 4.1.4(a) – Awareness raising (modal shift) – to raise general awareness on benefits of newer and efficient vehicles, and on the need of modal shift to public transportation. This will also include information on general climate change and GHG emissions to promote awareness within the public that would support the shift in their behavior. The successful implementation of modal shift technology cannot be achieved without the acceptance of end users. This will be achieved through the dissemination of information regarding benefits of taking public transportation, both on the environment and public health and in achieving Palestine's climate mitigation goals.

Activity 4.1.4(b) – Awareness raising (upgrade of existing vehicle fleet) – to raise general awareness on benefits of newer and efficient vehicles. Awareness campaign can focus on hybrid and electric vehicles, as well as on fuel efficiency of vehicles and will also include awareness on general climate change issues.

Entity-in-charge: The implementing entity for the overall capacity building and awareness raising actions is proposed to be spearheaded by MOT.

Costs: The costs associated with the implementation of this action is estimated at USD 750,000 which involves conducting workshops, trainings, skills development, engaging international experts, and deploying public awareness materials.

Action 4.2 –Development of an enabling environment

Activity 4.2.1 – Policy development (modal shift and social nets) – to develop policies and regulations that would promote modal shift to public transportation. This will also include development of sound policies on social nets that would support current taxi drivers in transitioning to employment in other areas.

Activity 4.2.2 – Design and introduction of programme components (modal shift) – once institutions have the ability to make informed decisions through enhancement of their capacities, it will be important to design and introduce programme components relevant in building the enabling environment for introduction of these technologies. For modal shift, this could include design of programmes that would support users from shifting to using public transportation, and incentives for taxi drivers in transitioning to employment in other areas.

Activity 4.2.3 – Policy development (upgrade of existing vehicle fleet) – to develop policies and regulation to upgrade existing vehicle fleet of taxis in Palestine to newer cars, with the aim to eliminate taxis older than 10 years by 2030. The target will be introduced from 2025 – 2030, with enforcement of

the policy to take place in 2030.

Entity-in-charge: The implementing entity for the overall development of an enabling environment action is proposed to be spearheaded by MOT.

Costs: The costs associated with the implementation of this action is estimated at USD 400,000. This estimated amount applies only for the development of policies and not its enforcement.

Action 4.3 – Development of the inspection process

Once incentives, policies, and regulations are implemented through capacity building activities and development of an enabling environment, it would be important to implement and execute inspection of vehicles, which covers among others, the vehicle's manufacture date, safety and maintenance requirements, fuel economy and levels of emissions, to understand the current status of vehicles that are in operation in Palestine. This will allow to measure progress in the future against the target and overall goal. This also provides an opportunity to make any modification, if necessary, in the program or program components to be able to support the shift in the sector, related to public and private transportation. This will also provide opportunity to track and update passenger and vehicle information, which is identified as an important action in Palestine's NDC.

Activity 4.3.1 Execution of inspection of vehicles – to collect and track data on vehicles that are currently operating in Palestine as well as collecting improved data on passengers and vehicles. This will ultimately help in measuring how Palestine is progressing toward its mitigation goal, as well as measuring the change in behavior of the public. This will also provide Palestine with an opportunity to modify and introduce new actions, if needed, depending on the progress to achieve this goal by 2030.

Entity in-charge: The implementation of this action will be led by MOT.

Costs: The associated cost for the implementation of this action is estimated at USD 200,000.

Action 4.4 – Dissemination of public transportation (modal shift)

The introduction of modal shift to public transportation will involve the development of public transportation services and upgrade of existing vehicle fleet of buses to newer vehicles. Successful implementation will rely on the development of supporting road network infrastructure.

Activity 4.4.1 – Deployment of public transportation (modal shift) – the dissemination of public transportation (modal shift) will focus on providing inter-city bus transit services. This includes the implementation of organized timetable and schedule of operations, as well as promotion of park-and-ride concept wherein parking lots are provided within public transportation connections to allow commuters heading to cities, to park their vehicles and take public transportation. In promoting modal shift to public transportation, which will increase the number of vehicles used for public transportation, it is important to consider using and introducing vehicles that perform more efficiently. Thus, the shift to public transportation will include focus on upgrading the existing vehicle fleet to newer vehicles that perform better and release less GHG emissions, contributing to improving the environment and overall air quality in Palestine.

Entity in-charge: The dissemination of modal shift to public transportation will be the responsibility of MOT in addition to the engagement of the private sector, with potential for public-private partnership, with external support from international organizations.

Costs: The implementation of these actions is expected to cost around USD 285,000,000.

Action 4.5 – Upgrade of existing vehicle fleet

Upgrading of the existing old and inefficient vehicle fleet can commence once the enabling environment has been established, and inspection processes enforced. Successful implementation will also depend on the development of supporting road network infrastructure.

Activity 4.5.1 – Upgrade of existing vehicle fleet – upgrading the existing vehicle fleet to newer, more efficient modeled vehicles is seen as a short- to medium-term solution, while the introduction of more advanced hybrid vehicles and electric vehicles is considered for the long-term. The vehicle upgrades will mainly focus on taxi fleets and eventually target to include private-owned vehicles.

Entity in-charge: The upgrade of existing vehicle fleet will be the responsibility of MOT in addition to the engagement of the private sector, with external support from international organizations.

Costs: The implementation of these actions is expected to cost around USD 247,000,000.

Action 4.6 – Development of infrastructure

The introduction of modal shift to public transportation and upgrade of existing vehicle fleets will require supporting road networks and infrastructure.

Activity 4.6.1 – Development of infrastructure – this requires significant external resource with potential public-private partnerships for the development of the road infrastructure, as well as facilities such as charging stations. Introduction of EVs, in the long-term, will need access to energy, for charging purposes. This will require ensuring that charging stations can be developed, in addition to these charging stations being connected to the grid that integrate energy from renewable energy sources. Thus, it will be critical that both PENRA and MOPWH are involved to ensure that grid upgrade is performed in the energy sector that would support this technology in the transport sector, while also ensuring necessary infrastructure can be secured. For long-term use, Palestine can explore innovative options to provide access to energy, such as development of small-scale charging stations in remote places that are connected to solar PV or wind turbines or alternative renewable energy technologies, as an example.

Activity 4.6.2 – Securing land and energy – to secure land and energy access to implement the technologies. The development of infrastructure related to road network development and power infrastructure may require use of additional land in area C. Securing access to these will be crucial in de-risking investments in these technologies.

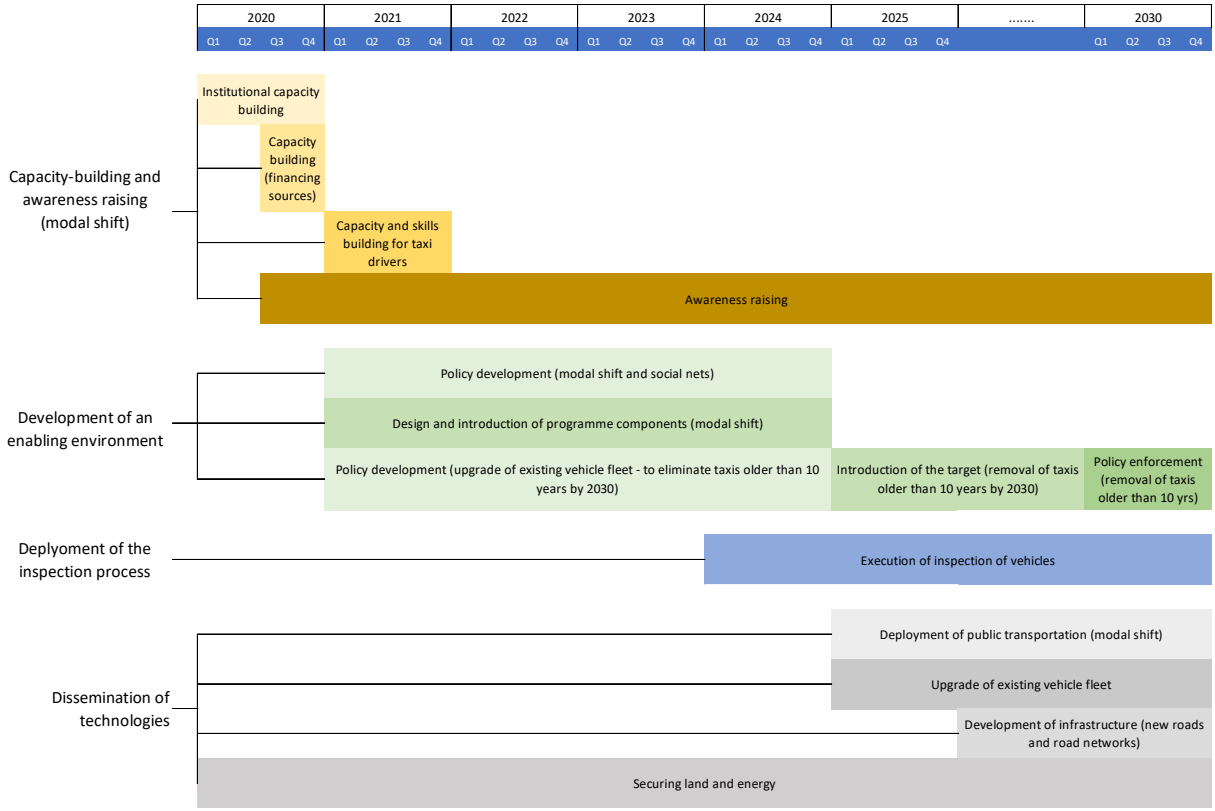
Entity in-charge: The development of infrastructure to support the dissemination of modal shift to public transportation and upgrade of existing vehicle fleets will be the responsibility of MOT in addition to the engagement of the private sector, with potential for public-private partnership, with external support from international organizations.

Costs: The implementation of these actions is expected to cost around USD 31,000,000.

3.4.7.Timeline

The following figure shows the overall timeline for the implementation of technologies related to transport in Palestine. The implementation timeline for setting up the enabling environment is planned to be completed within three years. Progress check through delivery of inspection process will be executed within five years, with longer term de-risking measures such as negotiations with Israel and infrastructure development, will enable introduction of public transportation and vehicles, such as EVs, at a large scale.

Figure 14: Transport Sector Implementation Timeline



3.4.8. Expected impacts

In Palestine's NDC, climate mitigation actions such as, improving the efficiency of the road vehicles by updating the vehicle fleet, disposing of old vehicles, and promoting and encouraging the use of efficient vehicles, promoting modal shift to public transportation are identified as key measures for the transport sector. This will contribute to the reduction of GHG emissions, which will also help Palestine meet its mitigation goal. While improving the travel experience, thus improved well-being, of Palestinians. Palestine's goal is to achieve 25 percent shift to public transportation by 2030.

3.4.9. Financing

The overall approach to financing for the roadmap is detailed in Annex 2: approach to financing. In the transport sector, the financing approach will aim at driving household demand for new vehicles in order to upgrade the fleet and at encouraging modal shift, by developing the enabling environment, such as policies and tax incentives, as well as larger scale investments, such as in infrastructure.

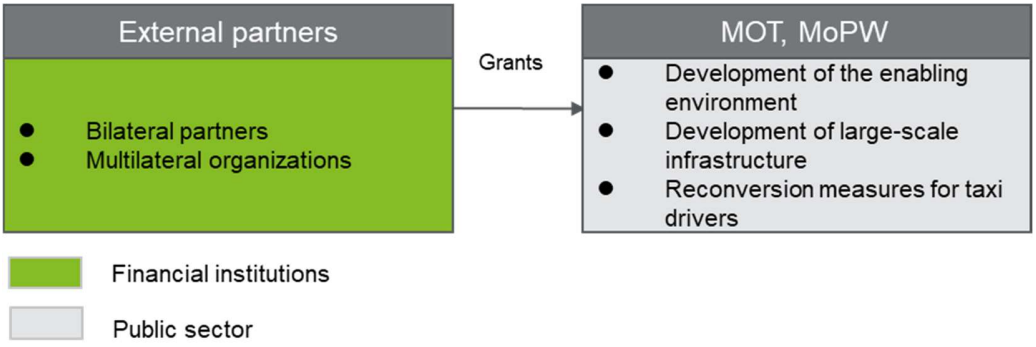
Under this approach, Palestine and international partners will mainly provide grant financing related to technical assistance as well as for the implementation of these technologies. Activities financed will not only include technical assistance towards the public sector, but also support to awareness activities and reconversion measures for taxi drivers. It will be extremely important to provide new employment opportunities to taxi drivers in order to facilitate the development of the implementation plan.

Another important aspect of the financing strategy will be to encourage households in investing in new

vehicles. This will be done by providing financing to support the inspection process, which will enforce regulations, while at the same time, providing additional incentives to drivers, such as tax-breaks, to upgrade their vehicle.

Additionally, the large-scale infrastructure on the long-term is expected to be financed from international climate finance on the long-term. It is not expected that Palestine will be able to cover all costs related to infrastructure development for EV vehicles, such as charging stations and power stations. It will be important to determine how best the private sector can invest in the infrastructure supporting EV development, as it already started doing in Ramallah and Hebron. This may be encouraged by the provision of financing at better rates, such as with concessional loans or through blended finance, in order to cover some of the risks experienced by the private sector.

Figure 15: Potential Financing Options for the Transport Sector



Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in Table 39.

Table 39: Financing for Transport Sector Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 4.1 – Overall capacity building and awareness raising	Technical assistance	750,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 4.2 – Development of an enabling environment	Technical assistance	400,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 4.3 – Development of the inspection process	Technical assistance	200,000	Grant	Bilateral donor / International organization / Domestic resources
Action 4.4 – Dissemination of public transportation	Infrastructure and equipment	285,000,000	Grants and international climate funds	Local financial institutions and developers

(modal shift)			Potentially concessional finance	
Action 4.5 – Upgrade of existing vehicle fleet	Equipment	247,000,000	Private sector led	Local financial institutions, households
Action 4.6 – Development of infrastructure	Infrastructure development	31,000,000	Grants and international climate funds Potentially concessional finance	Local financial institutions and developers

Indirect costs and financing

Other actions, that may stem from the measures undertaken under the implementation roadmap, include the implementation of the policies developed under the roadmap. For example, the costs associated to the introduction of incentives and the inspection process, as well as fees related to the provision of power for EV development have not been included.

External financing

Requests for external financing will focus on measures that cannot be financed by Palestine and which are of high priority to the country. The transport sector will need extensive technical assistance and infrastructure development before the technologies can be implemented. External financing will therefore focus on strengthening the sector's capacities and supporting the development of economic alternatives for taxi drivers.

External financing will also be requested for infrastructure development. In the case private sector can be leveraged, external financing should focus on providing concessional financing, which will lower the barriers for private sector investment.

Potential sources of financing include the GCF, GEF as well as international organizations, such as the World Bank, MDBs, and bilateral donors.

3.5. Solid waste sector

3.5.1. Current status of the sector

In Palestine, the amount of municipal solid waste produced was estimated at 2,622 tons/day (957,030 tons/year) in 2019. The management of the growing solid waste generated in the country has been gaining attention over the years due to the environmental, social and economic impacts of this problem. Solid waste management in the country faces significant hurdles including those at the legislative, organizational, technical and financial levels. Until recently when the Data Book on Solid Waste Management of Joint Services Councils in West Bank and Gaza is developed in 2019, the sector lacked accurate data and statistics on the amounts, quality and composition of solid waste produced which is crucial to formulating

an effective management plan to tackle the problem. The current political situation of Palestine adds another layer of challenges that the sector has to face.

On top of this, climate change impacts pose to adversely exacerbate these problems. Extreme weather conditions such as rise in temperature or changes in precipitation patters may lead to the spread of disease emanating from illegal dumpsites. Conversely, the improper management of solid waste will lead to increased greenhouse gas emissions from the decomposition of the waste, thereby, contributing more to worsening climate change conditions.

The Palestinian government is well aware of this growing problem in the sector and have taken actions in recent years to address it. These actions include the issuance of policies relevant to solid waste management such as those contained in the Environment Law No. (7) and the Solid Waste Management Strategy. As of 2017, 90 percent of the Palestinian population are being served by their solid waste collection service provider. However, the sorting of waste is currently not being implemented. In fact, only about 6,400 tons of waste was recycled in 2010, representing less than one percent of all solid waste in the country. Other concrete actions toward addressing the solid waste problem include the implementation of several regional sanitary landfills such as those in Jenin, Bethlehem, Jericho and Deir-El-Balah in Gaza. These actions greatly contributed to addressing the environmental and health impacts caused by illegal means of disposal.

In spite of these efforts, there are still significant needs to improve the solid waste management sector to ensure that the problems are addressed. In order to support the development of the sector towards addressing these needs and ensure growth towards low-carbon and sustainable development, it is essential to implement solid waste management technologies that could result in reduction of overall waste volumes, proper collection and segregation of waste, recycle and re-use of materials, and reduced waste ending up in landfills.

3.5.2.Institutional Framework

The implementation and scaling up of solid waste management technologies in Palestine involves the engagement and participation of key government institutions from the solid waste sector. The following key government institutions were identified which would play the leading role:

Table 40: Key Government Institutions in the Solid Waste Sector

Lead Institution	Description
Ministry of Local Government	The Ministry of Local Government (MOLG) is the government body responsible for the advancement of local government institutions to achieve sustainable development with effective community participation. Their work includes building capacities and enhancing resources of local government units to enhance local governance. The MOLG is also responsible for the solid waste sector on the national level and will have a key role in establishing an enabling environment for solid waste management practices and implementation of solid waste management technologies to spread in the country.
Ministries Relevant to Solid Waste Management	Aside from the MOLG, key institutions also play major roles in solid waste management at a national level such as the Environment Quality Authority which is responsible for the development of national strategies and plans for solid waste sector in cooperation with other relevant institutions. Other relevant institutions include the Ministry of Health responsible for licensing of waste facility operations, Ministry of Finance and Planning responsible for integrating solid waste management in national development plans, Ministry of Agriculture, Ministry of National Economy, Ministry of Education, Ministry of Higher Education, and Prime Minister's Office. This is a result of solid waste management being a cross-sectoral responsibility. As such,

	these government institutions will play a key role to ensure that all efforts among different institutions are well coordinated and does not overlap.
Joint Service Councils for Solid Waste Management	Joint Service Councils (JSC) for solid waste management comprised of local government units such as municipalities, towns and villages, are responsible for providing solid waste services in their jurisdiction. These include the collection of waste, its transfer to landfills, and operation of the landfills. JSCs will play an important role in the dissemination and implementation of solid waste management technologies and practices being the institution on the ground tasked with providing the service to the Palestinian population.
Local Government Units	Local government units bear the responsibility of overall solid waste management within their jurisdiction. Although they comprise JSCs which provides the services at a governorate level, their authority as a local government will be key in the implementation of solid waste management technologies and practices especially within their constituents and communities.

