

Climate Technology Centre & Network

State of Palestine - Environment Quality Authority

Technology Road Map for the Implementation of Climate Action Plans in Palestine

Case studies

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1. Introduction

The State of Palestine is vulnerable to the impacts of climate change with severe implications for its economy. 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, and water saline intrusion.

The Palestinian Government is committed to addressing these climate change vulnerabilities while at the same time, achieving its national development and policy objectives. This is reflected in its submissions to the United Nations Framework Convention on Climate Change (UNFCCC) namely, Initial National Communication Report (INRC), National Adaptation Plan (NAP) and Nationally Determined Contribution (NDC).

To achieve sustainable economic development while contributing to the reduction of greenhouse gas emissions, it is important to prioritize various adaptation and mitigation measures through the development and diffusion of climate friendly technologies. In order to identify relevant technologies which could be applied in the Palestinian context and can be implemented to achieve the country's climate change mitigation and adaptation objectives, there is a need to identify and assess the different barriers that exist hindering the transfer of these technologies.

This report assesses the gaps, needs, challenges and opportunities to scale up the proven and viable adaptation and mitigation solutions and inclusive businesses in the State of Palestine. Case studies present best practices from around the world, with relevance to the Palestinian context.

2. Waste – Municipal waste management, compost production and recycling: “TakaTaka Solutions” (Kenya)

Waste management is a major challenge in large cities in Kenya, especially in Nairobi, a rapidly growing megapolis. Innovative models for waste management using the circular economy model have been proposed as a solution to this issue.

1 Background

Nairobi produces around 2,400 tons of waste every day, out of which only 38 percent is collected and less than 10 percent recycled (JICA, 2010). The remaining 62 percent is left on illegal dumpsites or next to houses or burned.

Waste collection services in Nairobi are paid and unaffordable to a large part of the city population, due to the costly and inefficient municipal solid waste (MSW) disposal at overfilled dumpsites by existing waste collectors. The typical waste collection pattern in Nairobi involves long queuing of the collection trucks at landfill or dumpsites, traffic congestion due to lack of roads and inefficient manual off-loading. As a result of this, Nairobi’s waste companies do on the average only one collection trip per truck per day, which eventually results in high collection charges.

The private sector waste collectors also overlook the income generating opportunities from waste, such as recycling and composting. As a result, existing private sector companies in Nairobi collect waste only **in middle to higher income areas**, while not engaging in any recycling of waste. This leaves two thirds of residents of the megapolis without any proper waste management services.

Although the National Climate Change Action Plan, 2013-2017 (NCCAP) stated that the share of the waste sector on the country’s total GHG emissions is low, GHG emissions from the waste sector are expected to increase from 0.8 million tCO_{2e} per year in 2010 to 2 million tCO_{2e} in 2030. Waste management remains, therefore, an important priority for Kenya’s climate change mitigation strategy.

2 Description of the technology

The issue of waste management in Nairobi is addressed through the design of a circular economy model for waste management, developed as Nationally Appropriate Mitigation Actions (NAMA) in Kenya. The circular economy approach goes further than implementing sustainable practices into isolated links of production systems. The circular economy approach requires a comprehensive design of the production chain, which aims at creating value through restoration, regeneration and re-use of resources. The NAMA focuses on the implementation of waste collection and waste sorting practices, which leads to new opportunities in the recycling industry and compost production.

The NAMA creates multiple new links currently missing in the value chain -establishment of recycling points, where waste will be sorted for subsequent recycling; and composting facilities, for the organic waste treatment. The NAMA also provides support to research and operationalization of new recycling technologies, as well as strengthen existing recycling industries.

The model promoted in Nairobi by the NAMA includes the following elements:

- Waste collection companies collect waste from households and businesses.
- The collected waste is taken to decentralized recycling points instead of landfills or dumpsite.
- At the recycling points, the waste is sorted into various fractions.
- Recyclable materials (30 percent of the total waste collected) are sold to recycling industries.

- Organic waste (60 percent of the total waste collected) is taken to a composting plant, where it is turned into compost.
- Remnants (10 percent of the total collected) is taken to sanitary dumping sites / landfills.

3 Justification

Lack of / in appropriate waste management is a major issue in urban areas in Kenya and presents, among others, immediate health hazard risks. The lack of awareness at household level makes it more complicated to encourage sorting practices there. For urban centers in Kenya it, therefore, makes sense to develop waste collection centers where waste can be sorted.

Additionally, through recycling and composting, waste can constitute an additional source of revenues for the private sector, thus making it possible to decrease waste collection fees. This can eventually lead to higher collection rates among the poorer strata of the population.

4 Rationale

Uncollected waste and accumulated waste in landfills lead to GHG emissions, mainly methane (CH₄), and odors. Additionally, uncollected waste causes severe health and environmental problems, and represents a missed opportunity from a development and economic perspective.

5 Concrete application of the technology

TakaTaka Solutions (“TakaTaka”) is a waste management enterprise based in Nairobi and founded in 2011, which operates a successful a circular economy model. It provides an innovative solution to Nairobi’s waste management challenges.

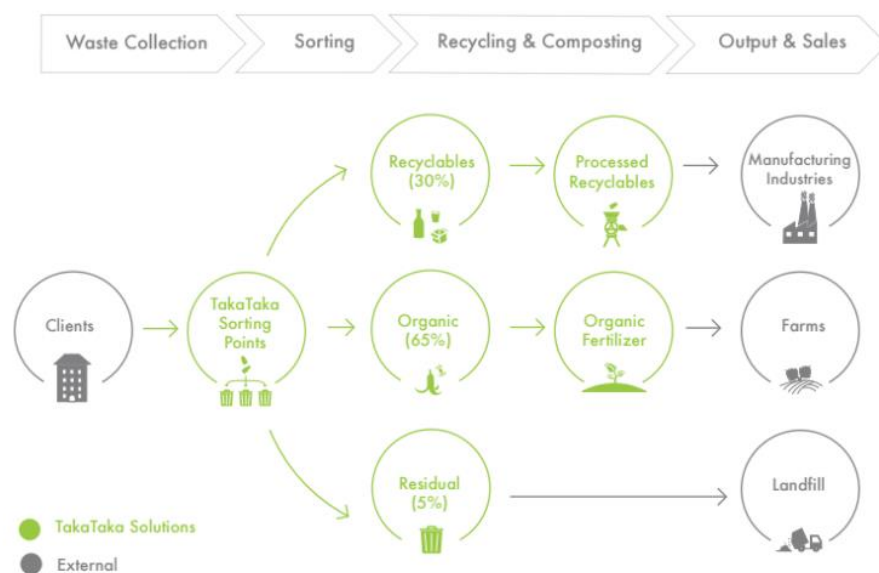


Figure 1 Waste collection, sorting and recycling process

TakaTaka collects source-separated waste from its clients (organic and recyclable waste). After collection, its trucks take the waste to sorting points, called “TakaTaka Points”. There, the waste is manually sorted into different recyclable materials.