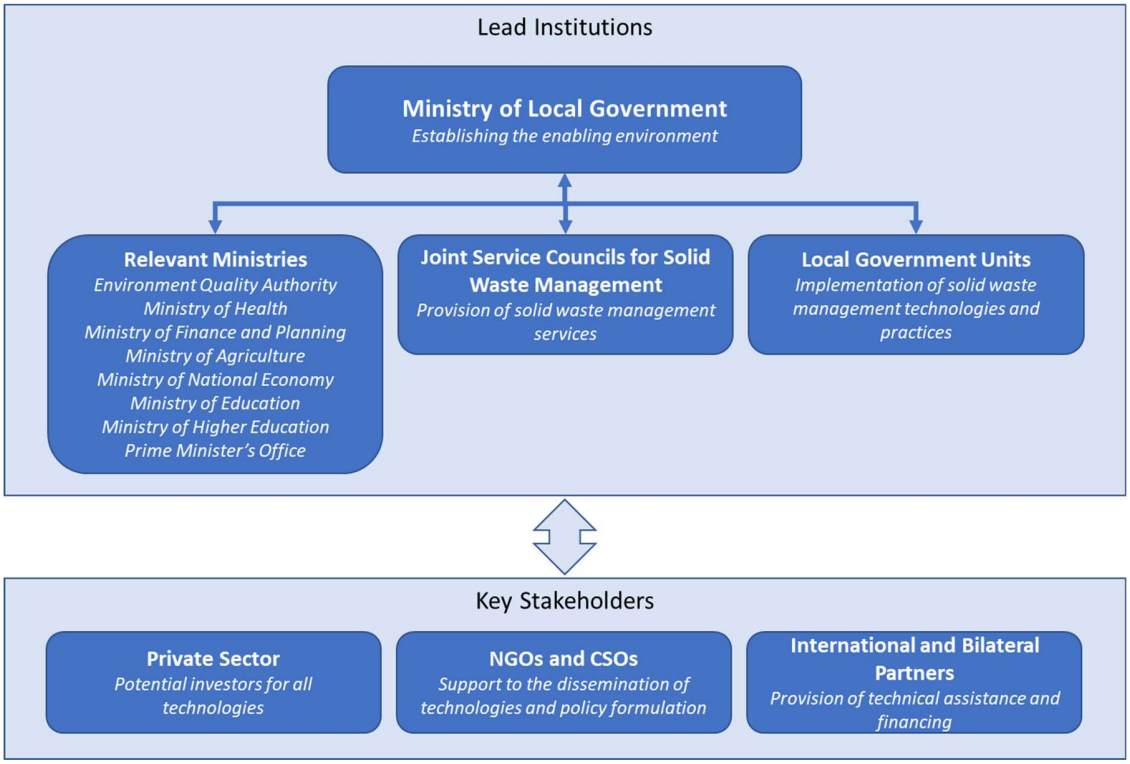
The following key stakeholders were also identified which would play major roles in the implementation of prioritized technologies under the solid waste sector, as well as supporting lead institutions:

Table 41: Key Stakeholders in the Solid Waste Sector

Key Stakeholders	Description
Private Sector	Although the Palestinian government and its institutions have the overall responsibility to ensure that solid waste are well managed, the private sector will be key in the development of the sector. These include private sector actors which finds business opportunities along the solid waste value chain, from opportunities to reduce overall waste generation, to collection, sorting, materials recovery, re-use, and recycling.
NGOs and CSOs	Non-governmental organizations and civil society organizations relevant to the solid waste sector in Palestine will be key to the implementation of prioritized technologies. Their engagement and participation will be important for activities in the implementation plan such as policy formulation. They also may provide financial resources for the implementation of activities under the roadmap.
International and Bilateral Partners	Plays a key role as partners to the Palestinian government in providing support in consideration of the country's limited resources. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the solid waste sector is illustrated in Figure 16.

Figure 16: Solid Waste Sector Institutional Framework



3.5.3. Objectives and goals of the sector

The solid waste sector is identified as a sector with high vulnerability to climate change under Palestine's NDC and NAP. As part of the country's plan to address the vulnerability, it has identified mitigation and adaptation actions under the sector including interventions is solid waste management such as improvement of waste collection system, improved management of landfill sites, and the reduction, re-use and recycling of waste.

The implementation of solid waste management technologies and practices as part of the action plan for the sector will greatly contribute to achieving its goals. The technology roadmap will therefore focus on strengthening capacities of all stakeholders involved in the sector which will pave the way for an effective and efficient solid waste management in Palestine. This will establish a business case for private sector investments for their involvement in key activities within the solid waste value chain.

3.5.4. Current status of technologies and technology overview

The technologies prioritized under the solid waste sector are the 6Rs for sustainable solid waste management with focus on waste sorting, composting of organic waste, and recycling of recyclable materials.

3.5.4.1. Waste sorting technologies

A holistic solid waste management approach takes into account the management of waste throughout the solid waste value chain from source to its final disposal. As such, waste sorting, including the concept of

6Rs, present waste management options on every stage of the value chain that will help reduce its overall environmental impact. The 6Rs are as follows:

- Refuse – avoiding the purchase and use of items which contribute to waste being disposed. This includes the purchase of one-time use materials (plastic bottles, straws, etc.), overpackaged products, and things you do not need.
- Reduce – less consumption means less waste generated. Purchase only the amount of goods that you need.
- Reuse – finding alternative uses for materials that are no longer needed. This includes repurposing of existing materials as raw materials for other products, without the need for processing such as those for recycling.
- Recycle – processing of waste materials into new materials. Recyclable materials include glass, paper, metal, plastic, tires, textiles, batteries, and electronics.
- Recover – pertains to the recovery of energy from organic waste. This include production of solid biofuels such as briquettes from the recovered waste, biodiesel from agricultural waste, biogas from anaerobic digestion, and other waste to energy options.
- Rot – waste which cannot be reused, recycled or recovered sent to sanitary landfills. These facilities could be equipped with advanced technologies to limit negative impacts to the environment, and recovery components such as landfill gas recovery system for additional source of energy generation.

The prioritized technology for this roadmap focuses on the implementation of waste sorting technologies and practices which will pave the way for opportunities throughout the solid waste value chain to open up such as the recycling and composting of waste, both of which are included as prioritized technologies under the sector. Waste sorting is the process of separating the waste into different classifications of materials. This can be implemented from the small-scale household level to large-scale materials recovery plants, applying hand-sorting manually to automated facilities.

The implementation of waste sorting technologies and practices will allow for other waste management options under the 6R such as recycling and composting technologies become financially viable. This will greatly contribute to the overall reduction of waste that goes to landfills and disposal sites, resulting in the improvement of environmental, social and health conditions of the sector, and reducing greenhouse gas emissions associated with the decay of waste in disposal sites.

Waste sorting technologies to use is influenced by the waste composition of the collected municipal solid waste which serves as its incoming waste stream and the market for the resulting material fractions, i.e., for recycling and composting. There are two technical approaches to sorting waste into usable materials, manual and automatic sorting. Generally, sorting facilities use a combination of both approaches. The configuration of the sorting facility will depend on experiences gained in solid waste management. For example, in advanced economies, waste sorting facilities usually employ more sophisticated technology-based solutions, while in emerging economies, lower technology solutions are enough and more realistic. Some of the main technologies used in waste sorting facilities are described in Table 42.

Table 42: Waste Sorting Technologies

Waste Sorting Technologies	Description
Waste Screening	Separation of waste materials based on size classifications using screens. • **Trommel screen** – angled rotating cylinder with holes that allow waste

	of a given size to fall through. • **Disk screen** – bed of vertical-spaced discs that transports large waste items but allows smaller items to drop through the gaps. • **Oscillating screen** – vibrating/oscillating declined bed that allows smaller waste to pass through while transporting larger waste to the end.
Air Separation	Use of air flow to separate different waste materials based on weight. • **Zigzag air classifier** – waste is dropped through an upward air current in a zig-zag shaped flue. Light waste is blown to the top, while heavier waste falls to the bottom. • **Rotary air classifier** – trommel screen separator with an air current that captures the lightweight fraction. • **Cross-current air classifier** – waste is fed on a conveyor and dropped through an air stream. The light components are blown horizontally to a collection point and the heavy components drop through. • **Suction hood** – Sucks light weight waste directly from the conveyor belt.
Ballistic Separation	Steeply inclined bed with a perforated plate screen deck, with alternate vibrating elements. Light fractions are lifted by cams to the top of the bed, heavy fractions fall to the bottom.
Film Grabber	Waste is accelerated onto a rotating drum with spikes. These hook plastic film and let other waste drop.
Magnetic Separation	Magnets either lift ferrous metal from the waste, or hold ferrous metal to the conveyor while other waste is allowed to drop.
Eddy Current Separation	Eddy currents are used to push non-ferrous metals with magnets into separate collection points, with non-metallic waste falling into another.
Manual Sorting	Employees are positioned beside the conveyor and manually remove materials either in positive or negative sorting.
Sensor Technology	Use of sensory technologies to identify and differentiate waste materials. • **Near infrared (NIR)** – used to differentiate between plastics (PET, HDPE, PVC, PP and PS). • **Visual spectrometry (VIS)** – used to identify materials based on color. • **X-ray fluorescence (XRF)** – used to differentiate between metals / alloys (for example, copper from steel). • **X-ray transmission** – identifies materials based on atomic density – for example, halogens and organic components. • **Electromagnetic sensor (EMS)** – Identifies metals based on their conductivity.

Source: ISWA[58]

3.5.4.2. Composting

Composting effectively reduces the overall waste volume that ends up in landfills. As waste material required for the production of compost is organic, this consequently reduces the decomposition of organic waste in landfills thereby reducing GHG emissions. At the same time, the final product, compost, are valuable inputs to the soil and serves as soil conditioner providing nutrients for agricultural production.

Municipal solid waste in Palestine generally consists of about 50 to 55 percent organic waste. Due to lack of proper solid waste management, these wastes normally end up in open dumpsites and burned. This practice presents threats to the environment and to human health.

To address this concern, several initiatives on composting of organic waste have been introduced in Palestine. Pilot composting projects have been initiated with participation from several stakeholders such as those in Jenin, Jericho and Betillo in Ramallah and Al-Bireh. Several studies have also been conducted on the potential of composting in Palestine. Results show that local farmers are keen on using the compost on their farms. However, the quality of compost currently produced could be considered medium-quality as there is a lack of regulation which defines standards for compost production.

Potential technologies for composting include windrow composting which is an outdoor composting method with passive or forced aeration, aerated static pile involving bulking agents to provide pile porosity to enhance the flow of air and control temperatures, and several types of in-vessel composting which involves treatment in an enclosed container.

Table 43: Composting Technologies

Composting Technologies	Description
Windrow Systems	Windrow composting systems involve spreading of the organic waste into long narrow piles (windrows) which are aerated periodically through turning by using mechanical equipment or forced or induced aeration through pipes to maintain even decomposition. Advantages of using windrow systems include its low cost and simple equipment requirements despite having potential for processing high volumes of wastes. However, it is labor intensive and requires large area of land. Additionally, since this is an outdoor composting method, there is potential for odor issues. • **Turned windrows** – also known as open turned piles, the organic feedstock is turned periodically by mechanical equipment to aerate the system. For small- to moderate-scale operations, turning can be accomplished using tractors with front-end loader or bucket loader. For larger scale operations, there are specialized machines that can be used for the turning process that could reduce time and labor, thoroughly mix the materials, and produce more uniform compost. The ideal pile height is between 1.5 to 1.8 meters with a width between 2.4 to 3.6 meters to generate enough eat, maintain temperatures, and allow oxygen flow to the windrow's core. • **Passively aerated windrows** – under this method, air is supplied to the composting material through perforated pipes embedded in each windrow, thereby eliminating the need for turning. The air flows into the

[58] McKinnon D, Fazakerley J, Hultermans R, International Solid Waste Association. *Waste sorting plants: Extracting value from waste. An Introduction*. 2017.

	pipes (pipe ends are open) and through the windrows due to the chimney effect as hot gases rise upward out of the windrow. Since this method does not involve regular turning of the windrows, organic waste feedstock must be mixed thoroughly before they are placed in windrows. At the same time, because of this, windrows could be built with base material and covering layer of straw, peat moss or finished compost to insulate the windrow to help retain moisture as well as control odor. • **Aerated static pile** – works the same principle with passively aerated windrows, but forcing aeration through the use of blowers (active aeration) to supply air to the composting materials. This allows windrows to be piled higher than its passive counterpart, with heights of around 2.0 to 2.6 meters. The system can compost larger volumes of organic materials and quickly with less labor. However, it is comparatively higher in cost due to equipment required, operation and maintenance, and trainings for operation.
In-vessel Systems	In-vessel composting refers to composting methods confining composting materials within an enclosed building, container or vessel. The confined conditions allow for a controlled environment resulting in better composting efficiency, regardless of outside weather conditions. It utilizes a variety and combination of mechanical turning and forced aeration to accelerate the composting process. It can process large amounts of waste without taking up as much space compared with windrow methods. In-vessel composting systems provide high amounts of process control and involve the intensive use of equipment and technology such as ventilation equipment, recirculation ducts and mechanisms to heat or cool the recirculated air. As a result, these systems also tend to be more expensive centralized composting method. In-vessel systems may refer to: • **Bin composting** – simplest in-vessel method. This includes modular in-vessel containers that can be designed in different shapes, usually rectangular, to bulk storage buildings. It operates in principle similar to aerated static pile system. It involves active or passive aeration with little to no turning of the composting materials. • **Agitated beds** – in-vessel composting with a mechanical agitation component. Composting materials are loaded in the front end of long channels with walls in in-vessel bays, and an agitation machine travels on top of the bed to mix the materials. Aeration is introduced through the floor. The composting materials slowly progress from the front end to the discharge end, while mechanical turners moving along the channel agitates the materials. • **Rotary drums** – uses a slowly rotating horizontal cylindrical drum to mix, aerate and move materials through the system. Aeration can be provided through natural ventilation by creating perforations along the wall of the drum or can be provided through forced aeration. Air is supplied through the discharge end and is incorporated into the material as it tumbles. Compost near the discharge is cooled by the fresh air. In the middle, it receives the warmed air, which encourages the process; and the newly loaded material receives the warmest air to initiate the process. This system provides higher organic matter decomposition rate with shorter retention time. Generally, rotary drum systems are used with other composting systems (windrows and/or in-vessel) for

	further decomposition of the materials if necessary.

Source: Various

3.5.4.3. Recycling

Recycling of reusable materials such as plastic, paper, metal, glass, among others, is a proven solution to reduce the amount of waste that is finally disposed of in landfills. This component of the solid waste value chain, similar with composting technologies, will heavily depend on the successful implementation of efficient waste collection and segregation management systems.

There are existing recycling facilities in Palestine. However, these are mainly small in scale and have limited capacities. Initiatives on recycling such as the pilot project on composting with waste sorting component as part of an overall waste management approach conducted in Jenin, recyclable materials collected including cartons, plastic bottles, glass and metals are shipped to Israel and Jordan. This is due to the absence of a recycling market in Palestine to make use of the available materials.

There exists a plethora of technology options for recycling that could cater to specific qualities of recyclable materials recovered in a particular region. For example, plastics are common material for recycling. Majority of the plastics currently recycled are composed of polyethylene terephthalate (PET), which is the component used in most water bottles, and polyethylene, the most highly produced plastic. These can be used as source of material for the manufacture of new plastic-based products.

Table 44: Recycling Technologies

Recycling Technologies	Description
Plastics	There are several common types of plastics which can be recycled such as polystyrene (PS), polypropylene (PP), polyvinyl chloride (PVC), low-density polyethylene (LDPE), high-density polyethylene (HDPE), acrylonitrile butadiene styrene (ABS) and polyethylene terephthalate (PET). In Palestine, recycling of plastics is practiced at very small scale with mainly PP, HDPE, LDPE and ABS being recovered. • **Shredded** – although plastic recycling processes vary based on the type of plastic, it generally involves sorting of plastic by type, shredding, washing and drying to produce a final product of clean shredded plastic. • **Pellets** – to produce pelletized plastic as final product, an extrusion process where plastic is melted and formed into continuous strands is included in the process. The strands are then cooled and cut into granules or pellets. A study conducted reveals potential profit of about 200 – 300 NIS per tonne of shredded plastic for recycling, while pelletized plastic can potentially generate profits of about 300 – 800 NIS per tonne.[59] It is also noteworthy that PET is the most commonly recycled type of plastic worldwide but is not currently being recycled in Palestine. This can be considered as an opportunity for Palestine to expand its plastic recycling industry to include PET, as the technology for its recycling is proven worldwide.
Glass	Glass bottles and containers are resources with great recycling potential as these can be recycled indefinitely with virtually no loss of quality. The recycling process

[59] Presentation on a recycling session entitled, *Recycling in Palestine – Current Status: Strengths, Weaknesses, Opportunities, Treats*.

	typically involves the following: • **Sorting** – sorting of waste glass according to type and color increases recycling efficiency. Separating by color ensures that production of final product meet standards (i.e., color standards) of customers without requiring further treatment (de-colorizing or dyeing). For example, production of green glass can utilize 90 to 95 percent of recycled glass cullets replacing natural raw materials, brown glass utilizing about 70 percent, and white glass utilizing 60 percent. • **Cullet** – industry term for furnace-ready recycled glass. In this stage, the sorted waste glass is crushed and grinded into tiny pieces called cullets. Using recycled glass cullets to replace natural raw materials for glass production results in reduced energy consumption of about 20 percent when using 65 percent cullets,[60] thereby resulting in reduced GHG emissions. This is because the melting point of cullet is lower than that of the mineral raw materials. • **De-contamination** – waste glass usually contains contaminants from its labelling, contained products, and those accumulated from storage. This stage involves washing of the glass cullets to remove these contaminants, as well as additional de-contamination to remove other contaminants such as metal, paper, plastic and ceramic. If contaminants are allowed to remain, the quality of glass recycled can be affected such as having structural defects. • **De-colorizing and Dyeing** – when glass cullets do not match the desired end product glass color, it has to go through de-colorizing and dyeing during the melting process. De-colorizing involves oxidizing the melted glass cullet. Some of the coloring agents used for dyeing recycled glass include borax, cobalt carbonate erbium oxide, neodymium oxide, potassium permanganate, titanium dioxide and zinc oxide. • **Glass production** – glass cullets are melted, then molded into the desired glass products such as bottles and containers. In Palestine, glass recycling industry is present in Hebron albeit at a small scale. Glass bottles and containers with quantities of up to 0.5 tonne per day is recycled into glass art craft products. The current market of glass recycling is limited to this as there are no industries that can produce glass bottles and containers for use by the beverage industry.
Metals	Metal recycling involves the recovery of scrap metal from end of life products, structures, as well as manufacturing by-products, and processing it to be used as raw material in the production of new metal products. Metals can be recycled repeatedly without degradation to its properties. At the same time, the use of recycled metals for production reduces energy required in processing new products using virgin raw materials. This therefore results in reduced GHG emissions and other harmful gases, reduced production costs, and preserves natural resources. Recyclable metals can be classified into two categories, ferrous and non-ferrous. Ferrous metals are materials containing iron such as carbon steel, alloy steel,

[60] Recovery Recycling Technology Worldwide. *Glass recycling – Current market trends*. 2018. https://www.recovery-worldwide.com/en/artikel/glass-recycling-current-market-trends_3248774.html

	wrought iron and cast iron. Non-ferrous metals are materials which does not include iron as a component such as aluminum, copper, lead, nickel, tin and zinc. Scrap metal recycling process normally involves the following: • **Collection** – collection of scrap metal typically differs from other waste materials due to its higher value. In Palestine, households and industries mostly sell their scrap metal to itinerant scrap metal buyers. Also, its informal sector typically collects metal scraps from random solid waste containers and dumpsites, as well as collecting metals from used tires. • **Sorting** – separation of metals according to their types. In automated recycling operations, magnets and sensors are used to help in material separation. • **Shredding** – done to facilitate the melting process. Shredding increases surface are which allows for less energy used for the melting process. For example, aluminum is shredded into tiny sheets. • **Melting** – metal is melted through furnaces specifically designed for certain metal types. This is the most energy intensive stage of the process. However, the energy required to melt and recycle metals is much less than the energy required to produce metals from virgin raw materials. • **Purification** – done to remove contaminants in the metal, ensuring high quality final product. Electrolysis is one of the most commonly used methods of purification. • **Solidification** – the metal is then cooled and solidified. At this stage, the metals are formed to specific shapes such as bars for ease of use for production of new metal products. There is currently no recycling industry for scrap metal within the West Bank. Most of the collected scrap metals are exported to either Jordan or Israel. The presence of export market for scrap metal in Palestine indicates opportunity for its scrap metal recycling industry to be established and developed with proper support.
Paper	Waste paper recycling is the process of turning waste paper into new paper products. Waste paper sources are categorized into pre-consumer waste consisting of scrap paper generated in paper making process (mill broke) and production operations such as trimmings from final paper products; and post-consumer waste which are paper products that have served their intended purpose such as old/used cardboard boxes and containers, newspapers, printing and writing paper. The recycling process often involves the following: • **Collection** – a crucial first step in paper recycling. This can be done from source without mixing with municipal solid waste such as those through curbside programs, drop-off centers and paper drives; and through commercial waste collections systems which sorts out waste paper along with other recyclable materials. In Palestine, cardboard is discarded separately beside communal solid waste containers and can be collected easily, presenting good opportunity for recycling. • **Sorting** – waste papers are sorted by grade and level of cleanliness. This is important as paper mills manufacture different grades of

	materials depending on the final product being produced. In most cases, waxed and coated paper products such as those used for food packaging are not accepted in standard recycling mills, as it needs to undergo specialized process for recycling. The sorted waste paper are then compressed into compact bales for easy handling. • **Pulping** – the next step is shredding the baled waste paper and mixing it with water into the pulper and agitated to breakdown into a fiber and water slurry called pulp. Chemicals sometimes are added to the pulper to hasted the pulping process. • **Filtering and De-inking** – filtering process is done to remove foreign materials such as plastics and metal staples, and impurities such as glue and tape. De-inking process involves passing the pulp through a floatation device made up of chemicals that removes any forms of ink or dyes through a series of filtering and screening. This de-colorizes the pulp, ready for reuse. • **Finishing** – at this stage, the pulp is ready to be processed into its final output. Virgin paper materials (fresh pulp) are usually added with the recycled pulp as using recycled pulp alone can result in lower quality paper which wears and tears faster. The pulp is allowed to dry as it passes through machines which presses out and evaporates excess water, and facilitates the formation of long rolls of the new paper product.

Source: Various

3.5.5.Barriers overview for the sector and specific to technologies

The solid waste sector faces the following barriers for the introduction of solid waste management technologies:

Table 45: Barriers in the Solid Waste Sector

Type of barrier	Summary
Regulatory	Lack of regulations governing solid waste management, lack of standards for various stages of the value chain
Institutional	Ambiguity in roles and responsibilities resulting in overlap in efforts due to variations in interpretations of responsibilities of relevant institutions
Technical	Lack of expertise and know-how on waste sorting, composting and recycling technologies
Social	Lack of awareness and acceptance

The introduction of solid waste management technologies and practices is limited by significant regulatory barrier. Specific to the prioritized technologies, there are currently no regulations which require the sorting of solid waste either from the household level or central/communal level. There is also a lack of regulations on standards for the various stages of the value chain such as those for recycling.

Institutionally, the roles and responsibilities of solid waste management in Palestine are distributed among several national institutions which are resulting in overlap of efforts due to variations in interpretations of

responsibilities. Technically, there is a need to introduce efficient waste sorting methodologies and technologies to promote alternative options for waste management such as recycling and composting. In addition, the adoption of this technology is limited by lack of acceptance from users and stakeholders.

3.5.6. Implementation Plan

The successful implementation of solid waste management technologies and practices will greatly contribute to achieving sustainable development in Palestine's solid waste sector. This includes its objectives on establishing an effective legal and organizational framework for solid waste management, strong and capable governing institutions, deliver an effective, environmentally safe and financially viable solid waste management services and activities, increasing private sector participation, and more participative and aware community.

To achieve these objectives, it is important to determine which technologies and practices can be used and which actions will be the main drivers in order to ensure their dissemination. Given the precursor that proper waste collection and waste segregation brings toward making business sense and financial viability to alternative waste treatment options along the solid waste value chain, it would be advisable to focus on the implementation of waste collection and sorting technologies and practices as a first step. This would pave the way for the development of a market for composting and recycling technologies and practices.

As the managers of household waste, women's increased knowledge of separation, reduction and composting at home can directly affect their ability to effectively and efficiently manage waste, as well as influence other members of the family to do the same. However, care must be taken to ensure that the domestic burden on women does not increase as a result of the implementation of the Roadmap. Awareness raising should emphasize the contribution of all family and community members - particularly men – to solid waste management. In this way, the social, economic, safety and health benefits of solid waste management can lead to a decreased domestic burden on women and girls.

The roadmap for the implementation of solid waste management technologies and practices is developed with actions, measures and timelines defined in line with the country's national priorities and targets. The implementation action and measures for solid waste management technologies and practices are proposed as follows:

Action 5.1 – overall capacity building and awareness raising

Building the capacity and awareness of the relevant stakeholders such as government institutions, potential investors, developers, end-users, and financial institutions, will enable both short-term and long-term actions to be implemented efficiently. On the short-term, this will support the implementation scaling -up of solid waste management technologies and practices, including waste sorting, composting and recycling. This will also support and pave the way for the implementation of more advanced technologies for the sector such as the use of automated facilities and sensory systems.

Activity 5.1.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions of the solid waste sector such as MOLG, JSCs, LGUs and other cross-sectoral ministries. This would allow them to make informed decisions to design the required policies such as regulations, standards, fiscal instruments and incentives, among others, to support the implementation and dissemination of solid waste management technologies and practices.

Activity 5.1.2 – Technical capacity building – to enhance the technical capacity of relevant government institutions responsible for the collection, transportation, handling and overall management of municipal solid waste. This would allow them to build technical know-how, to better implement solid waste management services and activities. This will also prepare the government for medium to longer-term actions in the sector requiring technical expertise.

Activity 5.1.3 – Capacity building for private sector – for potential private sector project developers and investors to have in-depth understanding of solid waste management technologies and practices which would allow them to take advantage of business opportunities along the solid waste value chain. The private sector in Palestine, from smallholders to large companies, are expected to be instrumental in developing a viable market for technologies both in the short-term and long-term. It is important for them to understand the de-risking measures that the Palestinian government has undertaken in terms of regulatory measures and incentives, as well as understand the economic, environmental, and social benefits that such projects bring.

Activity 5.1.4 – Capacity building for financing sources – for financial institutions to have in-depth understanding of solid waste management technologies such as waste sorting, composting and recycling, their application, the enabling environment that the government has laid out for de-risking. This would allow potential investors and project developers to have better access to financing available technologies related to the sector.

Activity 5.1.5 – Awareness raising – to raise general public awareness. The successful implementation of solid waste management technologies and practices cannot be realized without the acceptance, support and participation of the general population from individual Palestinians to large companies. This can be achieved through the dissemination of information regarding benefits of implementing solid waste management technologies and practices, and how these can alleviate environmental, social, economic, safety and health issues.

Entity-in-charge: The implementing entity for the overall capacity building and awareness raising actions is proposed to be spearheaded by MOLG.

Costs: The costs associated with the implementation of this action is estimated at USD 350,000 which involves conducting workshops and trainings, engaging international experts, and deploying public awareness materials.

Action 5.2 – Development of an enabling environment

To effectively implement sustainable solid waste management in Palestine, it is important to create an enabling environment that would enhance key stakeholder engagement and drive private sector participation.

Activity 5.2.1 – Policy development and enforcement – to create an enabling environment for an effective and sustainable solid waste management. Once capacities of key government institutions are enhanced, they will be well-informed to develop clear legal framework to regulate the sector, as well as effectively enforce existing laws such as the Solid Waste Management Regulations and Joint Service Council Regulations. This would result in the alleviation of the risks involved in the sector and incentivize the market for the various stages of the solid waste sector. These include the clear delineation of roles and responsibilities of every government institutions involved in solid waste management from national level to community level, and development of standards for sorting, composting and recycling.

Entity-in-charge: The implementing entity for the development and enforcement of relevant policies is proposed to be spearheaded by MOLG.

Costs: The costs associated with the implementation of this action is estimated at USD 200,000, which involves engagement of international and national consultants to support the formulation and development of policy measures, and to conduce the necessary workshops, trainings and consultations.

Action 5.3 – Dissemination of waste sorting technologies

The main driver behind the dissemination of waste sorting technologies will be the Joint Service Councils

and Local Government Units, which are responsible for solid waste management in their respective jurisdictions. It is expected that its successful implementation should be supplemented by private sector participation.

Activity 5.3.1 – Dissemination of waste sorting technologies – Solid waste sorting technologies and practices can be implemented from the source at the household level, community level, and facility level. The scale at which its dissemination is achieved heavily depends on the enabling environment that would be laid out in previous activities. Results from previous piloting activities on waste sorting as well as consultations with stakeholders from the solid waste sector indicated that waste sorting at the household level may not work in current national context. Therefore, on the shorter term, implementation of waste sorting could be focused at the community level, while the short to medium-term actions can develop to larger scale sorting activities. The scaling up of the technologies in solid waste management and waste sorting is expected upon enhancement of the value chain market resulting from the development of the policy environment and incentives as part of government actions. Similarly, it is expected that climate finance through financial institutions will be able to provide financial products available to the sector players.

Entity-in-charge: The diffusion of waste sorting technologies will mainly be implemented by Joint Service Councils and Local Government Units supplemented by private sector participation.

Costs: The implementation of this action is estimated at USD 15,000,000.

Action 5.4 – Dissemination of composting technologies

The implementation of composting technologies will require significant investments. The main driver for its dissemination will be the private sector through the development of an attractive market.

Activity 5.4.1 – Dissemination of composting technologies – The dissemination of composting technologies will require the development and establishment of a composting industry and compost market in Palestine. As feedstock for composting activities will be primarily sourced from the waste sorting activities, it is crucial that this enabling environment is in place to ensure the industry and market develops.

Entity-in-charge: The diffusion of composting technologies will mainly be private sector driven.

Costs: The implementation of this action is expected to leverage investments from the private sector amounting to USD 9,500,000 (USD 1,500,000 for 72 ton/day facility in West Bank for a total of 5 facilities, and USD 2,000,000 for Gaza).

Action 5.5 – dissemination of recycling technologies

The main driver behind the dissemination of recycling technologies will be the private sector.

Activity 5.5.1 – Dissemination of recycling technologies – Similar with composting technologies, the dissemination of recycling technologies will require the development and establishment of a recycling industry and recycling market in Palestine. As the availability and higher quality of raw materials recovered from waste sorting activities is increased, the opportunities to produce new higher quality recycled, recyclable and innovative products will open up, and present to be a viable option for investment from the private sector. Aside from addressing environmental, social and health issues associated with solid waste management, this action will also contribute to the growth of the Palestinian economy.

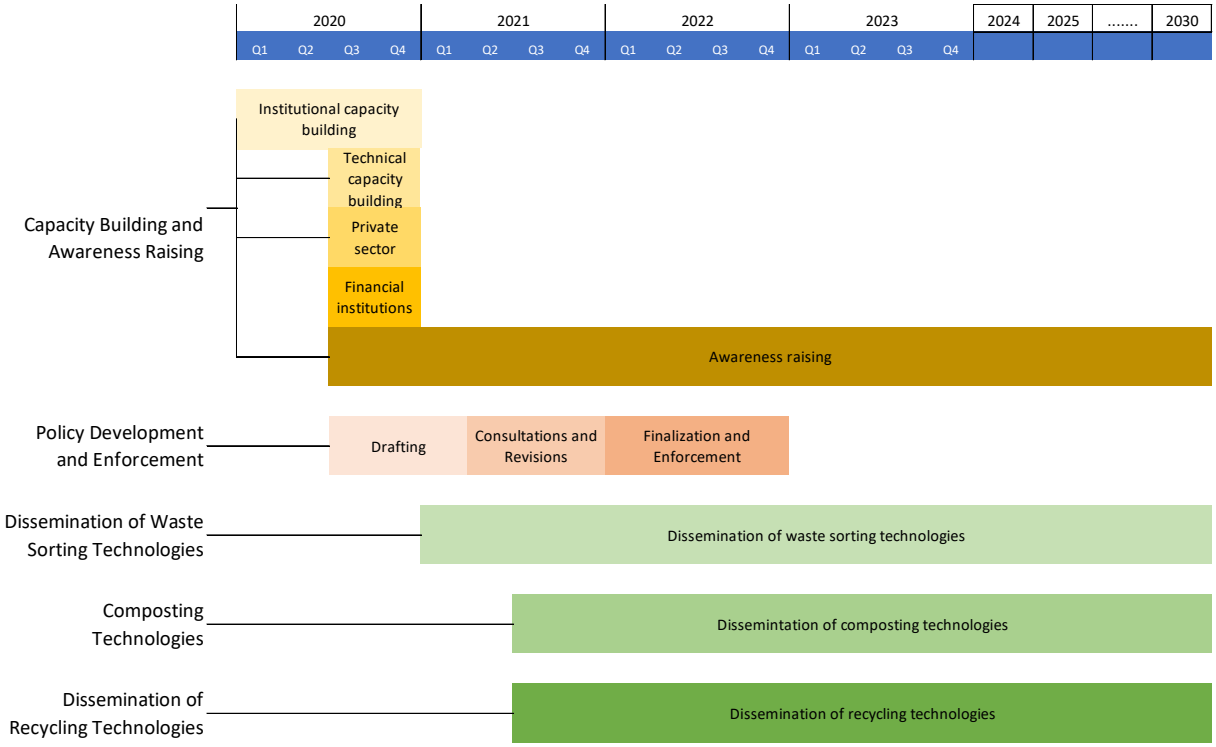
Entity-in-charge: The diffusion of recycling technologies will mainly be private sector driven.

Costs: The implementation of this action is expected to leverage around USD 10,000,000 from the private sector.

3.5.7. Timeline

The following figure shows the overall timeline for the implementation of solid waste management technologies and practices in Palestine. The implementation timeline for the for setting up the enabling environment is planned to be completed within two years. After which, it is planned that de-risking measures are in place allowing for investments in solid waste management technologies to scale-up towards contributing to Palestine's goals.

Figure 17: Solid Waste Sector Implementation Timeline



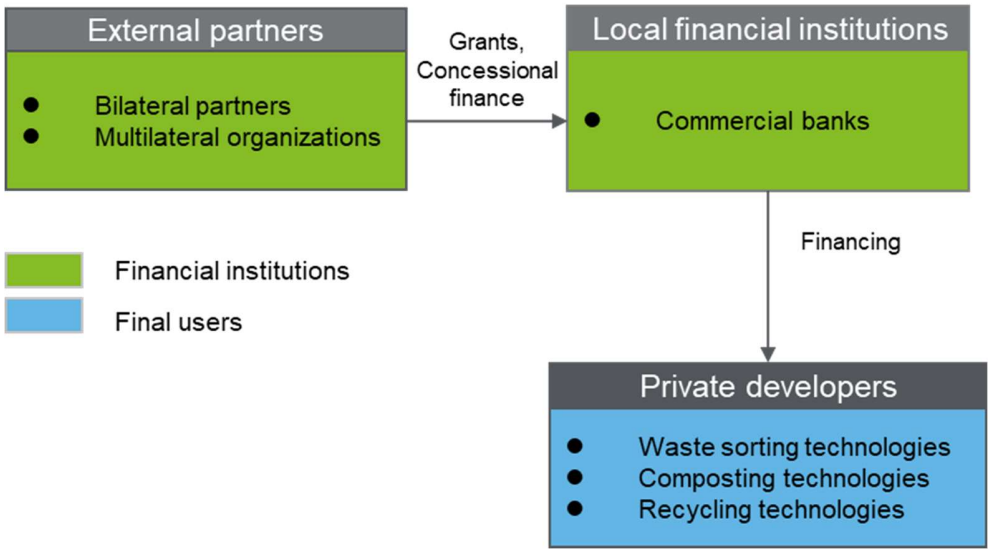
3.5.8. Expected Impacts

The successful implementation of a solid waste management in Palestine and diffusion of related technologies for waste sorting, composting and recycling will result in cascading benefits for the country and its people. It will greatly contribute to addressing the existing solid waste problem of the country and will lead to better conditions for the Palestinian people in terms of environment, social, economy, safety and health. The solid waste sector will become an additional resource providing raw materials for the value chain within the sector such as for composting and recycling, as well as potentially for the energy sector providing biomass fuel for energy generation. The sector can become an income generating industry creating numerous opportunities for businesses, employment and livelihood while at the same time, providing solutions to sustainable development of the country.

3.5.9.Potential financing

The overall approach to financing for the roadmap is detailed in Annex 2: approach to financing. In the solid waste management sector, the financing approach will aim at attracting climate finance from international financial institutions and trigger private sector investments from the private sector by supporting the development of all stages of waste management and by developing the enabling environment for the introduction of new technologies.

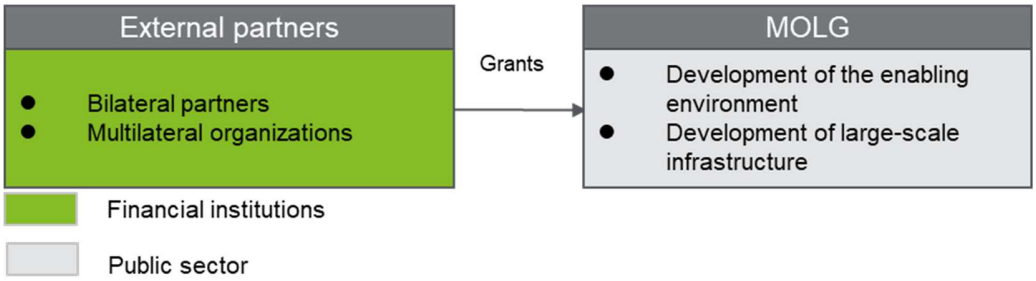
Figure 18: Potential Financing Options for the Solid Waste Sector



While the development of the enabling environment, in terms of regulations and revenue streams, is paramount for private sector engagement, it is also important to emphasize that solid waste management involves significant investments related to infrastructure. The private sector may not be ready to invest in these without prior experience in Palestine. It is therefore crucial to provide early-adopters with adequate financing conditions to encourage the off-take of the technologies.

Under this approach, Palestine and international partners will provide grant financing related to technical assistance as well as grants and/or concessional financing to private sector stakeholders up to a certain extent. It is expected that providing concessional financing will leverage significant investments from the private sector on the long-term.

Figure 19: Potential Financing Options for the Solid Waste Sector, Grant Approach



Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in the table below.

Table 46: Financing for Solid Waste Sector Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 5.1 – overall capacity building and awareness raising	Technical assistance	350,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 5.2 – policy development and enforcement	Technical assistance	200,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 5.3 – dissemination of waste sorting technologies	Infrastructure and equipment	15,000,000	Grants / Private sector led Concessional financing / Blended finance	International organization / Local financial institutions, developers
Action 5.4 – dissemination of composting technologies	Infrastructure and equipment	9,500,000	Grants / Private sector led Concessional financing / Blended finance	International organization / Local financial institutions, developers
Action 5.5 – dissemination of recycling technologies	Infrastructure and equipment	10,000,000	Private sector led Concessional financing / Blended finance	International organization / Local financial institutions, developers

Indirect costs and financing

Other actions, that may stem from the measures undertaken under the implementation roadmap, include the implementation of the policies developed under the roadmap. For example, the costs associated to the introduction of tariffs, such as tipping fees for waste management and costs related to financing arrangements have not been included.

External financing

Requests for external financing will focus on measures that cannot be financed by Palestine and which are of high priority to the country. As mentioned above, the solid waste sector is currently mainly based on public sector stakeholders. However, involving the private sector would allow to leverage additional investments in the sector. The private sector will therefore be the focus of the financing strategy and external financing will mainly be requested to prepare the enabling environment for its participation.

The first set of priority measures to be financed by external resources is therefore the development of the enabling environment for private sector engagement in all steps of waste management. This will include

the development of incentives, such as tipping fees, and other schemes in order to encourage the private sector to invest in waste management.

Waste sorting technologies should be the first technologies to benefit from concessional financing supported by external resources. Efficient waste sorting processes and technologies will enable the development of the whole value chain and encourage the private sector to get involved in recycling and composting.