Recyclable materials (30 percent of the waste) are sold to recycling industries. Organic waste (60 percent of the waste) is taken to TakaTaka Solutions’ own composting plant for further processing into compost.

The residual waste (less than 10 percent) is disposed at landfills or dumpsites.

As only 10 percent of the waste is disposed and additional income is generated from recyclable and compost sales, TakaTaka Solutions is able to offer waste collection services at less than the equivalent of USD1/household/month in low-income areas.



TakaTaka Solutions' recycling rate of more than 90 percent is one of the highest recycling rates in the world (compared to, for example, an average of 35 percent in the US). Its waste collection fees are amongst the most affordable in Africa.

6 Enabling factors

Some of the enabling factors for this technology and approach to be operational in Kenya include the following:

- *Organizational capabilities:* The approach taken in Kenya does not require the sorting of waste at household level. This avoids the challenge of raising awareness in households.
- *Economic factors:* At the proposed low cost, waste management is affordable for almost all income-earners.
- *Earlier success stories:* Existence of early adopters (TakaTaka Solutions in Kenya) to support the business case.
- *Social awareness:* Awareness of the waste management issue at community level.
- *External support:* technological transfers for recycling and composting technologies, policy development support.

7 Gaps needs and challenges

Some of the gaps related to implementing the NAMA include the following:

- Lack of waste sorting centers and a lack of awareness regarding waste sorting;
- Lack of a market for organic waste. There is only one company currently composting organic waste in Nairobi. Composting businesses in Nairobi do not receive income from tipping (offloading) fees, which means that they need to generate all their revenue from sales of compost.
- Most farmers are not aware of the benefits and applications of compost (lack of sufficient demand for compost).
- Lack of a market for certain inorganic recyclable waste fractions.

8 Sustainability and exit strategy

Some of the strategies used to ensure the sustainability of the technology in Kenya include the development of an enabling environment, which includes policy support, building business cases, as well as encouraging the private sector in participating in waste management through the development of new income streams.

9 Stakeholder analysis

9.1 Lead agency and partners

The project is implemented under the supervision of the Government of Kenya, through the National Climate Change Secretariat (NCCS), established under the Ministry of Environment and Natural Resources, which oversees its activities, including financial flows, capacity building activities and policy development interventions.

9.2 Role of the Government

The Government oversees all activities under this project and leads capacity building activities and policy development interventions. This includes developing standards on recyclable materials and monitoring their implementation and improving the standard on compost with a specific focus on developing the laboratory testing capacity in Kenya. The Government also provides an in-kind contribution in the form of land for the development of plants.

9.3 Role of the private sector

The private sector takes the lead in installing and operating recycling and composting facilities.

9.4 Role of donors and international organizations

Donors and international organizations, such as the NAMA facility and UNDP provide technical assistance and financing for the implementation of the NAMA.

10 Opportunities

The proposed circular economy approach introduced bring the following opportunities:

- Disposal costs significantly decrease, as less than 10 percent of waste will eventually remain as residual waste to be disposed at landfills or dumpsites;
- Additional revenues from the sale of recyclable materials;
- Additional revenues from the sale of compost;
- Additional revenues from the payment of tipping fees;
- Existing landfills have a longer useful time as they do not get full as fast;
- The budget used to expand existing landfills can be shifted to upgrade the recycling / composting facilities at national level; and
- The land degradation due to expansion of landfill is decreased.

11 Relevance to Palestine

11.1 Relevance to the Palestinian context

This case study is highly relevant to the Palestinian context. In Palestine Waste is collected by Joint Service Councils and LGUs from households and businesses, at a rate up to 95%. The amount of solid waste produced in the State of Palestine is estimated, according to national strategy of solid waste management (2017-2022), at 105,651 tons per month, with organic waste constituting 50 to 55 percent of that amount. Most of the solid waste produced is sent to landfills. Disposal poses a critical issue in Palestine, among others, due to the lack of sufficient space for the construction of new landfills in the area which are under Palestinian control, as the most suitable areas for constructing landfill are located in the area "C". In this sense, the situation is close to that observed in Nairobi.

The approach is also relevant to the National strategies related to Solid Waste management in Palestine. The National strategy for solid waste management in the Palestinian territory (2010 – 2014) develops a series of policies related to the 3Rs, such as encouraging the reduction of solid waste quantities destined for landfilling, achieving cost recovery and self-financing for SWM and increasing the participation of the private sector, among others.

Local Government Units (LGUs) and Joint Council Services (JSCs) for solid waste management can lead this process initially, although it is crucial to look into the possibility of involvement of the private sector in the future.

11.2 Linkages to Palestine’s NDC

This case study is strongly linked to Palestine’s NDC, as waste management has been identified as one of the highly vulnerable issues there. Some of the adaptation and mitigation actions identified include improving waste collection system and encourage the 3Rs(reducing, re-using and recycling).

11.3 Co-benefits

Improving waste collection and introducing reduce, re-use, recycle (3Rs) practices in Palestine will bring various co-benefits.

Sector	Co-benefits
Mitigation (as per the NDC)	<ul style="list-style-type: none"> ● Improved waste collection would reduce the likelihood of burning in situ and if combined with reverse osmosis would greatly reduce release of methane.
Financial/Economic	<ul style="list-style-type: none"> ● Additional revenue streams (composting, recycling) ● Cost savings (landfills) ● Potential for the creation of new businesses
Social benefits	<ul style="list-style-type: none"> ● Waste collection fees decreased ● Job creation
Environmental	<ul style="list-style-type: none"> ● Reduction of air, water, and soil pollution
Health	<ul style="list-style-type: none"> ● Reduction of health problems of citizens

11.4 Acceptability

Given the low level of awareness at household level related to the sorting of waste, a central MSW sorting facility is deemed to be more acceptable in the Palestinian context. A number of pilot projects related to waste sorting at household level have been conducted the past three years. However, they were not successful. This project also answers social concerns related to waste management (e.g. health hazards, odors), by providing an approach accessible to low income communities that mitigating the negative environmental effects from landfills.