Potential sources of financing include the GCF, GEF as well as international organizations, such as the World Bank, other multilateral development banks, and bilateral donors. JICA has provided technical assistance in relation to waste management through a number of projects to Palestine. JICA could be a source of financing for further technical assistance.

3.6. Other technologies

3.6.1. Provision of beach nourishment, reclamation and beach drift rehabilitation

3.6.1.1. Technology overview

There are two approaches in addressing coastal erosion: hard and soft engineering solutions. Hard engineering approach involves establishing structures which aim to resist the energy of the waves and tides. Hard engineering structures modify strongly the natural hydrodynamic movements of the water and sediments of the area where they are applied. Therefore, in most cases, hard engineering structures can increase the erosion processes in neighboring areas. Soft engineering, or nature-based, approach involves establishing elements which aims to work with nature by manipulating natural systems which can adjust to the energy of the waves, tides, wind and especially the sediment transport[61]. Soft engineering methods usually have a lesser impact on the environment and may require less maintenance. Beach nourishment is one of soft-engineering adaptation technologies primarily used in response to shoreline erosion. It is used in coastal protection, which involves the artificial addition of sediment of suitable quality to a beach area[62].

The provision of beach nourishment, reclamation and beach drift rehabilitation is a national priority for Palestine taking into consideration the limited area of the coastal line of the Gaza Strip. This technology is of significance to the Gaza area as there are implications to the people living in these areas from changes in climate. Impacts include effects and risks of sea level rise and flooding. The implementation of coastal erosion management technology will ensure safety of the people in these areas from impacts of climate change.

Table 47: Coastal Erosion Management Technologies

Technologies	Description
'Hard engineering' technologies for coastal erosion management[63]	
Breakwater	Breakwaters are protective structures placed offshore, generally in hard materials such as concrete or rocks, which aim at absorbing the wave energy before the waves reach the shore.
Gabion	The gabion is a metal cage filled with rocks, about 1 metre by 1 metre square. Gabions are stacked to form a simple wall.
Geotextiles	Geotextiles are permeable fabrics which are able to hold back materials

[61] McInees, R. (2003). International Conference on Coastal Management 2003.

[62] http://www.climatetechwiki.org/content/beach-nourishment

[63] National Institute of Coastal and Marine Management of the Netherlands (2004). "A guide to coastal erosion management practices in Europe: lessons learned". Accessed from: < http://www.eurosion.org/shoreline/lessons_learned.pdf>

	while water flows through. Geosynthetic tubes are large tubes consisting of a woven geotextile material filled with a slurry-mix. The mix usually consists of dredged material (e.g. sand) from the nearby area but can also be a mortar or concrete mix.
Groin fields	Groins are structures that extend perpendicularly from the shore. Usually constructed in groups called groin fields, their purpose is to trap and retain sand, nourishing the beach compartments between them. Groins may be made of wooden or rocky materials. They interrupt the longshore transport of littoral drift.
Revetments	Revetment is a sloping feature which breaks up or absorbs the energy of the waves but may let water and sediment pass through. The older wooden revetment consists of posts fixed into the beach with wooden slats between. Modern revetments have concrete or shaped blocks of stone laid on top of a layer of finer material.
Seawall	Bulkheads and seawalls protect banks and bluffs by completely separating land from water. Bulkheads act as retaining walls, keeping the earth or sand behind them from crumbling or slumping. Seawalls are primarily used to resists wave action.
'Soft engineering' technologies for coastal erosion management	
Artificial beach reef creation	Building an artificial reef which absorbs the wave energy (thus providing coastal defense), while providing a natural habitat for marine biodiversity and opportunities are recreational activities.
Beach drainage	Beach drainage decreases the volume of surface water during backwash by allowing water to percolate into the beach, thus reducing the seaward movement of sediment. Beach drainage also leads to drier and "gold" colored sand, more appreciated for recreational activities.
Sand supply or nourishment	Artificial increase of sand volumes in the foreshore via the supply of exogenous sand. Sand supply may be achieved through the direct replacement of sediment on the beach through trickle charging (placing sediments at a single point), or through pumping. It can also take place in the emerged part of the foreshore ("beach nourishment") or under the water line ("underwater nourishment") which is generally cheaper.
Beach scraping	Artificial re-profiling of the beach when sediment losses are not severe enough to warrant the importation of large volumes of sediments. Re-profiling is achieved using existing beach sediment.
Cliff drainage	Reduction of pore pressure by piping water out of the cliff and therefore preventing accumulation of water at rock boundaries.
Cliff profiling	Change of cliff face angle to increase cliff stability. The angle at which cliff become stable is a function of rock type, geologic structure and water content.
Cliff toe protection	Protection of the cliff base by placing rocks at the foot of potential failure surface.
Creation of stable bays	Increasing the length of the coastline to dilute wave energy per unit length of coast. While some coastline segments are protected, erosion continues between these hard points leading to the formation of embayment.
Dune regeneration	Wind-blown accumulation of drifted sand located in the supra-tidal zone. Wind velocity is reduced by way of porous fences made of wood, geo-textile, plants, which encourages sand deposition.
Marsh creation	Planting of mudflats with pioneer marsh species, such as *Spartina sp*. Marsh vegetation increases the stability of sediment due to the binding

	effects of the roots, increasing shear strength and decreasing erodability. Marshes also provides cost-effective protection against flooding by absorbing wave energy.
Mudflat recharge	Supply of existing mudflats with cohesive sediments. This is achieved via trickle charging, rainbow charging, and polders.
Rock pinning	Prevention of slippage in seawards dipping rocks by bolting layers together to increase cohesion and stability. Does not prevent wave attack at the cliff base, but does reduce the threat of mass movement and thus reduces net erosion rates.
Sand by-passing	Reactivation of sediment transport processes by pumping sediments accumulated up-drift by coastal infrastructure normal to the coastline and injecting them down-drift. A variant of sand by-passing is to use materials dredged for navigational purposes to reactivate the sediment transport.
Vegetation planting and/or stabilization	Colonization of coastal soils by vegetation whose roots bind sediment, making it more resistant to wind erosion. Vegetation also interrupt wind flow thus enhancing dune growth. As for cliffs, vegetation increases cohesion of surface soils on cliff flops to prevent downhill slumping and sliding.

3.6.1.2. Barriers overview

Table 48: Barriers in Coastal Erosion Management

Type of barrier	Summary
Political	Lack of clarity in regards to who would be responsible for the implementation
Access to materials	Approval is required from Israel on importation of materials
Financial	High cost associated with the construction of the technology (this will be dependent on the technology to be selected)
Awareness	Lack of awareness related to risks of coastal erosion and related technologies amongst the general public.

There are a number of barriers that must be addressed when implementing coastal erosion management technology in Palestine. Politically, there is a need to identify which government institution would lead the overall implementation work. In addition, Palestine will need to work with international organizations in order import necessary materials such as cement and steel, based on technology selected for implementation of this technology in Palestine. Currently, imports of these materials are strictly controlled by Israel. However, there are exceptions to this, given that international organizations are involved in the management of material use. There have been cases in which imports of these materials have been approved by Israel, given that international institutions are involved. Financially, the construction will require significant finances, as well as technical assistance support in the construction of this technology in Gaza. There is also a lack of awareness among the general public regarding the risks associated with coastal erosion and technologies available for coastal erosion management.

3.6.1.3. Institutional arrangement

The implementation of this technology in Palestine will require responsible leading government institutions to be identified. The following key government institutions have been proposed to play the leading role:

Table 49: Key Government Institutions for Coastal Erosion Management

Lead Institution	Description

Ministry of Public Works and Housing	The Palestinian Ministry of Public Works and Housing (MOPWH) is the main government entity responsible for the building and construction sector. MOPWH will play a key role in the implementation of coastal erosion management related to construction, as well as holding chairmanship in the Coastal Erosion Task-Force.
Environment Quality Authority	The Environment Quality Authority (EQA) aims to promote sustainable environmental development in Palestine. It is responsible for protecting the environment with all elements and preventing environmental hazards threatening all living things. It is the umbrella for all activities and studies related to environmental planning, protection, monitoring and control. EQA will play a key role in supporting the introduction of technology to ensure coastline is protected from environmental hazards.
Ministry of Local Government	The Ministry of Local Government (MOLG) is responsible for ensuring that local government units have the ability and tools to take actions in meeting strategic objectives. MOLG will play a critical role in identifying government institution and relevant stakeholders for the implementation of this technology in Palestine.
Local Government Units	Local Government Units (LGUs) for coastline in Gaza. This is specific to municipalities in coastal areas.

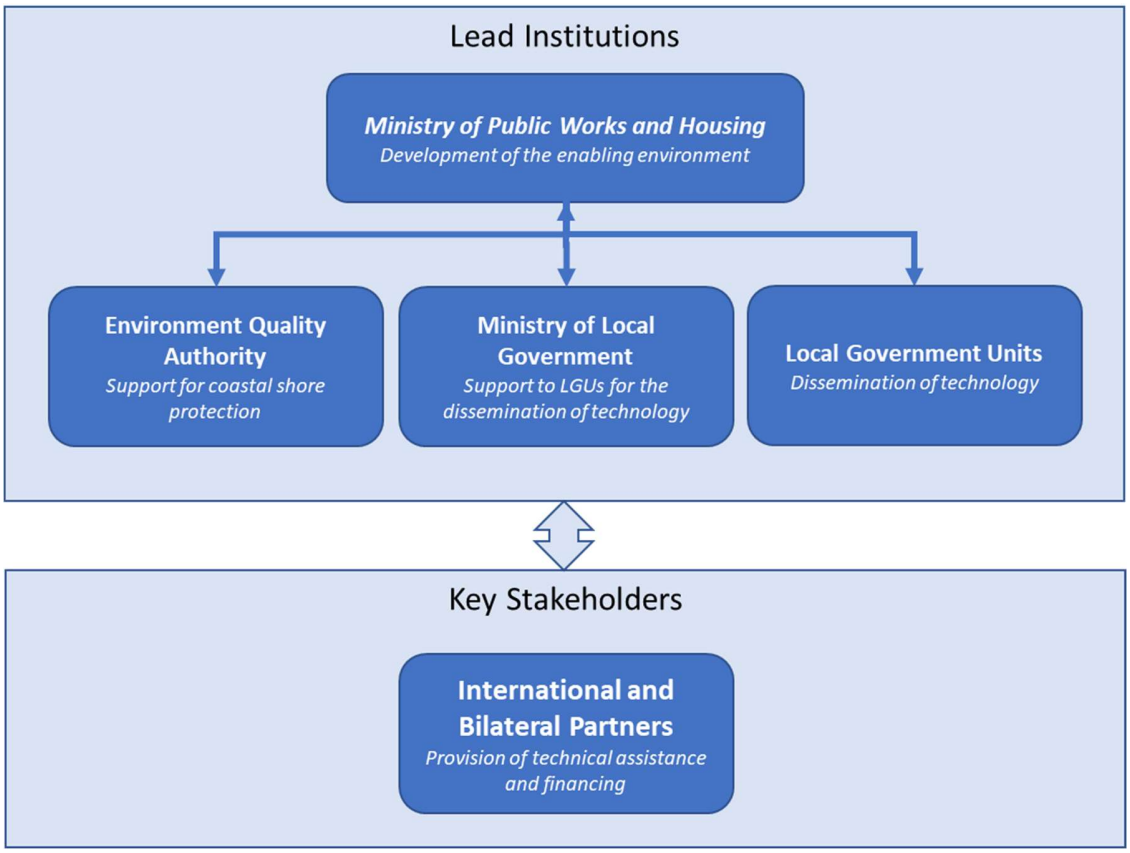
The following key stakeholders were also identified which would play major roles in the implementation of this technology.

Table 50: Key Stakeholders in Coastal Erosion Management

Key Stakeholders	Description
International and Bilateral Partners	International and bilateral partners will play a key role in providing support in consideration of Palestine's limited resources and capacities. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the implementation of this technology is illustrated in Figure 20.

Figure 20: Institutional Framework for Coastal Erosion Management



3.6.1.4. Implementation Plan

The successful implementation of this technology will contribute to protecting the people and their assets, especially in Gaza, from climate change impacts. It is a high priority for the country to ensure that there are adaptation measures in place for combating flooding arising from risks related to sea-level rise.

In the short-term, the implementation plan will focus on identifying lead government institutions who will be responsible for the overall implementation of coastal erosion management technology in Gaza. This will be achieved through institutional capacity-building. In addition, technical capacity-building activities will be conducted to enhance know-how of each of the technology available for coastal erosion management. This is critical in order to identify which technology is applicable and beneficial in the context of Palestine. This will impact materials that will need to be imported in to Palestine and understanding the necessary steps that need to be taken. Awareness raising activities will also be in scope of short-term focus to raise public's awareness regarding the risk of coastal erosion and climate change impacts. Relevant policies and regulation, targeting the use of beach and users of the beach, will also be developed in the short-term.

In the long-term, the implementation plan will focus on deployment of selected coastal erosion management technology by working closely with international donors and organizations.

Flood prevention will have a life-saving effect, particularly on women and girls. Worldwide, females are 4 times more likely to die of flooding than males (UNDP, 2011). This is due to cultural barriers that prevent them from learning how to swim, from operating or owning vehicles and from fleeing the house in an

emergency without being fully clothed or without obtaining permission from their male relatives.

The timeline for the implementation of coastal erosion management technology will be set for 2030.

Action 6.1.1 – Overall capacity building and awareness raising

Building the capacity of government institutions, including technical capacity, will be important to identify applicable technology for use in Palestine. Awareness raising will also be critical to ensure that users of the beach and people in Gaza, in general, are aware of the risks associated with coastal erosion.

Activity 6.1.1.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions. This is critical in identifying who is leading the overall implementation of this technology in Palestine, specifically in Gaza.

Activity 6.1.1.2 – Technical capacity building – to enhance the technical capacity of relevant government institutions. This will allow them to build technical know-how to better asses and identify applicable technology for implementation in Palestine.

Activity 6.1.1.3 – Awareness raising – to increase understanding and appreciation of the public on beach nourishment, reclamation and beach drift rehabilitation.

Entity in-charge: The implementing entity for the overall capacity building action is proposed to be led by the MOPWH.

Cost: The associated cost for the implementation of this action is estimated at USD 400,000 which involves technical support and feasibility study, engaging international experts, and conducting workshops and consultations.

Action 6.1.2 – Policy development and enforcement and mapping of shoreline

To effectively implement this technology, it is important to create an enabling environment as well as to further understand the shoreline with respect to physical, climate and population.

Activity 6.1.2.1 – Policy development and enforcement – to create an enabling environment for the implementation of this technology. Even though this technology has been identified as an important national priority, there is a need to develop policies that would support the implementation. A relevant government institution, once identified, will be able to design specific policy measures.

Activity 6.1.2.2 – Mapping of shoreline – to further conduct assessment of the shoreline that would support in identifying which of the technology, especially for nature-based solution, would be most effective in Palestine. Protective benefits of each technology are very site- and context-specific. Whether each technology contributes to coastal protection depends significantly on the physical and social vulnerabilities of an area, cost constraints, and the nature of the storm or sea-level rise hazard to be withstood. Therefore, in order to identify the relevant technology, there is a need to map major coastal habitat types with physical, climate and social data (i.e. population) that includes information on natural biological and geomorphic characteristics of a region, the effect of storms by incorporating observed data on waves surge potential, wind forcing, and information on sea-level rise[64].

Entity in-charge: The implementing entity for the development and enforcement of relevant policies is

[64] Arkema, K., Brenner, J., Faries, J., Griffin, R., Guannel, G., Guerry, A., Rosenthal, A., Ruckelshaus, M.H., Silver, J. & Verutes, G. (2016). "Evaluating the Benefits of Green Infrastructure for Coastal Areas: Location, Location, Location". Coastal Management, 44;5, pg. 504 – 516.

proposed to be led by MOPWH.

Costs: The associated costs for the implementation of this action is estimated at USD 400,000, which will involve engaging international and national consultants to support the development and enforcement of relevant policies.

Action 6.1.3 – Deployment of coastal erosion management technology

The deployment of coastal erosion management technology will require significant investment and international support.

Activity 6.1.3.1 – Deployment of selected coastal management technology – once the enabling environment is established, there will be a need to secure investment and funding support for the construction. Depending on which technology is selected, Palestine may require negotiation with Israel for importation of materials.

Activity 6.1.3.2 – Secure materials and equipment – it is crucial that Palestine has access to materials and equipment necessary for the implementation of erosion management technologies.

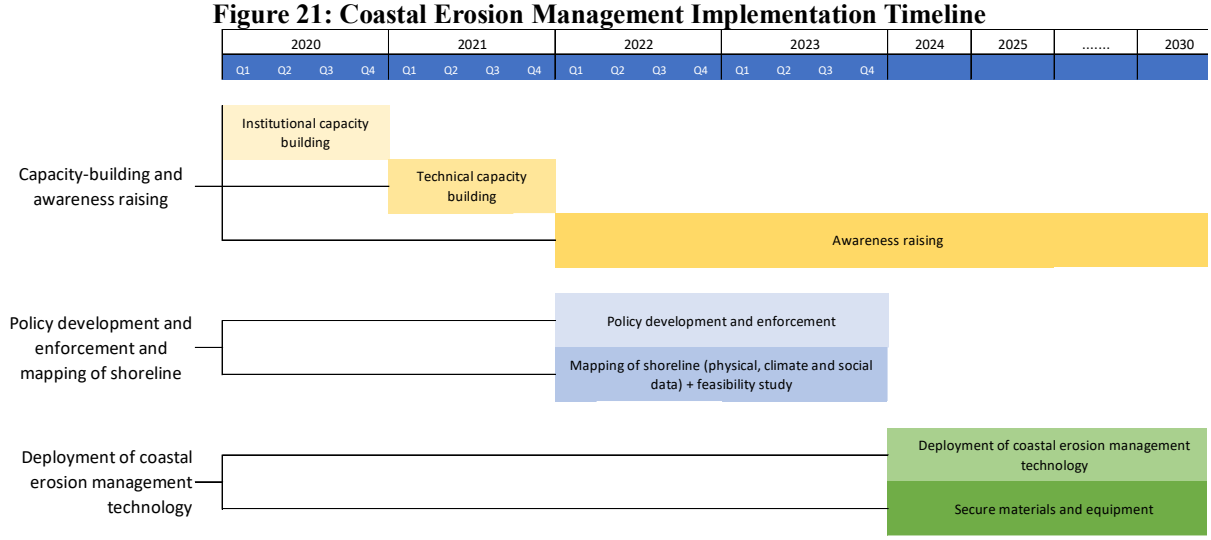
Entity in-charge: The deployment of this technology will be led by the MOPWH.

Costs: The associated cost for the implementation of this action is estimated as USD10,000,000.

3.6.1.5. Timeline

The following diagram presents the overall timeline for the implementation of coastal erosion management technology in Palestine. It is expected that this will be completed by 2030.

Figure 21: Coastal Erosion Management Implementation Timeline



3.6.1.6. Expected Impacts

The implementation of this technology will protect the people in the targeted area from experiencing severe climate change impact, such as flooding. The technology will enhance the resilience of Palestine toward climate change and will play as an important adaptation measure.

3.6.1.7. Potential financing

Beach nourishment technologies are expensive and are most often not the target of private investment. For private beaches to have an economic interest for the private sector, tourism is a crucial factor, as the erosion of beaches may threaten the tourism ecosystem, such as hotels, restaurants and other activities, led by the private sector. In Gaza, tourism is a minor sector of activity given the Israeli blockade. Beach nourishment therefore has to be led by the public sector.

Given the investments required by the technology, support from international partner is crucial in order to succeed in introducing beach nourishment technologies. Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in the table below.