Waste management fees are already paid by households to municipalities in Palestine. However, it is important to emphasize that waste fee collection rate vary depending on the Governorates, reaching 100 percent in Hebron but only 35 percent in Ramallah. Using the revenues from composting and recycling can be a way to reduce the fees and to further improve the social acceptability of the technology.

11.5 Economic feasibility

In Kenya, the investment required to kick-off the development of recycling points and composting plants has been financed through grants, concessional loans and commercial finance. Concessional financing is mainly used to stimulate private investments for early adopters of the technology and build business cases. Commercial finance is expected to take over for further investments. It is also important to emphasize that the cost of waste collection in Nairobi was a major challenge for the implementation of this approach.

In Palestine, as mentioned above, waste management fees are already paid by households to municipalities and village councils, which provides a guaranteed revenue stream. Although there are only small-scale and limited recycling facilities in Palestine, with no large recycling capacity in Palestine, with improved sorting practices, there may be enough plastic to run a recycling factory. Exporting recycling materials can also be an alternative short-term option in order to secure additional revenue streams.

Although the market for compost is still underdevelopment, there are already small-scale compost facilities in Palestine, which are commercially viable and produce a compost that already meets Palestinian standards. This shows the existence of potential demand for compost and thus potential additional revenues.

Although the technology may need concessional financing, such as grants, to take off in Palestine, it is highly probable that it will be economically feasible, if the necessary policy and regulatory enabling environment is created.

11.6 Potential replicability and scalability

Given the situation of landfills in Palestine and household awareness levels, the technology appears replicable and scalable in Palestine.

11.7 Transferability to the country

The technology does not require any complex technology transfer. Recycling technologies are well known and could be transferred to Palestine. Formulating the relevant policy environment for waste collection and sorting, which define the pre-conditions to recycling and composting, will be extremely important to support the transfer and replicability of the technology in the country. This will answer to the lack of National policies and National laws which will be needed to provide the regulatory incentives for the industries to use recyclable materials.

In Palestine, a similar project could be led by the Ministry of Local Governments. As Joint Service Councils are in charge of collecting, transferring waste to landfill, they would be the responsible for the implementation of the waste separation before being sent to the recycling centers or composting station.

Furthermore, the Ministry of Local Government has already conducted a study on private sector engagement for solid waste management, which has analyzed the following:

- Institutional, regularity and economic mechanisms required for the promotion of solid waste partnerships
- Recommendations on the National strategies and plans, policies to promote for Public- Private Partnerships (PPP)
- Recommendations for JSCs to promote PPPs
- Recommendations for the private sector to implement partnerships in the field of solid waste

11.8 Possible occupation related challenges

Waste sorting stations, recycling and composting plants facilities require land. It will be necessary to assess

whether this location can be secured in areas A or B. If not, it will be necessary to assess its feasibility in areas C, even if it highly unlikely.

11.9 Potential for a pilot

In Nairobi, the technology was introduced through the implementation of pilots. A similar approach is proposed to be followed in the case of Palestine.

3. Water – Solar powered irrigation pumps (India)

India's agricultural sector employs about 50% of the country's workforce. For the sector, access to irrigation is critical in improving the livelihoods of farmers and increasing crop productivity. India has made sustainable irrigation for agricultural use a policy priority for meeting its development objectives. A community-based 'pay-as-you-go' service model for irrigation using solar powered water pumps is also offered as one type of service delivery models in India.

1 Background

India has one of the largest irrigated areas in the world. Irrigation is provided through groundwater pumps, which mainly operate on diesel or electricity. Electricity in India is provided at highly subsidized low tariffs, mostly at flat rates. This resulted in government spending of USD 6 billion, annually, for subsidies on the energy required to power groundwater pumps alone¹. This also accounted for 25% of India's total electricity consumption and 12% of its total diesel consumption.

Heavy reliance on electricity- and diesel-based water pumps has led to poor irrigation practices in India. The output of electricity water pumps may for example be extremely fluctuant, which is a factor of inefficiency for agricultural yields. Furthermore, environmental impacts from wasteful use of water and over-extraction of groundwater have resulted in overall decline of production, lower income for farmers, and disrupted livelihoods of rural population. In addition, impacts from climate change over the past decades have increased inconsistent rainfall patterns that further damaged crop productivity.

In the context mentioned above, solar-powered pumping systems were introduced in India as a promising solution to meet the irrigation requirements for small and marginal farmers. Additionally, decrease in cost of solar photovoltaic (PV) prices and increase in diesel prices in recent years further supported the switch to solar pumps for irrigation in India. In 2014, the Ministry of New and Renewable Energy (MNRE) in India set a target to deploy 1.6 million solar pumps for irrigation in the country. Since then, India has become a leader in solar water pump use for agricultural irrigation, with approximately 142,000 pumps already installed as of November 2017. This will likely increase with a new target of installing 1 million solar pumps by 2020/21².

2 Description of the technology

A solar powered irrigation system comes in many forms for many different applications, but are broadly divided into three components: the solar panels, the pump, and the electronic controls or a controller device³. Generally, the sunlight falls on the solar panels and produces direct energy current. The controller is an electronic device that matches the power output from the solar panels to the pump motor and regulates the operation of the pump based on sunshine intake. The pump consists of the motor, which drives the movement, and the pump impeller, which moves the water under pressure⁴.

The solar-powered irrigation system can be configured in different ways depending on the needs of the application. Direct pumping system is the simplest and the most-used system globally. It consists of solar panels, the pump, and the controller. This configuration type is adaptable to all sizes and irrigation methods.