Table 51: Financing for Coastal Erosion Management Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 6.1.1 – Overall capacity building	Technical assistance	400,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 6.1.2 – Policy development and enforcement and mapping of shoreline	Technical assistance	400,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Activity 6.1.3 – Deployment of coastal erosion management	Infrastructure and negotiations	10,000,000	Grant	Bilateral donor / International organization / Domestic resources

External financing

While Palestine can participate in the financing of technical assistance, it is expected that it will rely on external support for the development of this technology in Gaza.

Potential sources of financing include the GCF, GEF, as well as international organizations, such as the World Bank, and bilateral donors. The adaptation fund supports projects related to coastal zone management and may be ready to finance this type of projects.

3.6.2. Development of water, food and sanitation monitoring and safety systems using high technology related to health

3.6.2.1. Technology overview

The development of water, food and sanitation monitoring and safety systems using advanced, high-end technology is essential in ensuring the health and well-being of the Palestinian population. By having a safety system in place, Palestine will have the ability to provide access to safe water, food and sanitation to its people. The development of monitoring and safety systems of these resources will help reduce the country's vulnerability to major diseases related to water, food and sanitation and promote better management of these sources. Recently advanced monitoring systems for water, food and sanitation

involve the use and application of smart sensors, which is described below.

Table 52: Water, Food and Sanitation Monitoring Technologies

Technologies	Description
Smart sensors	Application of smart sensors in the monitoring process of water and food quality, as well as in sanitation has been increasingly gaining attention in recent years. Use of smart sensors is low-cost and it allow to measure and record data electronically. It can be designed to send out real-time alerts and notifications to users. Overall, wireless sensors improve water quality, food safety and sanitation by providing instant access to the data. For water quality monitoring, it is capable of measuring physiochemical parameters of water quality such as pH, temperature, conductivity, oxidation-reduction potential and turbidity in a pre-programmed time interval[65]. For food safety, this requires more complicated procedures which could be carried out by well-equipped laboratories for inspection and testing.

3.6.2.2. Barriers overview

Table 53: Barriers in Water, Food and Sanitation Monitoring

Type of barrier	Summary
Technical	Monitoring and safety systems relevant to the Palestinian context need to be identified
Financial	High cost associated with introduction of the technology
Capacity	Capacities of stakeholders need to be strengthened for the identification and use of systems
Awareness	Lack of adequate information about disease prevention in resource scarcity situations

In implementing this technology in Palestine, there is a need to first identify relevant water, food and sanitation monitoring and safety systems suitable for use in the Palestinian context. The introduction of this technology will also require investment and financial resources, which is a barrier for Palestine as it is limited in its resources. The effective implementation and operation of the technology will also require capacity-building activities for stakeholders as well as awareness raising on disease prevention measures.

3.6.2.3. Institutional arrangement

The implementation and scaling up of this technology will involve participation and engagement of government institutions. The following key government institutions were identified which would play the leading role:

Table 54: Key Government Institutions in Water, Food and Sanitation Monitoring

Lead Institution	Description
Ministry of Health	The Ministry of Health (MOH) of the Palestinian Authority is one of the

[65] Priya, S. K., Shenbagalakshmi, G. and Revathi, T. (2018). "Design of smart sensors for real time drinking water quality monitoring and contamination detection in water distributed mains." *International Journal of Engineering & Technology 7:1.1*, 47-51

	independent institutions state of Palestine committed to the principle of joint work with all national and international partners to develop performance in the health sector, and develop it in order to ensure a professional management of the health sector and create a leadership capable of policy development and organization of work and ensure the provision of quality services in all health sector; public and private. MOH is responsible for developing legislations and laws, and supervising private sector and providing all health services to Palestinian citizens. Therefore, it will play a critical role in leading the implementation of this technology in Palestine and for setting up the enabling environment.
Environment Quality Authority	The Environment Quality Authority (EQA) aims to promote sustainable environmental development in Palestine. It is responsible for protecting the environment with all elements and preventing environmental hazards threatening all living things. It is the umbrella for all activities and studies related to environmental planning, protection, monitoring and control. EQA will play a key role in supporting the introduction of technology to ensure proper monitoring is in place related to water, food and sanitation.
Ministry of National Economy	The Ministry of National Economy (MNE) is responsible for the economy sector in Palestine. The Ministry aims to improve the situation of the Palestinian people through the formation of a development framework for the private sector, which supports and contributes to the economic growth. The Ministry is also involved in forming partnerships with relevant ministries to advance and formulate economic policies. They will play a critical role in ensuring that appropriate food safety monitoring process is in place.
Ministry of Agriculture	The Ministry of Agriculture (MOA) is responsible for agricultural development in Palestine. It is the leading authority responsible for implementing priority technologies in the agriculture sector, which includes a technology that supports in increasing water availability in Palestine especially for use related to irrigation. It will play a key role in supporting this technology to ensure appropriate water, food and sanitation monitoring system is in place for quality purposes.
Palestinian Water Authority	The Palestinian Water Authority (PWA) is responsible for the overall management of water resources. It aims to protect water suppliers, carries out tasks related to planning, regulation and evaluation of water resources management in terms of economic and social feasibility, and monitoring the implementation of water and wastewater projects. PWA plays a key role in setting up the enabling environment and leading the implementation of prioritized technologies in the water and wastewater sector, including implementation of the water monitoring technologies. PWA will play a critical role in ensuring there is an alignment between implementation of monitoring systems related to water.

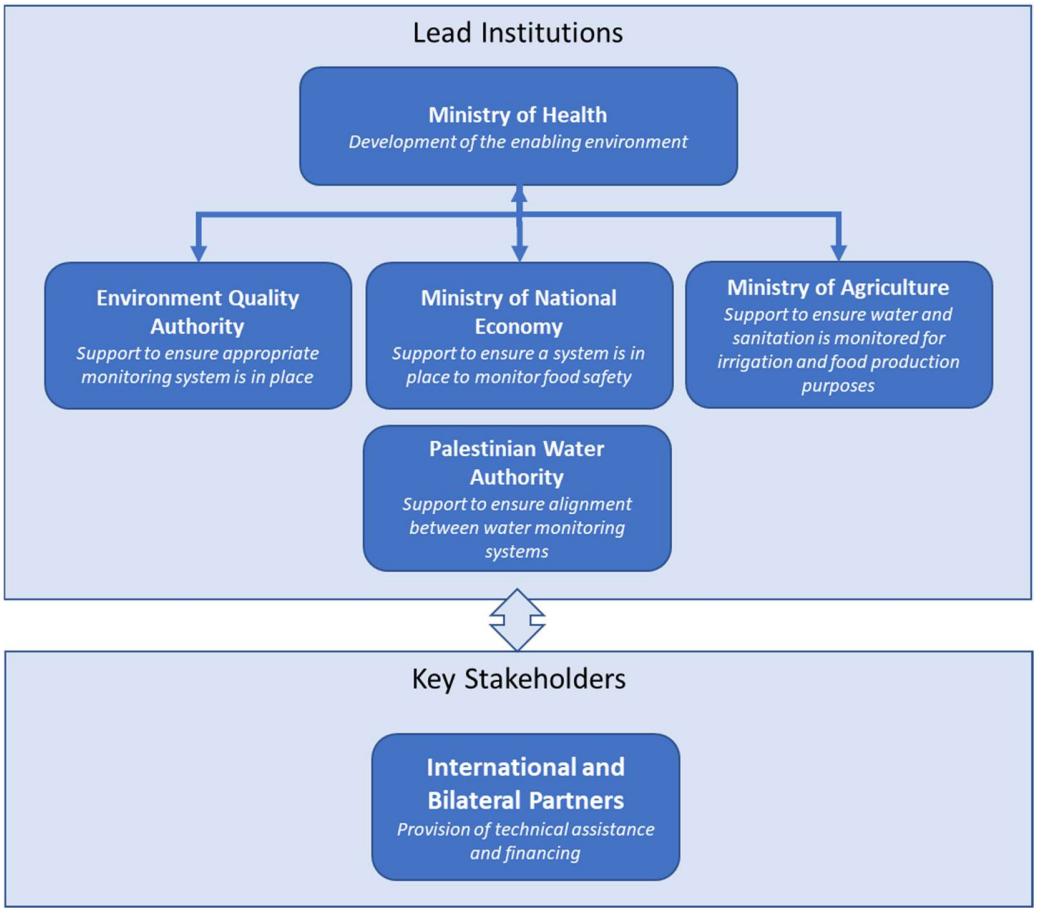
The following key stakeholders were also identified which would play major roles in the implementation of this technology.

Table 55: Key Stakeholders in Water, Food and Sanitation Monitoring

Key Stakeholders	Description
International and Bilateral Partners	International and bilateral partners will play a key role in providing support in consideration of Palestine's limited resources and capacities. This includes provision of technical assistance, enhancing enabling environment, and financing facilitation and support.

The institutional framework for the implementation of this technology is illustrated in Figure 22.

Figure 22: Institutional Framework for Water, Food and Sanitation Monitoring



3.6.2.4. Implementation Plan

The successful implementation of this technology in Palestine will improve the safety of food, water and sanitation and will enhance the protection of its people. This will contribute to overall security in food and water, improving the lives of Palestinians and proving safe environment.

In the short-term, the implementation plan will focus on building institutional and technical capacity building. There are currently a number of initiatives running on the ground, such as development of draft food security by-law, implementation of water monitoring technologies as one of the prioritized technologies in the water and wastewater sector, as well as pilot on the use of treated wastewater for irrigation purposes in the agriculture sector. Therefore, it is important to ensure that institutional capacities are developed to ensure appropriate coordination and alignment. In regards to technical capacity, it will be critical to identify what elements of water, food and sanitation will need to be monitored and tracked. In addition, this will allow for institutions to identify and develop most relevant monitoring and safety system applicable to Palestine. The technical capacity-building component will also cover knowledge of the required operational and maintenance procedures. This sis significantly critical for the overall operation and effectiveness of the system. Awareness raising activities will also be conducted, especially for users such as health

professionals, as well as women and children that are most effected by poor management of water, food and sanitation issues.

In the medium to long-term, the implementation plan will focus on the deployment of water, food and sanitation safety system in Palestine. The dissemination period will begin shortly after the completion of capacity building activities. The implementation is proposed to be completed by 2030.

As the primary caregivers of themselves, their spouses, children, the ill and the elderly at the household level, disease prevention awareness directly impacts the daily lives of women and girls, lessening their domestic burden and providing more time for educational, income-generating, social or leisure activities. When family members are healthy, their school attendance and economic activity increase and medical expenses are reduced.

Implementation actions and measures for the dissemination of this technology are provided below:

Action 6.2.1 – Overall capacity building and awareness raising

Capacity building and awareness raising will be provided to relevant government institutions.

Activity 6.2.1.1 – Institutional capacity building – to strengthen the capacity of relevant government institutions such as Ministry of Health, Ministry of National Economy, Environmental Quality Authority, Ministry of Agriculture and Palestinian Water Authority. This will allow them to make informed decisions on how to collaborate their efforts and streamline projects already implemented on the ground. This will, in the long-term, ensure the successful implementation of the technology in Palestine.

Activity 6.2.1.2 – Technical capacity building – to enhance the technical capacity of relevant government institutions responsible for the identification and coordination of the implementation of overall technology. This would allow them to build technical know-how to assess and determine the technology applicable to the context of Palestine. This will also provide deeper understanding on the ongoing maintenance and operation procedures required to be performed as well as elements to be monitored.

Activity 6.2.1.3 – Awareness raising – to raise general awareness regarding disease preventions. This activity will specifically focus on end users of the monitoring system, such as health professionals as well as population most impacted by water, food and sanitation risks, such as women and children. This will be delivered through dissemination of information regarding disease prevention measures that would help protect the public.

Entity in-charge: The overall implementation of capacity building and awareness training will be led by the Ministry of Health.

Costs: The associated cost for the implementation of this action is estimated at USD 3,680,000 which involves conducing workshops, training, engaging international expert and preparing awareness materials.

Action 6.2.2 – Deployment of water, food and sanitation monitoring and safety systems

The implementation of this technology will support in ensuring that Palestinians have access to safe environment and resources. The implementation will require significant external funding.

Activity 6.2.2.1 – Deployment of water, food and sanitation monitoring and safety systems – this will require to align with the implementation of water monitoring technologies to ensure that two systems are able to communicate to have an integrated system.

Entity in-charge: The deployment of water, food and sanitation monitoring and safety systems will be led by the Ministry of Health to establish correct handling procedures and treatment of medical solid waste to

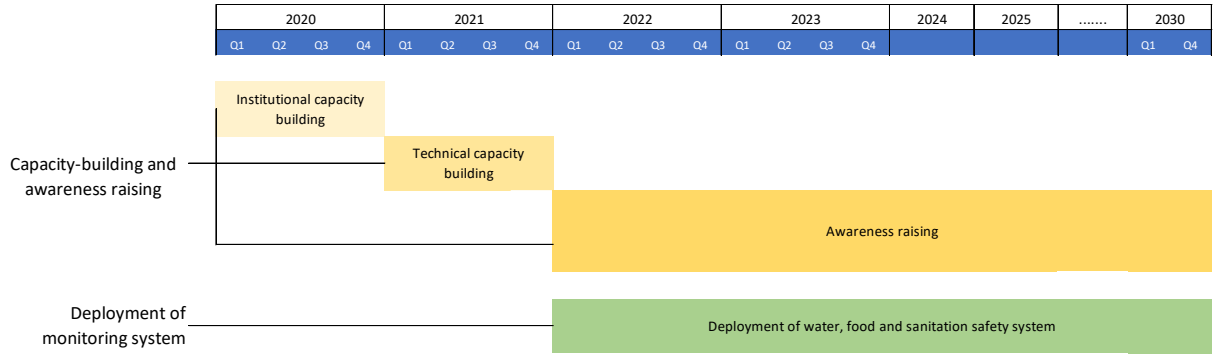
reduce environmental impacts.

Costs: Costs associated with the implementation of this technology are estimated to be USD 8,750,000.

3.6.2.5. Timeline

Figure 23 presents the overall timeline for the implementation of this technology in Palestine. The implementation of this technology is expected to be completed by 2030.

Figure 23: Water, Food and Sanitation Monitoring Implementation Timeline



3.6.2.6. Expected Impact

The implementation of this technology will promote to ensure the health and well-being of the Palestinian population. This technology will ensure that these resources are safe and properly managed, reducing the risk of vulnerability to major diseases related to water, food and sanitation.

3.6.2.7. Potential financing

Development of water, food and sanitation monitoring and safety systems using high technology related to health do not provide extensive opportunities for the private sector to get involved at implementation stage. The technology is related with water and food safety, as well as sanitation, which are public sector prerogatives. The public sector will therefore lead its implementation and financing.

Given the investments required by the technology, support from international partner is crucial in order to succeed in introducing these technologies. Taking this into consideration, financing options for the actions identified under the implementation roadmap are identified in the table below.

Table 56: Financing for Water, Food and Sanitation Monitoring Actions

Measure	Type of action	Associated costs (USD)	Preferred instrument	Sources of financing
Action 6.2.1 – Overall capacity building and awareness raising	Technical assistance	3,680,000	Grant / Domestic resources	Bilateral donor / International organization / Domestic resources
Action 6.2.2 – Deployment of water, food and	Technical	8,750,000	Grant	Bilateral donor / International

sanitation monitoring and safety systems	assistance			organization / Domestic resources

External financing

While Palestine can participate in the financing of technical assistance, it is expected that it will rely on external support for the development of this technology in Palestine.

Potential sources of financing include the GCF, GEF, as well as international organizations, such as the World Bank, and bilateral donors. As the technology pertains to health management, the World Health Organization may be interested in participating in its financing.

4. Synergies and nexuses

The implementation of prioritized technologies under the technology roadmap for some of the sectors are closely linked to one another in which some technologies take precedence in order for the implementation of other technologies to take place. These synergies can be seen both in cross-sectoral and intra-sectoral aspects. Therefore, it is important to consider how efforts to attain goals and targets in one sector or action would affect or be affected by efforts in another sector or action. To take this into consideration, the technology roadmap should aim to integrate goals and targets across sectors and actions to achieve a more cost-effective and efficient implementation. These synergies and nexuses are described below.

4.1. Cross-sectoral

4.1.1. Water-food-energy nexus

Today, it is highly recognized that the water-food-energy nexus is central to sustainable development. The nexus approach recognizes that water, food and energy are inextricably linked and that this plays a vital role in strengthening under growing natural resource scarcity and climate change. Water resources are significantly increasing in demand due to growing population, rapid urbanization, changing diets and economic growth. In the food production, the global agricultural sector consumes the largest amount of the world's freshwater resources, in which more than one-quarter of the energy used globally is consumed for food production and supply. This dependence on water resources, by the energy and the food sectors, require decision-makers to focus predominantly on management of water resources, ecosystem protection and water supply and sanitation as part of their policy and practice. In the energy sector, this means supporting and investing in less water-intensive renewable energy, such as solar and wind. For the agriculture sector, this means investing in efficiency measures such as precision agriculture and efficient irrigation practices[66]. For the water sector, this means investing in practices that use multiple water resources, including rainwater harvesting and reuse of treated wastewater. Therefore, building synergies across these sectors will be essential in helping reduce costs and increasing benefits for the people and the environment[67].

4.1.2. Agriculture-energy-water and wastewater nexus

There are cross-sectoral synergies among prioritized technologies in the agriculture, energy and water and wastewater sectors in Palestine. Water is extremely limited in Palestine and is a critical resource for all sectors, especially for agriculture. Restrictions over water management and the rehabilitation of water source are significant barriers for the development of an irrigated agriculture and overall agricultural production in Palestine. Therefore, improving irrigation efficiency and management of irrigation is crucial to secure sustainable agricultural productivity in Palestine. In implementing efficient irrigation practice, which is a prioritized technology for the agricultural sector, it is important to secure water available for use. To meet this need, water harvesting techniques, such as rainwater harvesting, as well as the use of treated wastewater offer solutions to the sector in Palestine. In addition, application of solar pumps for efficient irrigation also links to the prioritized technology for the energy sector, which is the application of various PV technologies. Increase in water availability also allow for effective agricultural practice, such as precision agriculture, to contribute to water savings for irrigation and for the overall climate-smart water management practice. Monitoring of can be performed through water resources monitoring technologies, for management purposes.

In order to ensure that introduction of these technologies in these sectors support actions of each sector, it is important to align these actions and the timing of introduction of each action. In the short-term, this means

[66] Water, Food and Energy". UN Water Organization, United Nations. Accessed from < https://www.unwater.org/water-facts/water-food-and-energy/>

[67] Bhaduri, A., Ringler, C., Dombrowski, I., Mohtar, R. and Scheumann, W. (2015). "Sustainability in the water-energy-food nexus". *Water International 40*: 5-6, 723-732.

that institutional and technical capacity-building, and awareness raising for these sectors take place coherently. This will ensure that capacities of relevant institutions are enhanced at the same time while technical capacities around these technologies are built in parallel. Additionally, successful introduction of these technologies requires significant acceptance, approval and participation from end-users such as farmers and households. Therefore, it is also important that awareness raising activities cater to these population in parallel for impactful outcome. For dissemination of technologies, both the agricultural sector and water and wastewater sectors require policy development and enforcement. Since institutional capacity-building activities are coordinated to take place coherently, it is also effective that policies are developed in line and enforced accordingly. Potential mapping of resources for the installation of technologies, such as rainwater harvesting and water harvesting is also proposed to be coordinated to achieve effective planning for the dissemination of these technologies. This will also allow private sector players and investors to understand infrastructure needs and opportunities.

4.2. Intra-sectoral

4.2.1. Energy sector

There is a strong synergy amongst prioritized technologies for the energy sector. Achieving national grid assessment and electricity grid upgrade is a prerequisite in successfully implementing other technologies in the sector, which includes various application of solar PV technologies. Upgrading the grid allows for integration of diversified energy sources into the grid system such as from renewable energy, which includes solar, which is one of resources with most potential in Palestine. Therefore, this makes various applications of solar PV technologies and other renewable energy technologies suitable for implementation in Palestine. However, the extent of these opportunities depends on the ability to implement grid assessment and upgrade technologies. In addition, access to land in Area C also dictates the ability to implement other technologies in the sector. Achieving national grid upgrade that support integration of renewable sources could also impact the introduction of vehicle fleet upgrade and advanced public transportation vehicles in the transport sector as electric vehicles would require additional power network and charging stations with reliable supply of energy, which could be supplied by renewable energy sources.

4.2.2. Agriculture sector

Technologies prioritized under the agriculture sector fall under the over-arching framework of climate-smart agriculture. All of the prioritized technologies for the sector, which include precision agriculture, efficient irrigation, conservation agriculture, water harvesting and resilient fodder production, aim to enhance the overall resilience of the sector in Palestine. These will be achieved through increased efficiency in water use as well as through increased alternative sources of water from both conventional and non-conventional sources. These achievements will contribute to improved and resilient food production in Palestine.

4.2.3. Solid waste sector

Prioritized technologies within the solid waste sector also presents strong synergy with each other. For the solid waste sector, introducing waste sorting technology of the 6R is a prerequisite for the introduction of other 6R-related technologies within the sector which includes composting and recycling. Without the implementation of waste sorting technology and practice, it would not be possible to have available the material used for recycling and composting technologies. This would make introduction more complex, as costs from sorting waste at facility level would be higher and would make the technologies not financially viable. This would not result in expected impact for the sector.

For these sectors, it is important that implementation plan focuses on actions to ensure that technology that is a prerequisite for the introduction and implementation of other technologies are supported and achieved. Actions proposed for each sector in the previous section are reflective of this need.

5. Monitoring and evaluation plan

Palestine's National Development Plan emphasizes the country's goal to enhance its national economy, secure economic independence and enhance its private sector productive capacity, competitiveness and ability to create jobs. At the same time, the State of Palestine becoming a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and to the Paris Agreement on Climate Change in 2016 signifies its intent to cooperate in achieving international goal to address climate change.

The State of Palestine is one of the countries and nations that are highly vulnerable to the adverse impacts of climate change. It formulated its Nationally Determined Contributions (NDC) and National Adaptation Plan (NAP) building on the country's climate initiatives to address this vulnerability and contribute to mitigating climate change. The NDC and NAP highlights mitigation and adaptation actions that the country intend to undertake which includes the implementation of prioritized technologies identified as needs for Palestine. To support these needs, a technology roadmap has been developed for the implementation of the country's climate action plans.

Monitoring and evaluation (M&E) are key activities for the implementation of the technology roadmap. M&E will enable Palestine to learn from past and current activities, and provide insights for future planning or to revise the M&E plan. This will allow to identify good practices, which could be replicated to other technologies or scaled-up, as well as practices which do not work in Palestine. To measure progress towards achieving targets and goals of the technology roadmap, a M&E plan needs to be developed. This will also provide basis for any mid-term corrective actions and adjustments in implementing the technology roadmap.

The goal of the M&E strategy is therefore to understand the extent to which the technology roadmap is achieving and will have achieved its objectives, as well as to learn from its implementation.

5.1. Monitoring and evaluation strategy

The M&E strategy will comprise of monitoring and evaluation.

Monitoring will provide routine tracking and reporting of key indicators and information that will allow to measure progress at each stage of implementation of the roadmap. Monitoring will aim to examine progress of the technology roadmap implementation against its planned targets and goals. It serves as a formal reporting to provide evidence on outputs delivered and milestones being met. It involves the systematic collection of data, disaggregated by gender where possible, on specific indicators to provide planners, decision makers, implementers and key stakeholders of the technology roadmap with indications of the extent of achievement of objectives and progress in the use of allocate funds. This will enable implementers to keep track on the progress of implementation and make well-informed decisions in case the implementation is deviating from what is planned. Results of monitoring will be the basis for evaluation.

Monitoring will be conducted at outcome, sectoral and portfolio level, against a set of criteria set in advance and revised as required. The approach underpinning the monitoring framework will be similar to the GCF's result management framework, in which Project outcomes contribute to fund level impacts, which then contribute to paradigm shift objective. In the case of the roadmap, outcome level indicators will contribute to sectoral level impacts, which will contribute to achieving the objectives of the roadmap.

While outcome level indicators will be mostly related to the activities implemented, sectoral level impacts shall clearly show how the sector will contribute to the NDC, by using a combination of quantitative and qualitative indicators, such as GHG emission reductions through low-emission energy access, reduced emissions from buildings, cities and appliances, and increased resilience of health and well-being, and food and water security, among others. These will be aligned on the GCF result management framework for easier integration into potential GCF projects.

Evaluation will aim to assess the outputs, outcomes and impacts achieved by the implementation of the technology roadmap. It involves the systematic and objective assessment of ongoing activities within the roadmap implementation in terms of their design, implementation and results. The evaluation will determine its relevance and if objectives are met, its implementation efficiency and effectiveness, its impacts and its sustainability. Evaluation will leverage on the results for lessons learned both from the success and lack thereof, and use this as basis for improvements. It would also provide best practices which could be applied in other aspects of development.

Gender responsive evaluations are proposed to be undertaken regularly during the implementation of the roadmap. This will allow to review its contents and actions and apply lessons learned to its implementation. The evaluation framework will be based on a set of evaluations, which will target each of the sectors, themes or the overall roadmap.

Table 57: Gender Responsive Evaluation Framework

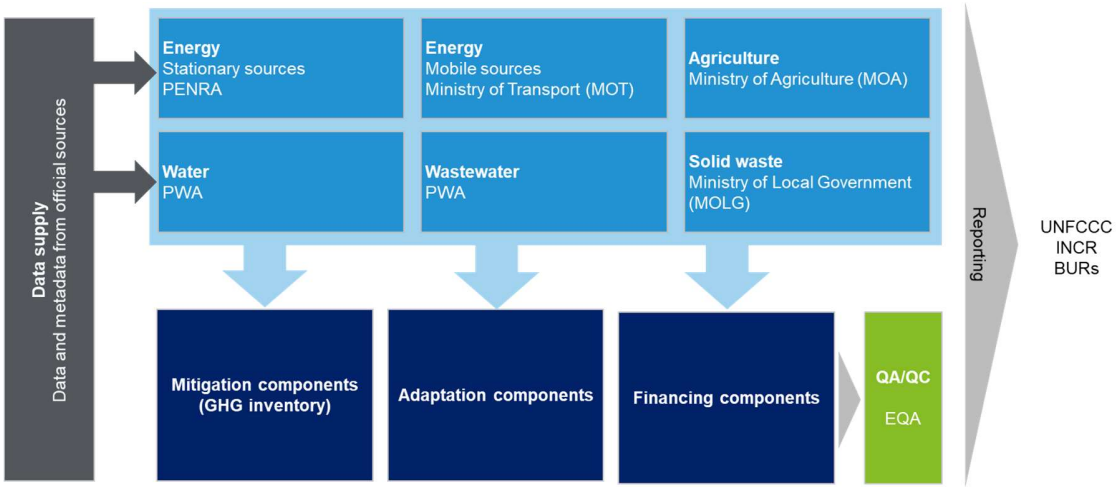
Type	Purpose and scope
Evaluation of the roadmap	Assess the overall contribution of the roadmap to Palestine's NDC and other climate actions
Sectoral evaluations	Review and assess sectoral contributions that highlight best practices in a sector and its contribution to the NDC
Thematic evaluations	Review and assess specific sub-sectoral areas, such as capacity building, financing, and others, that highlight best practices.

5.2. Roles and responsibilities of partners and exit strategy post receiving support

The technology roadmap will leverage the measurement, reporting and verification system developed as part of its INCR, as well as its institutional set-up[68]. The current MRV framework only refers to management of the GHG inventory. However, adaptation and financing, which are important areas of the M&E framework, will need to be included. The institutional set up for data collection for the M&E strategy is developed in Figure 24.

68 https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/State%20of%20Palestine%20First/NDC_State%20of%20Palestine_Implementation%20Road%20Map.pdf

Figure 24: Institutional Setup for Monitoring and Evaluation



5.3. Logical results framework

Monitoring and evaluation will be focused on the measurement and assessment of outcomes and impacts of the technology roadmap implementation, and will take a logical results framework approach. It involves a result-oriented structure which focuses on impacts, outcomes and outputs towards the achievement of objectives. The logical framework defines indicators, timelines and means for their verification, as well as the financing associated with the action.

Indicators are quantitative or qualitative metrics which allows measurement of achievements by interventions or actions implemented towards meeting the objectives. For M&E of the technology roadmap, indicators will be consistent with principles defined under the mitigation and adaptation performance measurement framework of the GCF and will be guided by the SMART principle:

- Specific – specific enough to measure progress towards achievement of the objective. What is being measured should be clear and capture the essence of the desired output.
- Measurable – the indicator is reliable and clear measure of results. It should have the capacity to be counted, observed, analyzed, tested or challenged.
- Achievable – targets attached to the indicator should be achievable as a result of the intervention or action, and is realistic.
- Relevant – indicators should be relevant to the intended outputs and outcomes. There should be a link between what the indicator measures and objectives in the context of the technology roadmap.
- Time-bound – indicators allow progress to be tracked at desired frequency and in a cost-effective manner.

Table 58 summarizes the list of individual actions for each sector, the details of which are presented in the succeeding section.

Table 58: List of Individual Actions for each Sector

Comprehensive List of Individual Actions

1. Energy Sector
Action 1.1: Capacity building and awareness raising for grid upgrading 1.1.1 – Institutional capacity building for PETL implemented 1.1.2 – Technical capacity building for PETL implemented 1.1.3 – Awareness campaign aimed at energy sector stakeholders and general public implemented
Action 1.2: National grid assessment 1.2.1 – Feasibility study conducted 1.2.2 – Stakeholders consulted
Action 1.3: Electricity system grid upgrading 1.3.1 – Grid upgrade implemented
Action 1.4: Overall capacity building and awareness raising 1.4.1 – Institutional capacity building implemented 1.4.2 – Technical capacity building for the public sector implemented 1.4.3 – Capacity building for the private sector implemented 1.4.4 – Capacity building for financing sources implemented 1.4.5 – Awareness campaign aimed at energy sector stakeholders and general public implemented
Action 1.5: Development of policy, standards and financing schemes 1.5.1 – Policies developed and enforced 1.5.2 – Financing schemes developed and available
Action 1.6: Dissemination of solar rooftop PVs 1.6.1 – Solar rooftops PVs diffused
Action 1.7: Dissemination of larger scale solar PV technologies 1.7.1 – Larger scale solar PV technologies deployed 1.7.2 – Use of land in area C negotiated
Action 1.8: Dissemination of solar water heating technologies 1.8.1 – solar water heating technologies deployed
Action 1.9: Deployment of energy efficient technologies 1.9.1 – Green buildings are constructed 1.9.2 – Older building are retrofitted
2. Agriculture Sector
Action 2.1: Overall capacity building and awareness raising 2.1.1 – Institutional capacity building implemented 2.1.2 – Technical capacity building and partnership built 2.1.3 – Awareness raised
Action 2.2: Development of the enabling environment for private sector engagement in climate-smart agriculture 2.2.1 – Policies developed and enforced 2.2.2 – Guidelines for the development of irrigation systems developed 2.2.3 – Water harvesting potential locations mapped 2.2.4 – Private sector capacity developed in relation to irrigation diagnostic and design 2.2.5 – Land, water and energy secured 2.2.6 – Financing schemes developed and available
Action 2.3: Dissemination of conservation agriculture practices 2.3.1 – Direct seeders and other inputs available and diffused

Action 2.4: Dissemination of efficient irrigation, solar pumps and climate-smart water management 2.4.1 – Efficient irrigation technologies available and disseminated 2.4.2 – Solar pumps available and disseminated 2.4.3 – Climate-smart water management practices widely disseminated and used
Action 2.5: Technology transfers 2.5.1 – Climate resilient species are identified and available in Palestine 2.5.2 – Technologies related to resilient fodder are available in Palestine
Action 2.6: Dissemination of water harvesting technologies 2.6.1 – Water harvesting technologies deployed
Action 2.7: Introduction of alternative cropping technologies 2.7.1 – Hydroponic farming is used
Action 2.8: Introduction of large-scale silos 2.8.1 – Large scale silos deployed
Action 2.9: Introduction of climate resilient seeds 2.9.1 – Climate resilient seeds introduced
Action 2.10: Introduction of technologies for soil and crop monitoring, including remote sensing 2.10.1 – Remote sensing and other high-end technologies introduced
3. Water and Wastewater Sector
Action 3.1: Overall capacity building and awareness raising 3.1.1 – Institutional capacity building implemented 3.1.2 – Technical capacity built 3.1.3 – Awareness raised
Action 3.2: Development of the enabling environment for stakeholder engagement in water and wastewater 3.2.1 – Policies developed and enforced 3.2.2 – Locations for rainwater harvesting and wastewater collection and treatment plants mapped
Action 3.3: Dissemination of rooftop rainwater harvesting technologies 3.3.1 – Rooftop rainwater harvesting widely disseminated in Palestine
Action 3.4: Dissemination of wastewater collection and treatment plants 3.4.1 – Onsite small-scale wastewater treatment plans disseminated in Palestine
Action 3.5: Technology transfer of relevant water resources monitoring technology applicable for Palestine 3.5.1(a) – Technologies related to water resources monitoring applicable to Palestine identified 3.5.1(b) – Technologies related to water resources monitoring correspond to Palestine's needs in terms of data 3.5.2 – Water monitoring technologies piloted and deployed
Action 3.6: Deployment of large-scale rainwater harvesting technologies 3.6.1 – Commercial and industry scale rainwater harvesting technologies available and disseminated
Action 3.7: Deployment of large-scale wastewater collection and treatment plants 3.7.1 – large-scale wastewater collection and treatment technologies available and disseminated
Action 3.8: Negotiations for Area C land use for large-scale projects

3.8.1 – Land for construction is secured
Action 3.9: Development of desalination plants in Gaza 3.9.1 – Desalination plant in Gaza built
4. Transport sector
Action 4.1: Overall capacity building and awareness raising 4.1.1 – Institutional capacity building implemented 4.1.2 – Capacity building for financing sources implemented 4.1.3 – Capacity building for taxi drivers implemented 4.1.4 – Awareness raised
Action 4.2: Development of the enabling environment 4.2.1 – Policies on modal shift developed and enforced 4.2.2 – Programme components designed and introduced 4.2.3 – Policies on vehicle fleet upgrade developed and enforced
Action 4.3: Development of the inspection process 4.3.1 – Vehicles are inspected
Action 4.4: Dissemination of public transportation (modal shift) 4.4.1 – Deployment of new buses and upgrade of existing bus fleet to newer vehicles, with organized timetable and schedule of operations
Action 4.5: Upgrade of existing vehicle fleet 4.5.1 – Newer and advanced vehicles are deployed
Action 4.6: Development of infrastructure 4.6.1.1 – Road network and infrastructure developed 4.6.1.2 – Infrastructure required for EVs is deployed 4.6.2 – Land and energy secured
5. Solid waste sector
Action 5.1: Overall capacity building and awareness raising 5.1.1 – Institutional capacity building implemented 5.1.2 – Technical capacity built 5.1.3 – Private sector capacity built 5.1.4 – Financial sector capacity built 5.1.5 – Awareness raised
Action 5.2: Development of enabling environment for stakeholder engagement and drive private sector participation 5.2.1 – Policies developed and enforced
Action 5.3: Dissemination of waste sorting technologies 5.3.1 – Waste sorting technologies disseminated
Action 5.4: Dissemination of composting technologies 5.4.1 – Composting technologies disseminated
Action 5.5: Dissemination of recycling technologies 5.5.1 – Recycling technologies disseminated
6.1. Provision of beach nourishment, reclamation and beach drift rehabilitation
Action 6.1.1: Overall capacity building and awareness raising 6.1.1.1 – Institutional capacity building implemented

6.1.1.2 – Technical Capacity built to assess applicable technologies 6.1.1.3 – Awareness raised
Action 6.1.2: Development of the enabling environment 6.1.2.1 – Policies developed and enforced 6.1.2.2 – Shoreline mapped
Action 6.1.3: Deployment of beach rehabilitation 6.1.3.1 – Beach rehabilitation technologies have been deployed in Gaza 6.1.3.2 – Material and equipment secured
6.2. Development of water, food and sanitation monitoring and safety systems using high technology related to health
Action 6.2.1: Overall capacity building and awareness raising 6.2.1.1 – Institutional capacity building implemented 6.2.1.2 – Technical Capacity built for to assess applicable technologies 6.2.1.3 – Awareness raised
Action 6.2.2: Deployment of water, food and sanitation monitoring and safety systems 6.2.2.1 – Systems deployed and water, food and sanitation monitored

5.3.1. Energy sector logical framework

Roadmap level objectives and indicators						Roles and Responsibilities	
The State of Palestine intends to reduce 24.4 percent of its GHG emissions by 2040 relative to business-as-usual under an independence scenario conditional to receiving international support, or 12.8 percent by 2040 relative to BAU under a status quo scenario. Under Palestine's NDC, the energy sector is considered the main sector that will contribute to achieving these targets. The roadmap will therefore contribute to these objectives.						**PENRA** will be responsible for the overall monitoring of the roadmap in the energy sector.	
Sectoral level objectives							
Renewable energy	The roadmap will contribute to achieving Palestine's objective of generating 20 - 33 percent of electricity using solar photovoltaic technologies						
Energy efficiency	The roadmap will contribute to achieving Palestine's objective of reducing total electricity consumption by 500 GWh each year for the 2020 – 2030 timeframe.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 1.1: Capacity building and awareness raising for grid upgrading Outcome 1.1: Enhanced capacity of PETL to develop relevant policies and standards associated with upgrading the grid and its operations; Raised awareness of stakeholders such as power producers (gas and renewable), distribution companies, energy technology providers, and end-users to understand benefits of upgrading the grid.							
1.1.1 – Institutional capacity building for PETL implemented	Capacity building through workshop and use of reference materials delivered to PETL officials and decision makers	No capacity building activities related to grid upgrade have been conducted	At least one workshop conducted and reference materials produced At least 20% of workshop attendees are women	PETL records	Q1 2020 – Q2 2020	PETL	USD 150,000
1.1.2 – Technical capacity building for PETL implemented	Capacity building through training conducted and training manuals produced for PETL technical personnel	No technical training related to grid upgrade has been conducted	At least one training conducted and manual produced At least 20% of workshop attendees are women	PETL records	Q2 2020 – Q3 2020	PETL	