¹ Case Study: Solar-Powered Irrigation Pumps in India – Capital Subsidy Policies and the Water-Energy Efficiency Nexus 2017, Global Green Growth Institute

² RE Case Study: Community-Based Service Delivery Model – Through Solar Irrigation Pump 2018, GIZ, Akshay Urja

³Solar Water Pumps: Technical, Systems, and the Business Model Approaches to Evaluation, Massachusetts Institute of Technology

⁴Frequently Asked Questions on Solar Powered Irrigation Pumps, German Society of International Cooperation (GIZ)

Multi-use systems, mainly for on-farm use, allow for irrigation use as well as other uses at times such as, milling, grinding, sawing, food processing, and cooling. This system is more complex to install compared to direct pumping system but provides additional use of the system aside of irrigation.

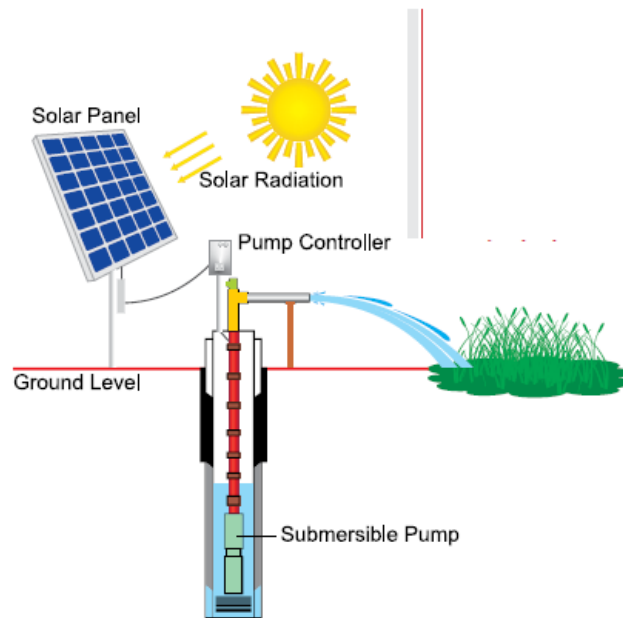


Figure 2 Solar powered pump

A community-based pumps in mini-grids provide power to various different uses such as for pumping and solar home systems. This is a complex system to install and technological solutions are still being developed.

Hybrid systems, a combination of solar pump systems and electricity- or diesel pumps working in parallel, operate in periods of night-time or when there is lower energy supply from solar. This system configuration is often used to lower the electricity fuel charges. Solar powered irrigation systems can also provide benefits such as providing physical shading space under the solar panels for suitable crop production or as shading for animals. Additionally, the solar panels can be placed floating on water or on roof of buildings or on top of water tanks⁵.

In solar-powered irrigation systems, there are two types of pumps: submersible pump and surface pump. A submersible pump is located deep below the ground level. A pump is installed within the water table in a bore-well, which requires the digging of a bore-well, a costly process, both financially and environmentally. A surface pump is located in the open by a water source such as open well, lake or canal. This is easy to install and maintain, and often a feasible option for cases where water table is within a depth of up to ten meters⁶. Both submersible and surface pumps are either direct current (DC) or alternate current (AC) pumps. A DC pump has a motor that operates on direct current. Solar panels generate DC current, which is then passed on to the DC pump motor through a controller. Since there is a direct use of current from solar panels, there is none to minimum loss of power between generation and consumption. An AC pump has a motor that operates on alternative current. For this pump, DC generated by solar panels is converted to AC by an inverter, which is then passed on to the AC pump motor. This results in minor power loss

⁵The benefits and risks of solar-powered irrigation – a global overview 2018, Food and Agriculture Organization of the United Nations

⁶Frequently Asked Questions on Solar Powered Irrigation Pumps, German Society of International Cooperation (GIZ)

between generation and consumption⁷.

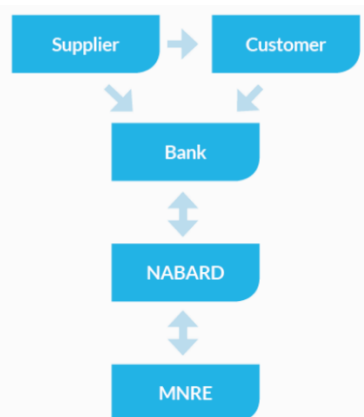


Figure 3 Credit-linked Capital Subsidy

3 Justification

Use of electricity water pumps presents high associated costs in purchasing of the diesel fuel. Rain-fed water pumps also reduce yield capacity, diminishing income for farmers, thus damaging the livelihood in rural India. While solar pumps have a higher up-front cost, their operating costs are very low compared to widely used diesel pumps, reducing risk of price fluctuations to farmers. They also increase crop productivity, proving access to increased income to the farmers. For a country with favorable climate for solar power systems, coupled with decreasing cost of solar PV, the use solar water pumps is suitable for India for its sustainable agriculture sector development.

4 Rationale

Replacement of fossil fuel pumps to solar-powered pumps led to significant GHG emissions reduction. It is estimated that in India, replacing 1 million diesel pumps and 1 million electric pumps reduced 25.3 million tons and 2.5 million tons of CO₂, respectively (Global Green Growth Institute, 2017).

5 Concrete application of the technology

India's approach to promote the use of solar pumping systems focused on removing the barrier for adoption by farmers by significantly reducing the high up-front costs. This was addressed through government subsidies – 30% from MNRE and additional 30-60% from state governments while farmers paid the rest of the cost.

The central and State governments of India, under the National Solar Mission program, support the farmers, not only by providing a capital cost subsidy on solar pump systems, but also by creating an enabling framework on their deployment by actively engaging stakeholders. In 2014, the MNRE launched a new “credit-linked capital subsidy scheme” which invited local financial institutions across the country to provide loans, reducing the subsidy burden on the government and making the system more affordable to farmers for use.

Under the new “credit-linked capital subsidy scheme”, launched by the MNRE in 2014, the process of bundling the subsidy with financing is implemented through a banking network, with the National Bank of Agriculture and Rural Development (NABARD) playing the role of the subsidy-channeling agency.

Suppliers connect interested customers to banks and provide support in submitting subsidy and loan

⁷Frequently Asked Questions on Solar Powered Irrigation Pumps, German Society of International Cooperation (GIZ)

applications. Based on MNRE's guidelines, solar pumps are eligible for capital subsidies ranging from USD 659 (INR 43,200) to USD 865 (INR 57,600) per horsepower (HP) pump set depending on the solar PV system and capacity. Beneficiaries are invited to contribute a minimum margin of 20% of the total financial outlay (TFO), along with bank loans at normal banking interest rates, over a 10-year repayment period (Global Green Growth Institute, 2017).

The MNRE also established targets for the number of solar pumps installed for each state government, while encouraging individual banks to set goals for financing solar pumps. This gave priority to solar loans, and reduced collateral requirements. Progress under the scheme is monitored by both NABARD and the MNRE on a regular basis.

In addition to MNRE's subsidy-based technology deployment model, a community-based 'pay-as-you-go model' has been piloted in India as one means of deployment. This model allows farmers to share solar pumps within the farmer community to meet their own needs. A prerequisite for formation of the group is that the farmers either need to have their land adjacent to the water pump or within the catchment area which the pump can cater to. In the case of Bihar, a solar pump was installed in two of the sites that had diesel pumps for irrigation use. An operator was nominated within the group, the Vaishali Area Small Farmer's Association (VASFA), who kept track of the usage of solar pump by different members and a service fee was charged based on the amount of water delivered to various members. Apart from the operator, a group leader was elected by the group members for collection of service charges. The service charge to be collected is also decided by the irrigation group and the collected money is partly used for salary of the operator and the rest is saved within VASFA for operation and maintenance of the solar pump. In this model, irrigation water is also shared with non-members after meeting the needs of the primary members. GIZ provided financial support to set up the site for the pay-as-you-go model while the ownership of the solar pump remained with VASFA. This creates an enabling environment for developing community-based asset sharing model.

6 Enabling factors

The factors that enabled the wide adoption of the solar powered water pumps for irrigation use in India include:

- *Economic factor:* Significant beneficial for the government, in terms of reduced subsidies for diesel imports and electricity use, and for increased crop productivity and long-term sustainability of the agricultural practice for the farmers. Additionally, declined cost of solar PV and incline in the cost of diesel fuel made solar power systems favorable for India.
- *Policy and regulatory framework:* Under the National Solar Mission, the MNRE set targets and created an enabling policy and regulatory framework for deploying solar energy technologies, including solar water pumping systems.
- *Awareness raising & capacity building:* Engaged a wide range of stakeholders including state government, the financial sector, the private sector, and other key stakeholders. State governments developed context-specific delivery models with support from external partners, while the MNRE conducted monitoring installation progress and supported information sharing with the public.

7 Gaps, needs and challenges

Although the wide adoption of solar powered pumps was successful in India, there still remains limitations and challenges. These include:

- Low number of users benefitting from the scheme, despite subsidies and loans supported under the credit-linked subsidy scheme.

- Lack of access to appropriate credit-linked subsidy instruments to purchase solar powered water pumps for the farmers.
- At the community-level, a change in the behavioral pattern of the farmers, who only use the water pump during a limited period of the day, could improve the utilization of solar pumps and water as a resource.
- The need of water for irrigation for the winter crops often remains unmet through the solar pump; having a water tank for storage may be able to support in addressing this issues.

8 Sustainability and exit strategy

Factors supporting the sustainability of the technology use in India include the development of an enabling environment, which is supported by policy and framework development, context-specific financial delivery model, and strong participation from the private sector in the development of the market, increasing the potential economic opportunities. Additionally, a community-based 'pay-as-you-go model' provides further sustainability in the deployment of technology as the ownership remains with the community and a service fee is charged to those members that use the pump for irrigation. This provides an opportunity for a group of farmers to invest in the solar-powered water pumps, inviting those farmers that are unable to access the market, due to constraints such as its size.

9 Stakeholder analysis

9.1 Lead agency and partners

The subsidy-channeling agency is the National Bank of Agriculture and Rural Development (NABARD), in which capital subsidy is implemented through a banking network.

9.2 Role of the Government

The Ministry of New and Renewable Energy (MNRE), together with state governments, created an enabling policy and regulatory framework for deployment of the technology. This also included awareness raising and capacity building activities that further engaged the financial sector and private companies, providing business opportunities for the industry and development of the market demand.

9.3 Role of the private sector

The private sector provided solar pumping systems to domestic market. Increased economic opportunities, coupled with the government promotion, and has also helped expand the number of private companies offering the system to international market.

9.4 Role of the community

A community-based organization helped create an asset sharing model, in which it can also facilitate in technology transfer and technology adoption.

10 Opportunities

The solar pump technology resulted in the following opportunities in India:

- Decrease in annual spending on fossil fuel imports, electricity use, and reduction of CO₂ emissions, improved crop productivity and energy access.
- Additional business opportunities in the international market for the private sector.

- Additional revenue streams, under the 'pay-as-you-go' model.
- New job creation and opportunities.

11 Relevance to Palestine

11.1 Relevance to the Palestine context

This case study in India is highly relevant to the context of Palestine. In Palestine, irrigated areas are in the West Bank, in which groundwater from wells and springs is the only source of water used for irrigation. A study by the Applied Research Institute – Jerusalem (ARIJ) highlighted that there is an inefficient use of water for agricultural in the West Bank, with increase in the amount of water lost due to the frequent practice of manually delivering water to the fields⁸. The water from most of the springs is conveyed to the irrigated fields through concrete or clay open channels and canals or pipes. These pipes are often made out of plastic or metal and are designed and installed by the farmers. Solar water pumps are fit for use when either installation of new pump is required or replacement of existing pump is considered, hence making it suitable for the case of Palestine⁹. In regards to the climate, study shows that Palestine has a high solar energy potential with about 3,000 hours of sunshine per year, or 5.4 kWh / m² / day on average,, supporting the suitability of solar energy for energy generation and security. Hence, use of solar powered water pumps is ideal to enhance the efficiency of water used for irrigation, improve the total agricultural production in the West Bank, and contribute to energy security and GHG emissions reduction.

Palestine is also home to many small isolated communities, located far away from the electric grid, most of them in area C. This type of technology, which enables them to access irrigation without diesel pumps or access to the grid is important to ensure their livelihoods.

11.2 Linkages to Palestine's NDC

This case study supports Palestine's NDC. Climate actions described in the NDC aim to increase food production and water resources, among others. Some of the adaptation actions mentioned for the agricultural sector, exclusively, include, improving water-use efficiency and using alternative water resources and enhancing sustainable community-level irrigation schemes and infrastructure.