1.1.3 – Awareness campaign aimed at energy sector stakeholders and general public implemented	Increased understanding and appreciation of the public on benefits of grid upgrading	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented	PETL records	Q3 2020 – Q2 2022	PETL	
Action 1.2: National grid assessment Outcome 1.2: National grid system assessed for potential upgrading							
1.2.1 – Feasibility study conducted	Delivered feasibility study of appropriate technologies for grid upgrade	No feasibility study has been conducted	One feasibility study delivered	PETL records	Q1 2021 – Q4 2021	PETL	USD 250,000
1.2.2 – Stakeholders consulted	Comments and feedbacks from stakeholders taken into account and incorporated into the feasibility study	N/A	All comments and feedback received from stakeholders are addressed in feasibility study	PETL records Feasibility study report	Q3 2021 – Q2 2022	PETL	
Action 1.3: Electricity system grid upgrading Outcome 3: Upgraded electricity grid system which allows for efficient distribution of electricity and integration of renewable energy sources							
1.3.1 – Grid upgrade implemented	The grid is upgraded and enables the integration of additional renewable energy capacities	The grid is not upgraded	Palestinian grid upgraded to a 161-kV transmission network	PETL records	Q3 2022 – 2025	PETL	Estimated during feasibility study under Action 1.2.1.
Action 1.4: Overall capacity building and awareness raising Outcome 1.4: Enhanced capacity for each stakeholder, which will enable the dissemination of solar PV technologies, solar water heating, and energy efficient technologies.							
1.4.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials	No capacity building activities related to solar PV technologies, solar water	At least one workshop by technology conducted and	PENRA records	Q1 2020 – Q2 2020	PENRA	USD 200,000

	delivered to PENRA, PETL and PERC, as well as MOPWH and PEA officials and decision makers	heating, and energy efficient technologies has been conducted	reference materials produced At least 20% of workshop attendees are women				
1.4.2 – Technical capacity building for the public sector implemented	Capacity building through training conducted and training manuals produced for technical personnel	No technical training related to solar PV technologies, solar water heating, and energy efficient technologies has been conducted	At least one workshop by technology conducted and reference materials produced At least 20% of workshop attendees are women	PENRA records	Q2 2020 – Q3 2020	PENRA	
1.4.3 – Capacity building for the private sector implemented	Capacity building through training conducted and training manuals produced for solar PV developers and water heater system designers and manufacturers	No training related to solar PV technologies and solar water heating directed at the private sector has been conducted	At least one workshop by technology conducted and reference materials produced At least 20% of workshop attendees are women	PENRA records	Q4 2020 – Q1 2021	PENRA	
1.4.4 – Capacity building for financing sources implemented	Capacity building through training conducted and training manuals produced for financing sources, related to solar PV, solar water heating and energy efficiency	No training related directed at the financing sources has been conducted	At least one workshop by technology conducted and reference materials produced At least 20% of workshop attendees are women	PENRA records	Q4 2020 – Q1 2021	PENRA	

1.4.5 – Awareness campaign aimed at energy sector stakeholders and general public implemented	Increased understanding and appreciation of the public on benefits of each technology	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented for each technology	PENRA records	2021 – 2022	PENRA	
Action 1.5: Development of policy, standards and financing schemes Outcome 1.5: Enabling environment for private investment in solar PV, solar water-heating and energy efficiency is developed and financing available.							
1.5.1 – Policies developed and enforced	Number of gender responsive policies and regulations developed	High level policies developed	Binding gender responsive policies and regulations pertaining to ensuring grid stability, ensuring revenues for IPPs, standards for energy efficiency and water heating, developed	PENRA records Score on World Bank RISE indicators for buildings sector	2021 – 2022	PENRA	USD 200,000
1.5.2 – Financing schemes developed and available	Number of new financing schemes	N/A	At least one scheme developed by technology	Financial institution records	2021 – 2022	PENRA	
Action 1.6: Dissemination of solar rooftop PVs Outcome 1.6: Increased access to renewable energy for households and individuals (additional MWs produced at household level)							
1.6.1 – Solar rooftops PVs diffused	Number of individuals and households with solar PV installed	N/A	At least additional 100 MW installed At least 15% of targeted households are female headed	PENRA records	2020 - 2030	PENRA	USD 125,000,000 (at 1,250,000 per MW)
Action 1.7: Dissemination of larger scale solar PV technologies and other renewable energy technologies Outcome 1.7: Increased number of small, medium and large solar PV power and other renewable energy suppliers (additional MWs delivered to the grid)							
1.7.1 – Larger scale solar PV technologies and other renewable energy	Number of new installations Additional MW's delivered to grid	N/A	At least additional 300 MW installed and 10 new installations	PENRA records	Q3 2021 - 2030	PENRA	USD 300,000,000 (at 1,000,000 per MW)

technologies deployed							
1.7.2 – Use of land in area C negotiated	Area C land utilized	N/A	Area C land utilized for large scale installations	PENRA records	Q3 2021 - 2030	PENRA	N/A
Action 1.8: Dissemination of solar water heating technologies Outcome 1.8: Increased number of solar-water heating installations in Palestine							
1.8.1 – solar water heating technologies deployed	Number of new installations	N/A	At least 400,000 new installations (includes new installations for out-of-order SWH systems)	PENRA records	2020 - 2030	PENRA	USD 3,165,000,000 (400 to 700 per small system of 300,000 new installations; 20,000 to 40,000 per large system of 100,000 new installations)
Action 1.9: Deployment of energy efficient technologies Outcome 1.9: Increased number of buildings in line with energy efficient standards							
1.9.1 – Green buildings are constructed	Number of green buildings	N/A	At least 50% of new buildings are certified green buildings	PENRA records	Q2 2020 - 2030	PENRA	USD 30,000,000
1.9.2 – Older building are retrofitted	Number of buildings retrofitted	N/A	At least 20% of older buildings are retrofitted	PENRA records	Q2 2020 - 2030	PENRA	

5.3.2.Agriculture sector logical framework

Roadmap level objectives and indicators						Roles and Responsibilities	
The technology roadmap will contribute in strengthening the resilience of the sector by supporting the introduction of climate smart agriculture in Palestine. It will also contribute to water resilient goals.						**MOA** will be responsible for the overall monitoring of the roadmap in the agriculture sector.	
Sectoral level objectives							
Climate smart agriculture	In its NDC, Palestine aims at introducing climate-smart agriculture in at least 50 percent of the farms in Palestine by 2040. Palestine aims to achieve climate smart agriculture in at least 10 percent of the farms by 2025, and at least 25 percent by 2030. The roadmap will contribute to achieving this objective.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 2.1: Overall capacity building and awareness raising Outcome 2.1: Enhanced capacity for each stakeholder, which will enable the implementation and scaling-up of climate smart agriculture technologies, such as solar pumps, efficient irrigation and introduction of climate resilient varieties.							
2.1.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials delivered to MOA, PACI and PIF officials and decision makers	No capacity building activities related to climate-smart agriculture	At least one workshop by technology conducted and reference materials produced At least 35% of workshop attendees are women	MOA records	Q1 2020 – Q2 2020	MOA	USD 400,000
2.1.2 – Technical capacity building and partnership built	Capacity building through training conducted and training manuals produced for technical personnel	No technical training related to medium to longer-term actions has been conducted	At least one workshop by technology conducted and reference materials produced, updated every 2 years At least 35% of capacity building recipients are women	MOA records	Q2 2020 – Q3 2020 for the first technical capacity building; recurring every 2 years	MOA	

2.1.3 – Awareness raised	Increased understanding and appreciation of the public on benefits of each technology	No awareness campaign executed	Continuous gender responsive public campaign aimed at the general public implemented at least once per year for each technology	MOA records	Q3 2020 – Q4 2030	MOA	
Action 2.2: Development of the enabling environment for private sector engagement in climate-smart agriculture Outcome 2.2: Enabling environment for private investment in climate-smart agriculture is developed and financing available.							
2.2.1 – Policies developed and enforced	Number of gender responsive policies and regulations developed	High level policies developed	Binding gender responsive policies and regulations pertaining to the climate smart agriculture ecosystem developed	Policies developed	Q3 2020 – Q2 2022	MOA	USD 750,000
2.2.2 – Guidelines for the development of irrigation systems developed	Gender responsive guidelines available to guide the private sector in developing irrigation systems	No guidelines available to guide the private sector	Gender responsive guidelines developed and diffused to the private sector	Guidelines and MOA records of workshops / dissemination	Q3 2021 – Q2 2022	MOA	
2.2.3 – Water harvesting potential locations mapped	Map of locations available for water harvesting	N/A	Map of locations available for water harvesting developed and disseminated	Map and records of it being disseminated	Q3 2021 – Q2 2022	MOA	
2.2.4 – Private sector capacity developed in relation to irrigation diagnostic and design	Smallholders and private sector have the capacity to assess and identify the best irrigation system adapted to their farm	No technical training has been conducted	Technical trainings developed for the private sector At least 35% of workshop attendees are women	MOA records	Q1 2022 – Q4 2022	MOA	

2.2.5 Land, water and energy secured	Smallholders and private sector have access to land, water and energy for the diffusion of the technologies	N/A	Additional lands in area C are available for development, additional resources of water and energy are available	MOA, PENRA, PWA records	Q3 2020 – 2030	MOA	
2.2.6 – Financing schemes developed and available	Number of new financing schemes, capital available (AUM) and investments leveraged from the private sector	N/A	At least one scheme developed by technology type (small scale and larger scale)	Financial institution records	Q3 2020 – 2030	MOA	
Action 2.3: Dissemination of conservation agriculture practices Outcome 2.3: Increased use of conservation agriculture practices by smallholders							
2.3.1 –Direct seeders and other inputs available and diffused	Number of smallholders possessing and using direct seeders	N/A	At least additional 1,000 seeders available	MOA records	Q3 2020 – 2030	MOA	USD 5,000,000
Action 2.4: Dissemination of efficient climate-smart irrigation, solar water pumps and climate-smart water management Outcome 2.4: Increased use of efficient irrigation practices and increased water resiliency							
2.4.1 – Efficient climate-smart irrigation technologies available and disseminated	Efficient climate-smart irrigation systems installed	N/A	Efficient climate-smart irrigation systems installed to cover at least 25% of irrigated lands (60,000 dunums)	WUAs records, surveys to smallholder producers	2022 – 2030	MOA	USD 48,000,000
2.4.2 – Solar water pumps available and disseminated	Number of irrigated areas installed with solar water pumps	N/A	At least 10% of irrigated area with solar water pumps installed	WUAs records, surveys to smallholder producers	Q3 2020 – 2030	MOA	USD 11,000,000
2.4.3 – Climate-smart water management	Number of farms using climate smart water	N/A	At least 10% of farms using climate smart	WUAs records, surveys to	Q3 2020 – 2030	MOA	USD 200,000

practices widely disseminated and used	management practices		by 2025, 25% by 2030	smallholder producers			
Action 2.5: Technology transfers Outcome 2.5: Longer-term technologies are introduced in Palestine							
2.5.1 – Climate resilient species are identified and available in Palestine	Types of seeds identified and feasibility studies	N/A	Seeds adequate to Palestine's climate challenges have been identified and introduced	Seed bank records, MOA reports	2020 – 2025	MOA	USD 500,000
2.5.2 – Technologies related to resilient fodder are available in Palestine	List of relevant technologies identified and feasibility studies	N/A	Relevant technologies have been identified and introduced	MOA reports	2020 – 2025	MOA	
Action 2.6: Dissemination of water harvesting technologies Outcome 2.6: Water harvesting technologies are widely used for irrigation purposes in Palestine							
2.6.1 – Water harvesting technologies deployed	Number of new installations Additional capacities of water	N/A	At least 1,000 new installations, representing 10 million m^3	MOA, PWA reports	Q3 2022 – 2030	MOA	USD 30,000,000
Action 2.7: Introduction of alternative cropping technologies Outcome 2.7: Hydroponic/aquaponic farming introduced for fodder production							
2.7.1 – Hydroponic / aquaponic farming is used	Number of new hydroponic / aquaponic farms	N/A	At least 700 dunums with hydroponic / aquaponic installed (100 per year)	MOA reports	2024 – 2030	MOA	USD 6,125,000
Action 2.8: Introduction of large scale silos Outcome 2.8: Increased volume of grain stored and used off-season or during droughts							
2.8.1 – Large scale silos deployed	Number of new installations	N/A	At least 10% of farms having new silo installations	MOA reports	2023 – 2030	MOA	USD 9,000,000
Action 2.9: Introduction of climate resilient seeds Outcome 2.9: Increased food productivity during extreme climate events							

2.9.1 – Climate resilient seeds introduced	Number of farms (farming area) using climate resilient seeds	N/A	At least 10% of farms using climate resilient seeds	MOA reports, surveys to the farmers	2024 – 2030	MOA	To be determined based on the results of 2.5.1
Action 2.10: Introduction of technologies for soil and crop monitoring, including remote sensing Outcome 2.10: Increased food productivity							
2.10.1 – Remote sensing and other high-end technologies introduced	Number of farms and private sector stakeholders introducing high-end technologies pertaining to soil and crop monitoring	N/A	At least 1% of farms and private stakeholders using high-end technologies pertaining to soil and crop monitoring	MOA reports, surveys to the farmers	2024 – 2040	MOA	USD 500,000

5.3.3.Water and wastewater sector logical framework

Roadmap level objectives and indicators						Roles and Responsibilities	
PWA's strategic plan identifies increasing the availability of water, both quantitatively and qualitatively, from both conventional and unconventional water resources as one of its objectives. The Technology Roadmap for this sector will therefore focus on increase and management of water resources from both conventional and unconventional resources.						**PWA** will be responsible for the overall monitoring of the roadmap in the water and wastewater sector.	
Sectoral level objectives							
Water	The technology roadmap will contribute to increasing water availability and quality, and improving water management.						
Wastewater	The technology roadmap will contribute to increasing the reuse of reclaimed wastewater, which is identified as an important objective by Palestine.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 3.1: Overall capacity building and awareness raising Outcome 3.1: Enhanced decision making capacity for each stakeholder, which will enable the implementation and scaling-up of alternative water and wastewater technologies.							
3.1.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials delivered to relevant government institutions of water and wastewater sectors	No capacity building activities related to alternatives water resources	At least one workshop by technology conducted and reference materials produced At least 20% of workshop attendees are women	PWA records	Q1 2020 – Q2 2020	PWA	USD 400,000
3.1.2 – Technical capacity built	Capacity building through training conducted and training manuals produced for technical personnel	No technical training related to medium to longer-term actions has been conducted	At least one workshop by technology conducted and reference materials produced, updated every 2 years At least 20% of capacity building	PWA records	Q3 2020 – Q4 2020 for the first technical capacity building; recurring every 2 years	PWA	

			recipients are women				
3.1.3 – Awareness raised	Increased understanding and appreciation of the public on water contamination hazards	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented related to water contamination	PWA records	Q3 2020 – Q4 2030	PWA	
Action 3.2: Development of the enabling environment for stakeholder engagement in water and wastewater Outcome 3.2: Enabling environment for the implementation of water and wastewater related technologies is developed.							
3.2.1 – Policies developed and enforced	Number of gender responsive policies and regulations developed	High level policies developed	Binding gender responsive policies and regulations pertaining to water resources monitoring technologies and wastewater collection and treatment plants developed	Policies developed	Q3 2020 – Q1 2022	PWA	USD 250,000
3.2.2 – Locations for rainwater harvesting and wastewater collection and treatment plants mapped	Map of locations available for water harvesting	N/A	Map of locations available for water harvesting developed and disseminated	Map and records of it being disseminated	Q3 2021 – Q2 2022	PWA	
Action 3.3: Dissemination of rooftop rainwater harvesting technologies Outcome 3.3: Additional volumes of water are available from rainwater harvesting							
3.3.1 – Rooftop rainwater harvesting widely disseminated in Palestine	Number of new installations	N/A	At least 20% of households with rooftop rainwater harvesting installed	PWA reports	Q3 2022 – Q4 2030	PWA	USD 597,000,000 (at 3,000 per unit cost)

			At least 15% of targeted households are female headed				
Action 3.4: Dissemination of onsite small-scale wastewater treatment plants Outcome 3.4: Additional volumes of water are available from treated wastewater							
3.4.1 – Onsite small-scale wastewater treatment plans disseminated in Palestine	Number of new installations	N/A	At least 10% of households with small scale wastewater treatment installed At least 15% of targeted households are female headed	PWA reports	Q3 2022 – Q4 2030	PWA	USD 398,000,000 (at 4,000 per unit cost)
Action 3.5: Technology transfer of relevant water resources monitoring technology applicable for Palestine Outcome 3.5: The enabling conditions for the public and private sector to use water resources monitoring technologies and rainwater harvesting are available in Palestine							
3.5.1(a) – Technologies related to water resources monitoring applicable to Palestine identified	List of relevant technologies identified and feasibility studies	N/A	Relevant technologies have been identified and introduced	PWA reports	Q1 2021 – Q2 2021	PWA	USD 150,000
3.5.1(b) – Technologies related to water resources monitoring correspond to Palestine's needs in terms of data	Data tracked is in line with Palestine's needs	N/A	Data is available	Data reported by PWA and other authorities		PWA	
3.5.2 – Water monitoring technologies piloted and deployed	Projects on water monitoring technologies piloted and implemented	N/A	At least one pilot project implemented Water monitoring technologies	PWA reports	Q3 2021 – Q4 2030	PWA	USD 880,000 (USD 4,000 – 13,600 per unit)

			installed in at least 100 monitoring stations covering surface and ground water resources				
Action 3.6: Deployment of large-scale rainwater harvesting technologies Outcome 3.6: Additional volumes of water are available from large-scale rainwater harvesting							
3.6.1 – Commercial and industry scale rainwater harvesting technologies available and disseminated	Number of new installations	N/A	At least one new installation	PWA reports	2022 - 2055	PWA	USD 154,770,000
Action 3.7: Deployment of large-scale wastewater collection and treatment plants Outcome 3.7: Additional volumes of water are available from treated wastewater							
3.7.1 – large-scale wastewater collection and treatment technologies available and disseminated	Number of new installations	N/A	At least one new installation	PWA reports	2022 - 2055	PWA	USD 58,000,000
Action 3.8: Negotiations for Area C land use for large-scale projects Outcome 3.8: Land available for large-scale projects							
3.8.1 – Land for construction is secured	Private sector stakeholders have access to land for the diffusion of the technologies	N/A	Additional lands in area C are available for development, additional resources of water and energy are available	PWA records	2022 - 2055	PWA	N/A
Action 3.9: Development of desalination plants in Gaza Outcome 3.9: Additional volumes of water are available from desalination plants							
3.9.1 – Desalination plant in Gaza built	Large scale desalination plant in Gaza built	N/A	At least one new desalination plant built	PWA records	2021 – 2030	PWA	USD 510,000,000

5.3.4.Transport sector logical framework

Roadmap level objectives and indicators						Roles and Responsibilities	
The technology roadmap for the sector will focus on reducing GHG emissions by supporting the introduction of modal shift to public transportation and upgrade of existing vehicles.						**MOT** will be responsible for the overall monitoring of the roadmap in the transport sector.	
Sectoral level objectives							
Modal shift	The technology roadmap will contribute to Palestine's goal to achieve 25 percent shift to public transportation by 2030 as per its NDC.						
Fleet upgrade	The technology roadmap will contribute to renewing the vehicle fleet in Palestine, by aiming to remove taxis older than 10 years in 2030.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 4.1: Overall capacity building and awareness raising Outcome 4.1: Enhanced decision making capacity for each stakeholder, which will enable the implementation of policies and standards for the development of the necessary enabling environment for upgrading the fleet and implementing modal shift in Palestine.							
4.1.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials delivered to MOT and MPWH related to modal shift and upgrading the fleet	No capacity building activities related to modal shift and upgrading the fleet	At least one workshop by technology conducted and reference materials produced At least 20% of workshop attendees are women	MOT records	Q1 2020 – Q4 2020	MOT	USD 750,000
4.1.2 – Capacity building for financing sources implemented	Capacity building through training conducted and training manuals produced for financing sources, related to modal shift and upgrading the fleet	No training related directed at the financing sources has been conducted	At least one workshop conducted and reference materials produced At least 20% of capacity building recipients are women	MOT and financial institution records	Q3 2020 – Q4 2020	MOT	