11.3 Co-benefits

Implementing solar powered pumps will offer various co-benefits as identified in the table below:

Sector	Co-benefits
Financial/Economic	<ul style="list-style-type: none"> ● Cost savings (reduced dependence on imported fuels) ● Increased energy security ● Reduced risks of exposure to volatility in the international energy markets ● Potential business opportunities and income generation ● Job creation
Environmental	<ul style="list-style-type: none"> ● Reduction of CO₂ emissions ● Sustainable water resources

⁸ Water and Irrigation Management in the Palestine West Bank, Applied Research Institute – Jerusalem (ARIJ)

⁹ Frequently Asked Questions on Solar Powered Irrigation Pumps, German Society of International Cooperation (GIZ)

Social	<ul style="list-style-type: none"> ● Improved standard of living of farmers
Health	<ul style="list-style-type: none"> ● Improved air quality ● Improved health of the population

11.4 Acceptability

This case study would help Palestine in meeting its sustainable development goals. The use of solar energy to improve water-efficiency in the agricultural sector is directly linked to its NDC. The ‘pay-as-you-go model’ also offers an opportunity to enhance sustainable community-level irrigation scheme. A similar project was also conducted in the Palestinian Jordan valley.

In general, the awareness of local communities regarding PV technologies is high, which also makes the technology socially acceptable.

11.5 Economic feasibility

The cost of PV panels has significantly decreased during the last decade; hence, resulting in reduced costs of solar pumps and system configurations. Use of solar powered technologies offers cost-effective solution for irrigation use for both large and small-scale farmers. They provide affordable energy thus reducing the cost of energy for irrigation. This offers viable advantage and benefits to farmers. The table below demonstrates, regardless of the high initial investment cost, how the solar powered irrigation system has become an attractive option for irrigation use. As mentioned earlier, this reduction in cost is mainly driven by government subsidies an investment schemes put in place for over a decade.

Item	Description	Price range (average) in USD
PV panels	Installed at site	USD 1.25 to 2.00/Watt
Solar pump	International brand	Up to USD 1 000
Pump controller (P)	International brand	Up to USD 1 000
Electric cables	Depending on pump depth and distance to PV panels	USD 5.00 to 14.00/m
Pump installation	Manual up to 30 m	USD 200.00 to 400.00
	With crane	USD 750.00 to 1 000.00
Drip irrigation	Header with filter	USD 300.00 to 450.00
Drip lines (85% irrigated)	Depending on line thickness, quality of drippers, life expectancy	USD 600.00 to 1 000.00
Small-scale portable pump (Kenya)	Up to 12 000 l/day, with 80 W panel and 24-month labour and spare parts guarantee	USD 650.00
Small-scale submersible pump (Myanmar)	Up to 12 000 l/day, with 260 W panels and stand	USD 375.00
Small-scale complete system (Kenya)	Submersible pump, 300 W panels on secured 3 m high stand with controller, filters and 1 acre drip irrigation, with planning, installation and guarantees for pump, panels and drip lines	Starting from USD 2 400.00

Figure 4 Cost estimation for Solar-Powered-Irrigation System components (2017)

In Palestine, installing one kW of PV capacity will cost between USD 1,200 and 1,400, including solar panels with all auxiliary components. The price of the pump has to be added to the cost of the solar system.

11.6 Potential replicability and scalability

Based on the availability of alternative energy source, water supply, cropping patterns, and crop irrigation needs, solar-powered water pumps appear replicable and scalable in Palestine.

11.7 Transferability to the country

A solar powered pump is easy to install and quick to commission. It also requires minimum maintenance and has significantly longer life expectancy than a diesel-fueled water pumps. Rather, it will be critical that appropriate policy and framework is developed for a successful deployment of the technology advancement.

11.8 Possible occupation related challenges

It will be necessary to assess whether there are shade free areas available for installation of solar panels in the West Bank's irrigated areas. This will need to be secured to ensure that solar panels can be installed for operation of water pumps. It is important to emphasize that under the current context, the digging of new wells is under the control of the Israeli occupation and therefore highly unlikely. Pumps should therefore be used with existing wells.

11.9 Potential for a pilot

Similar to the 'pay-as-you-go model' piloted in the Vaishali district of Bihar in India, this project can be implemented as a pilot-basis in the West Bank. Improved irrigation can deliver improved crop production and food security. As water security, energy security and food security are closely linked in Palestine, the use of the Water-Energy-Food-(WEF) Nexus approach could be explored for the pilot¹⁰.

¹⁰ <http://www.water-energy-food.org/nexus-platform-the-water-energy-food-nexus/>

4. Agriculture – Climate smart agriculture (St. Lucia and Uganda)

Impacts of the climate change on agriculture are already experienced around the world, in the form of more frequent extreme weather events that affect crops and livestock and disrupt food production. Agriculture is also a major source of greenhouse gas (GHG) emissions, generating approximately 19 – 29 percent of total global GHG emissions¹¹. Climate-smart agriculture (CSA) technologies have been applied in many parts of the world to manage landscapes such as, cropland, livestock, forests and fisheries. These technologies aim to achieve increased and sustainable productivity, enhanced resilience and reduced emissions. This case study focuses on concrete applications of CSA, such as in the Nationally Appropriate Mitigation Action (NAMA) in Uganda. While this case study emphasizes the approach taken by Uganda in the NAMA, it also provides concrete example of CSA technologies used in St. Lucia.

1 Background

Climate change poses a major and growing threat to global food security. Population growth and rising incomes in much of the developing world have pushed demand for food and other agricultural products to unprecedented levels. The Food and Agricultural Organization (FAO) has estimated that, in order to meet food demand in 2050, annual world production of crops and livestock will need to be 60 percent higher than it was in 2006. In developing countries, about 80 percent of the required increase will need to come from higher yields and increased cropping intensity and only 20 percent from expansion of arable land¹².

The CSA concept offers solutions to meeting the challenges of addressing agricultural planning under climate change. It calls for integration of the need for adaptation and the possibility of mitigation in agricultural growth strategies to support food security. CSA goes beyond agricultural practices and technologies to include enabling policies and institutions as well as identification of financing mechanisms.

Agriculture is the most important sector of the Ugandan economy as apart from the direct provision of food, it provides employment, accounts for nearly 20 percent of the value of nominal GDP, accounts for 48 percent of the value of export commodities, and provides a large proportion of the raw materials for industry. The agricultural sector in Uganda is also one of the main emitters of GHG in Uganda.

Adopting CSA practices in Uganda is therefore essential both to preserve the sector from the impact of climate change and propose adaptation options, as well as to mitigate its impact on climate change. The NAMA addresses the climate resilience of the dairy sector in Uganda and the mitigation of its GHG emissions. The objective of this NAMA is to trigger resilient low-carbon development in the dairy sector through the introduction of climate-smart agricultural practices and to bring the dairy production sector of Uganda onto a low carbon and more resilient path.

2 Description of technology

CSA refers to agricultural practices, approaches and systems that sustainably and reliably increase food production while minimize impacts on the environment. CSA is not a set of practices that can be universally applied, but rather an approach that involves different elements that are embedded in specific contexts and tailored to meet local needs.

In St. Lucia, climate change provides new challenges to local farmers. Local farmers suffered loss on their main cash crop, tomatoes, from unusual heavy rains and longer dry periods and water scarcity. Excessive rainfall had become more unpredictable, while heavy rainfall over short periods of time directly damaged crops. The extended drought periods and longer “dry season” conditions, not only affected traditionally dry

¹¹ Bringing the Concept of Climate-Smart Agriculture to Life 2018, International Bank of Reconstruction and Development/the World Bank

¹² Climate Smart Agriculture: Building Resilience to Climate Change, Food and Agriculture Organization of the United Nations, Natural Resource Management and Policy, 2018

areas, but also impacted those areas accustomed to regular rainfall¹³. These changes in climate severely affected the traditional growing season. In order to overcome these barriers, the Belle Vue Farmers' Cooperative, a local farmers' cooperative in St. Lucia, applied a combination of CSA technologies and practices. These technologies and practices are described below:

Technology¹⁴	Result
Drip irrigation	The irrigation units, together with water storage, have regularized access to water, improved efficiency in water use, allowed for production of target commodities like tomato year-round as opposed to the limited traditional growing period of a few months.
Water harvesting and storage	A water tank to collect water from the roof of Belle Vue Farmers' Cooperative was installed to provide a more stable water supply.
Mulching*	Increased awareness of the benefits of mulching, such as improving water use efficiency, improved soil moisture retention and the promotion of earthworms and nutrients in decomposition have led to elimination of use of weed killers by the Cooperative.
Introduction of more climate resilient varieties	The introduction of more heat and pests tolerant varieties of tomato, watermelon and sweet potato has provided more resilient varieties as well as improved earnings for farmers by being able to have more harvest per year.
Protected agriculture	The Cooperative purchased a greenhouse, with a deposit and monthly payment, that enabled the production of over 50 percent of the colored peppers consumed by households and hotels.
Bio-digester and solar power	A bio-digester was installed, on demonstration plot, to help control waste run-off from pig pens, produce liquid and solid fertilizer input and generate methane gas for preparing animal feed and household use. The solar electricity system is used to pump water from a rainwater collection tank to the seeding nurseries at the Cooperative office. The solar electricity system and rainwater collection resulted in savings of about USD 50 in bill payment per month.
Diversified production and food processing	The Cooperative has been working with farmers to engage in other on-farm income options. Production of commodities such as watermelon, herbs, cocoa, and fruit trees is promoted through a field school. The Cooperative is also holding a joint field school with a local hotel to produce mushrooms as a high value and low impact commodity that will be sold directly to hotel chefs. A similar initiative with cocoa is also being pursued. Value added activities, such as the production of smoothies by the Cooperative's youth arm, are also being promoted as an alternative form of income.

¹³Climate Smart Agriculture in the Eastern Caribbean States: the Path to Sustainability and Stability of Growth in a Changing Climate, Inter-American Institute for Cooperation on Agriculture

¹⁴ Climate Smart Agriculture in the Eastern Caribbean States: the Path to Sustainability and Stability of Growth in a Changing Climate, Inter-American Institute for Cooperation on Agriculture

Good agricultural practice demonstration plots	Demonstration plots were used to test new tomato and watermelon varieties and identify those more resilient under local conditions, pilot drip irrigation and water tanks, as well as to evaluate the performance of a bio-digester. The plot was managed with input from senior extension officers and technicians from the Ministry of Agriculture and was used to train both members and non-members of the Cooperative.
Field schools and training	Fields schools and training were implemented to build members' capacity in composting, alternative pest control, use of local materials, and the adoption of more climate smart practices. Youth in particular were targeted for capacity development initiatives.

*Mulching refers to applying of materials, such as plant debris, to the soil surface in order to reduce water loss, suppress weeds, reduce fruit splashing, modify soil temperatures and generally improve crop productivity.

Implementing all the technologies and practices mentioned above costed approximately USD 34,000 over a period of a year. Approximately 40 percent of the budget was used to install the solar power pump and to establish demonstration and validation plots, and the remainder of the budget was used on installation of water tanks.

In Uganda, the NAMA focuses on the application of CSA for the dairy sector, through the introduction of manure management and feed production technologies, among others. The concrete approach implemented by the NAMA is described below in section 5.

3 Justification

Agriculture can be used as an important instrument in improving the lives of the population through providing employment and income to majority of population in developing countries. However, the global agriculture sector is a significant contributor of GHG emissions, while being exposed to the effects of climate change. This makes it critical that sustainability issues, which relate both to mitigation and adaptation, are addressed to ensure long-term security of food and economy.

CSA technologies, such as those proposed under the NAMA, will create an improved market condition, thereby increasing the financial returns for farmers, and will reduce GHG emissions. The total emission reduction under the NAMA is expected to meet 3 percent of the 22 percent emission reduction target of Uganda.

4 Rationale

The sector is the leading emitter of the GHG, specifically methane (CH₄) gas, which is more potent than carbon dioxide. This causes detrimental effects on climate. There are also improvement opportunities in the sector that are not being addressed, which will increase both economic and development conditions.

5 Concrete application of the technology

The NAMA focuses on a set of interventions and measures related to policy development, technical assistance, and access to finance that contribute to enhanced agriculture productivity, climate change mitigation and adaptation, improved food security, and increased incomes.