4.1.3 – Capacity building for taxi drivers implemented	Number of taxi drivers trained in relations with transitioning to new sources of revenue	N/A	At least 50% of taxi drivers trained	MOT records	Q1 2021 – Q4 2021	MOT	
4.1.4 – Awareness raised	Increased understanding and appreciation of the public on low-carbon transportation	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented related to low-carbon transportation	MOT records	Q3 2020 – Q4 2022	MOT	
Action 4.2: Development of the enabling environment Outcome 4.2: Enabling environment for the implementation of modal shift and for upgrading the fleet is developed							
4.2.1 – Policies on modal shift developed and enforced	Number of gender responsive policies and regulations developed	High level policies developed	Binding gender responsive policies and regulations pertaining to modal shift developed	Policies developed	Q1 2021 – Q4 2024	MOT	USD 200,000
4.2.2 – Programme components designed and introduced	Development of programme	No programme in place or introduced	At least one programme introduced	Programmes developed	Q1 2021 – Q4 2024	MOT	
4.2.3 – Policies on vehicle fleet upgrade developed and enforced	Number of gender responsive policies and regulations developed	High level policies developed	Binding gender responsive policies and regulations pertaining to vehicle fleet upgrade developed	Policies developed, introduced and enforced	Q1 2021 – Q4 2030	MOT	USD 200,000
Action 4.3: Development of the inspection process Outcome 4.3: Data on the age of the fleet is available and incentives to drivers are provided through stricter enforcement of regulations							
4.3. 1 – Vehicles are inspected	Percentage of vehicles inspected in line with new regulations	N/A	100% vehicle fleet are inspected each year	Documentation control at inspection sites	Q1 2024 – Q4 2030	MOT	USD 200,000
Action 4.4: Dissemination of public transportation (modal shift)							

Outcome 4.4: Modal shift to public transportation is deployed							
4.4.1 – Deployment of new buses and upgrade of existing bus fleet to newer vehicles, with organized timetable and schedule of operations	Number of new and upgraded vehicles deployed Timetable and schedule of operations developed and deployed	N/A	0% of bus fleet operating are older than 10 years One timetable and schedule of operations developed and deployed in each city station	MOT reports	2025 – 2030	MOT	USD 285,000,000
Action 4.5: Upgrade of existing vehicle fleet Outcome 4.5: Vehicle fleet is upgraded with newer vehicles, hybrids and EVs							
4.5.1 – Newer and advanced vehicles are deployed	Number of newer vehicles (including hybrids and EVs) deployed	N/A	0% of taxi fleet operating are older than 10 years	MOT reports	2025 – 2030	MOT	USD 247,000,000
Action 4.6: Development of infrastructure Outcome 4.6: Road infrastructure developed							
4.6.1.1 – Road network and infrastructure developed	Road infrastructure developed and rehabilitated	N/A	Major road networks are developed and rehabilitated	MOT reports	2025 – 2030	MOT	USD 31,000,000
4.6.1.2 – Infrastructure required for EVs is deployed	Number of charging stations available % of power provided from renewable energy	N/A	At least one charging station per city are deployed 33% provided from renewable energy	Data reported by PENRA, PETL and MOT	2027 – 2030	MOT	(Charging stations are private sector driven)
4.6.2 – Land and energy secured	Palestine has access to land and to the power infrastructure for the diffusion of the technologies	N/A	Additional lands in area C are available for development, Palestine has access to the power infrastructure for the integration of EVs	Data reported by PENRA, PETL and MOT	2020 – 2030	MOT	

5.3.5.Solid waste sector logical framework

Roadmap level objectives and indicators						Roles and Responsibilities	
The solid waste sector is identified as a sector with high vulnerability to climate change under Palestine's NDC and NAP. The technology roadmap will greatly contribute to achieving Palestine's goal of an effective and efficient solid waste management in the country building adaptive capacity of the sector as well as contributing to reduction in GHG emissions.						**MOLG** will be responsible for the overall monitoring of the roadmap in the solid waste sector.	
Sectoral level objectives							
Solid waste management	The roadmap will contribute to achieving Palestine's objective for the solid waste sector specifically as defined in the NDC and NAP, improvement of waste collection system, improved management of landfill sites, and the reduction, re-use and recycling of waste.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 5.1: Overall capacity building and awareness raising Outcome 5.1: Enhanced capacity of key stakeholders to enable the implementation and scaling-up of solid waste management technologies and practices, including waste sorting, composting and recycling.							
5.1.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials delivered to officials and decision makers of MOLG, JSCs, LGUs and other cross-sectoral ministries	Yearly training program on solid waste management between 2016-2019 has been conducted	At least one additional workshop specific to solid waste management technologies conducted and reference materials produced for every relevant stakeholder At least 35% of workshop attendees are women	MOLG records	Q1 2020 – Q4 2020	MOLG	USD 350,000
5.1.2 – Technical capacity built	Capacity building through training conducted and training manuals produced for technical personnel	Yearly training program on solid waste management between 2016-2019 has been conducted	At least one additional workshop specific to solid waste management technologies conducted and reference materials	MOLG records	Q3 2020 – Q4 2020	MOLG	

			produced for every relevant stakeholder At least 35% of capacity building recipients are women				
5.1.3 – Private sector capacity built	Capacity building for in-depth understanding of solid waste management technologies and practices for private sector delivered	No capacity building activities related to solid waste management has been conducted	At least one workshop conducted and reference materials produced At least 35% of workshop attendees are women	MOLG records	Q3 2020 – Q4 2020	MOLG	
5.1.4 – Financial sector capacity built	Capacity building for in-depth understanding of solid waste management technologies and practices for financial sector delivered	No capacity building activities related to solid waste management has been conducted	At least one workshop conducted and reference materials produced At least 35% of workshop attendees are women	MOLG records	Q3 2020 – Q4 2020	MOLG	
5.1.5 – Awareness raised	Increased understanding and appreciation of the public on solid waste management	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented	MOLG records	Q3 2020 – Q4 2030	MOLG	
Action 5.2: Development of enabling environment Outcome 5.2: Enabling environment for implementation of solid waste management technologies and practices developed							
5.2.1 – Policies developed and enforced	Number of gender responsive policies and regulations developed	High level policies developed	Binding gender responsive policies and regulations pertaining to the climate smart	Policies developed	Q3 2020 – Q4 2022	MOLG	USD 200,000

			agriculture ecosystem developed				
Action 5.3: Dissemination of waste sorting technologies Outcome 5.3: Increased amounts of municipal solid waste sorted; reduced amount of waste ending up in landfills							
5.3.1 – Waste sorting technologies disseminated	Number of waste sorting facilities installed	No waste sorting facilities installed	At least one central facility installed in Gaza and five central facilities in the West Bank	MOLG reports	Q1 2021 – 2030	MOLG	USD 15,000,000
Action 5.4: Dissemination of composting technologies Outcome 5.4: Collected organic waste converted into compost material; increased use of compost in local market							
5.4.1 – Composting technologies disseminated	Number of additional composting facilities installed	N/A	At least one central facility in Gaza and five central facilities in the West Bank installed by JSCs	MOLG records	Q3 2021 – 2030	MOLG	USD 9,500,000
Action 5.5: Dissemination of recycling technologies Outcome 5.5: Collected recyclable waste reused and recycled into new products							
5.5.1 – Recycling technologies disseminated	Percentage of materials from waste recycled	less than 1% waste is recycled	At least 30% of materials from waste are recycled	MOLG records	Q3 2021 - 2030	MOLG	USD 10,000,000

5.3.6.Other sectors logical framework

5.3.6.1. Provision of beach nourishment, reclamation and beach drift rehabilitation

Roadmap level objectives and indicators						Roles and Responsibilities	
The provision of beach nourishment, reclamation and beach drift rehabilitation is a national priority for Palestine. This technology is of significance to the Gaza area as there are implications to the people living in these areas from changes in climate. It will contribute to climate change adaptation in Gaza.						**MOPWH** will be responsible for the overall monitoring of the roadmap provision of beach nourishment, reclamation and beach drift rehabilitation.	
Sectoral level objectives							
Beach nourishment	The technology roadmap will contribute to Palestine's coastline's resilience, which will be less prone to flooding.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 6.1.1: Overall capacity building and awareness raising Outcome 6.1.1: Enhanced decision making capacity for MOLG and other relevant stakeholders in order to identify the most relevant technology for beach nourishment							
6.1.1.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials delivered to MOLG and other stakeholders	No capacity building activities related to beach nourishment technologies	At least one workshop conducted and reference materials produced At least 20% of workshop attendees are women	MOPWH records	Q1 2020 – Q4 2020	MOPWH	USD 400,000
6.1.1.2 – Technical Capacity built to assess applicable technologies	Capacity building through training conducted and training manuals produced, related to the identification and assessment of technologies for beach nourishment	No technical training has been conducted	At least one workshop conducted and reference materials produced related to assessing technically the technologies for beach nourishment At least 20% of capacity building	MOPWH records	Q1 2021 – Q4 2021	MOPWH	

			recipients are women				
6.1.1.3 – Awareness raised	Increased understanding and appreciation of the public on beach nourishment, reclamation and beach drift rehabilitation	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented related to beach nourishment, reclamation and beach drift rehabilitation	MOPWH records	Q1 2022 – Q4 2030	MOPWH	
Action 6.1.2: Development of the enabling environment Outcome 6.1.2: Enabling environment for the implementation of beach rehabilitation							
6.1.2.1 – Policies developed and enforced	Number of gender responsive policies and regulations developed	No policies developed except in the NDC	Binding gender responsive policies and regulations supporting the implementation of the technology	Policies developed	Q1 2022 – Q4 2023	MOPWH	USD 400,000
6.1.2.2 – Shoreline mapped	Map of the shoreline available for erosion management	N/A	Map of the shoreline available for erosion management developed and disseminated	Map and records of it being disseminated	Q1 2022 – Q4 2023	MOPWH	
Action 6.1.3: Deployment of coastal erosion management technology Outcome 3: Beaches are rehabilitated in Gaza and as a result, less floods are experienced							
6.1.3.1 – Beach rehabilitation technologies have been deployed in Gaza	Area of beaches reclaimed and protected	N/A	At least 50% of total beach areas have been reclaimed and protected	Data reported by MOPWH	Q1 2024 – 2030	MOPWH	USD 10,000,000
6.1.3.2 – Material and equipment secured	Palestine has access to material and equipment for the diffusion of the technologies	N/A	Material and equipment imported for beach rehabilitation and protection	Data reported by MOPWH	Q1 2024 – 2030	MOPWH	

5.3.6.2. Development of water, food and sanitation monitoring and safety systems using high technology related to health

Roadmap level objectives and indicators						Roles and Responsibilities	
This technology will contribute to improving access to safe water, food and sanitation in Palestine.						**MOH** will be responsible for the overall monitoring of the roadmap in water, food and sanitation monitoring and safety systems.	
Sectoral level objectives							
Water, food and sanitation monitoring and safety systems	The development of monitoring and safety systems of these resources will help reduce the country's vulnerability to major diseases related to water, food and sanitation and promote better management of these sources.						
Expected Results (Outputs)	Indicators	Baselines	Targets	Data Source / Means of Verification	Timeline	Roles and Responsibilities	Budget
Action 6.2.1: Overall capacity building and awareness raising Outcome 6.2.1: Enhanced decision making capacity for MOH and Ministry of National Economy in order to identify the most relevant technology for water, food and sanitation monitoring and safety systems							
6.2.1.1 – Institutional capacity building implemented	Capacity building through workshop and use of reference materials delivered to MOH and Ministry of National Economy	No capacity building activities related to water, food and sanitation monitoring and safety systems	At least one workshop conducted and reference materials produced At least 20% of workshop attendees are women	MOH records	Q1 2020 – Q4 2020	MOH	USD 3,680,000
6.2.1.2 – Technical Capacity built for to assess applicable technologies	Capacity building through training conducted and training manuals produced, related to the identification and assessment of technologies for	No technical training has been conducted	At least one workshop conducted and reference materials produced related to assessing technically the technologies for water, food and	MOH records	Q1 2021 – Q4 2021	MOH	

	water, food and sanitation monitoring and safety systems		sanitation monitoring and safety systems At least 20% of capacity building recipients are women				
6.2.1.3 – Awareness raised	Increased understanding and appreciation of the public on disease prevention measures	No awareness campaign executed	At least one gender responsive public campaign aimed at the general public implemented related to disease prevention measures	MOH records	Q1 2022 – Q4 2030	MOT	
Action 6.2.2: Deployment of water, food and sanitation monitoring and safety systems Outcome 6.2.2: Water, food and sanitation monitoring and safety systems are deployed and data is used so that Palestinians have access to safe environment and resources							
6.2.2.1 – Systems deployed and water, food and sanitation monitored	Data gathered and analyzed by the systems	No data available	Data related to water, food and sanitation is available and analyzed	MOH data	2022 – 2030	MOH	USD 8,750,000

Annex 1: Long list of adaptation and mitigation technologies identified

Sector	Technologies	Relationship with the NDC
Energy	➢ **National grid assessment and electricity grid upgrade**	➢ Electricity grid upgrade, provision of reliable energy supply
	➢ **Various applications of PV technologies**	➢ Solar photovoltaic, solar water heaters, generation of solar electricity for medium / large scale commercial / industrial application, use of renewable energy such as solar to reduce imported energy, providing reliable energy supply
	➢ **Other renewables, including hybrid applications**	➢ Use of renewable energy, such as solar, to reduce energy import and provide reliable energy supply
	➢ **Natural gas power generation**	➢ Provision of reliable energy supply
	➢ **Enhancing the equipment and efficiency of the Gaza Power Plant (GPP)**	➢ Enhancing the equipment and efficiency of the Gaza Power Plant (GPP)
	➢ **Energy efficiency**	➢ Energy efficient lighting, energy efficiency of buildings, implementation of energy efficiency measures, reducing energy consumption through introduction of modern production technologies, conducting energy audits, promoting green buildings
	➢ **Solar water heating**	➢ Promote increased use of solar thermal energy including solar water heaters
	➢ **Using local contractors and materials to limit emissions**	➢ Replace imported raw materials with local materials whenever possible
Agriculture	➢ **Water harvesting**	➢ Improve water-use efficiency and using alternatives water resources, rainwater harvesting, enhance the use of additional and alternative water resources for non-domestic resources, develop and improve storm-water systems
	➢ **Crop alternation systems**	➢ Enhancing agricultural value chain
	➢ **Conservation agriculture**	➢ Minimize soil erosion, increase available water in the soil profile
	➢ **Efficient irrigation**	➢ Enhance community level irrigation schemes and infrastructure, improve water-use efficiency, enhancing agricultural value chain, supporting improvements in efficient use of water in women's private small scale agricultural projects. Precision irrigation, computerized irrigation and fertilization systems.
	➢ **Aquaponics**	➢ Improved water-use efficiency and use of alternatives water resources, Enhancing agricultural value chain
	➢ **Heat/drought resilient crops**	➢ Climate-smart production practices, enhancing agricultural value chain
	➢ **Climate smart agriculture (precision agriculture)**	➢ Climate-smart production practices, enhancing agricultural value chain, greenhouse management
	➢ **Resilient animal fodder**	➢ Increase the availability of animal fodder, enhancing agricultural value chain

	➢ **Introduction of new saline-/ heat tolerant crops**	➢ Increase the availability of animal feed, enhancing agricultural value chain
	➢ **Animal pens**	➢ Energy efficient lighting, energy efficiency of buildings, implement energy efficiency measures, reducing energy consumption through introduction of modern production technologies, conducting energy audits, promoting green buildings
	➢ **Cold chain, storage**	➢ Fish packaging /preservation industry, construction of large-scale cold storage, construct large scale steel silos for grain
Water and wastewater	➢ **Rainwater harvesting**	➢ Rainwater harvesting, enhance the use of additional and alternative water resources for non-domestic resources, develop and improve storm-water systems at different scales
	➢ **Desalination (including renewable energy application)**	➢ Enhance the use of additional and alternative water resources for non-domestic resources, build a large desalination plant for Gaza
	➢ **Solar pumps for pumping and distribution**	➢ Use of renewable energy such as solar to reduce imported energy
	➢ **Wastewater collection and plants**	➢ Improved water supply through wastewater collection and treatment systems
	➢ **Activated sludge**	➢ Improved water supply through wastewater collection and treatment systems
	➢ **Water resources monitoring technologies**	➢ Improved water-use efficiency
Transport	➢ **Upgrade of the existing vehicle fleet**	➢ Hybrid electric vehicles, compressed natural gas powered vehicles, upgrade the vehicle fleet, control the technical condition of vehicles and periodic maintenance
	➢ **Improved transportation planning in cities**	➢ Reduction of traffic jams
	➢ **Public transport (modal shift)**	➢ Modal shift programs, public transport
	➢ **Resilient roads, including efficient lighting (interactive lights, wind-powered lights, vehicle specific lanes)**	➢ Rehabilitation of resilient road infrastructure
	➢ **Efficient use of rainwater drainage**	➢ Improve water-use efficiency and using alternatives water resources, rainwater harvesting, enhance the use of additional and alternative water resources for non-domestic resources, develop and improve storm-water systems
	➢ **Flood prevention**	➢ Improve water-use efficiency and using alternatives water resources, rainwater harvesting, enhance the use of additional and alternative water resources for non-domestic resources, develop and improve storm-water systems
Solid waste	➢ **Waste sorting**	➢ Improving waste collection system, 3R

	➢ **Recycling**	➢ Improving waste collection system, 3R
	➢ **Composting**	➢ Improving waste collection system, 3R
	➢ **Waste to energy**	➢ Use of waste for electricity generation
	➢ **Reduction of methane from landfill**	➢ Reduction of methane from landfill
Others	➢ **Provision of beach nourishment, reclamation and beach drift rehabilitation**	➢ Provision of beach nourishment, reclamation and beach drift rehabilitation
	➢ **Development of water, food and sanitation monitoring and safety systems using high technology related to health**	➢ Development of water, food and sanitation monitoring and safety systems using high technology related to health
	➢ **Flood management schemes**	➢ Flood management schemes (cultural sites, eco-tourist attractions), developer and improve storm water systems and drainage infrastructure
	➢ **Fuel storage facilities**	➢ Reduction of transportation emissions

Annex 2: Approach to financing

In order to be implementable, potential sources of financing and potential financiers mapping need to be identified for the implementation plan. Sources of financing will include Palestine's own financial resources, international and bilateral donor support as well as private sector financing.

It is important to emphasize that the State of Palestine has limited financial resources. In 2018, the financing gap for its public budget was estimated at USD 420 million by the World Bank Group[69]. Most of its NDC is conditional to external financing. Given that Palestine is a fragile State, which remains under Israeli occupation, it also has limited borrowing capacities. When directed at the public sector, grants are the most relevant financial instrument for Palestine.

While involving the public sector at all stages of the financing strategy is important, involving the private sector in the financing of climate measures can leverage significant amounts of financing and is paramount to achieving the objectives of the roadmap, especially in sectors which can bring revenues. At the same time, it is also crucial to recognize that grant financing provided by international partners is limited and tends to be decreasing globally. Most donors aim at levering grants in order to crowd-in larger investments to achieve broader objectives. It is therefore essential to make the best use of grant financing for the implementation of the roadmap.

The private sector can be involved at several levels. The financial sector, project developers and smallholders such as households and farmers are the main targets of the financing approach. Leveraging the financial sector in Palestine will be crucial in order to channel climate finance to developers and to leverage efficiently external resources provided by donors and external partners. In Palestine, the financial sector is composed primarily of traditional banking. In 2017, total net assets of the banking sector exceeded USD 15 billion[70], and remains risk-averse. Supporting the financial sector in providing additional investments in climate actions will therefore require incentives and de-risking. This may be achieved by providing concessional financing to the sector, including with the provision of grants and guarantees.

Similarly, the private sector, which has already limited financial capacities, will require additional incentives in order to finance the incremental costs related to implementing climate actions.

Under these circumstances, support from external partners is key to achieving the objectives of the roadmap. Donors, by focusing on providing highly concessional finance, such as grants, to the public and private sector in Palestine, can support the development of a building environment for public and private engagement in climate actions.

Additionally, it is important to emphasize that donors usually adopt different strategies regarding financing. Some donors may choose to adopt a sectoral perspective, providing support for measures encompassing the whole sector. Others may choose to support one-off actions or projects. For example, the GCF adopts an approach seeking paradigm shift. Under such an approach, financing will aim at provoking fundamental changes in the sectors supported by the GCF in Palestine.

[69] World Bank, Economic Monitoring Report to the Ad Hoc Liaison Committee, 2018
[70] World Bank, Economic Monitoring Report to the Ad Hoc Liaison Committee, 2018