Under the NAMA in Uganda, the technical assistance flow is designed to channel through the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). MAAIF will provide the required training, capacity-building, and awareness-raising to key stakeholders such as cooperative. Farmers' organizations, cooperatives, or group will, then, be provided with the knowledge and skills to train the individual participating farmers of the NAMA. MAAIF will also prepare a manual documenting implementing activities that reduce methane emissions from enteric fermentation such as appropriate feeding strategies, feed

supplements and additives, and diet manipulation.

The financial assistance flow is designed to be delivered by several existing funds and financial entities, thus eliminating the need for any additional financial support for project implementations. However, the NAMA will require donor for the initial implementation of the project in providing trainings. These assistance flows ensure that interventions and measures proposed are integrated within sustainable commercial oriented investment activities for long-term sustainability.

6 Enabling factors

Factors that supported the successful implementation and operation of the CSA technologies in St. Lucia include the following:

- *External supporters:* Alliances with national, regional and international organizations and businesses such as, the UNDP, GEF, GIZ, and local hotels and restaurants helped in mobilizing resources, building technical capacity and improving access to information and knowledge on CSA.
- *Social awareness:* An awareness of the need to adopt climate resilient agricultural practices by farmers.

Enabling factors for a successful implementation of the proposed NAMA in Uganda include:

- *Economic factor:* The financial support for implementation does not require any additional financial support due to the use of existing funds and financial entities. Some of these funds include Uganda Yield and Agdevco in Uganda.
- *Social awareness:* An awareness of the need to supplement livestock with concentrates among the farmers for enhanced productivity.
- *External supporters:* Technology transfer of installation and maintenance of bio-digesters and construction of storage facilities.

7 Gaps, needs and challenges

The issues and challenges experienced by the Cooperative in St. Lucia include:

- Lack of basic infrastructure (greenhouse/protected structure, irrigation system, storage shed)
- Lack of basic knowledge on good agricultural practices to improve water use and better care for soil
- Need for additional skills such as improved record keeping

The issues and challenges that the NAMA will aim to address include the below:

- Most of the farmers lack in understanding of the benefits of CSA technologies (hay production and supply for quality feed and prevention of soil erosion)
- Lack of policies and standards on the quality of feed
- Lack of facilities for storage and milk collection points
- Lack of proper treatment of livestock manure
- Lack of control in the informal market of the milk products

8 Sustainability and exit strategy

For the case of St. Lucia, the Belle Vue Farmers' Cooperative involved engagement of youth and women farmers, which was crucial in changing the farming culture and helping new farmers adapt. The approach also included capacity-building and training, in which farmers received training and support to help identify, adapt and finance equipment to enhance the resilience of their farms with items such as, water tanks, drip lines, weed cutters, water harvesting and storage.

For the proposed NAMA in Uganda, the components of the NAMA create an enabling environment through commercialization of activities, policy introduction, and development of commercially driven business models. These models are implemented by individual farmers and cooperatives, as well as private sector participation. The technical component of the NAMA focus on capacity-building and awareness-raising, in partnerships with farmers' organization and other key stakeholders. This ensures that a new low carbon dairy supply chain is sustainable. It also allows for the necessary know-how knowledge, of operation and maintenance of proposed technologies, to be transferred.

9 Stakeholder analysis

9.1 Lead agency and partners

- **St Lucia:** The Cooperative, with the support of Ministry of Agriculture, led the initiative.
- **Uganda:** The NAMA in Uganda is implemented by the MAAIF, as the NAMA Implementer. The MAAIF will work closely with farmers' organizations, cooperatives, the Dairy Development Authority (DDA) and other groups such as feed producers and land owners.

9.2 Role of the Government

- **St Lucia:** Senior extension officers and technicians from the Ministry of Agriculture provided training to both members and non-members of the Cooperative on good agricultural practices and use of technologies.
- **Uganda:** The government of Uganda will oversee all activities under the NAMA, including tracking of which NAMA activities have been implemented.

9.3 Role of the private sector

- **St Lucia:** Local businesses such as hotels and restaurants supported the farmers' of the Cooperative in earning additional income through purchasing of newly introduced varieties of tomato, mushrooms and watermelons.
- **Uganda:** The private sector will deliver technologies required, such as construction of cooling facilities and testing facilities.

9.4 Role of donors and international organizations

- **St Lucia:** International organizations, such as the UNDP, GEF, GIZ, helped in mobilizing resources, building technical capacity and improving access to information and knowledge on sustainable agricultural practices.
- **Uganda:** Donor will provide the initial funding to support for providing tax breaks/tax discounts and technical assistance for trainings and awareness-raising for activities that are carried out under the NAMA.

9.5 Role of investment funds

Yield Uganda Investment Fund is a EUR 12 million fund for investment in small and growing agribusinesses in the agricultural sector in Uganda. Additionally, African Agricultural Development Company (AgDevCo) is a social impact investor operating exclusively in the agricultural sector in Africa. They will provide funding sources to support in establishment of the milk purchase points as places for attracting certified milk producers.

10 Opportunities

The case study offered the following opportunities:

- Cost savings and additional income for farmers
- Increased productivity
- Improved local diet

11 Relevance to Palestine

11.1 Relevance to the Palestinian Context

Climate smart agricultural practice is highly relevant to the Palestinian context. Climate change poses both direct and indirect impacts on agricultural productivity, ranging from changing rainfall patterns, drought, flooding and spread of pests and diseases. This will also effect Palestine where agriculture plays an important role in the country's culture, food security, economy and employment.

11.2 Linkages to Palestine's NDC

This case study links directly to Palestine's NDC. Palestine has a target to apply climate-smart agricultural practices to at least 50 percent of farms by 2040. The NDC identifies adoption of climate-smart production and post-harvest practices as mitigation measures in reducing GHG emissions and increasing carbon sequestration in plant biomass and soil organic matter.

11.3 Co-benefits

The climate-smart agricultural practice in Palestine will provide several co-benefits.

Sector	Co-benefits
Financial/Economic	<ul style="list-style-type: none"> ● Increased food production ● Improved family income
Environmental	<ul style="list-style-type: none"> ● Reduction of CO₂ emissions ● Increased water resources
Social	<ul style="list-style-type: none"> ● Improved food security
Health	<ul style="list-style-type: none"> ● Improved health and well-being

11.4 Acceptability

The importance of climate-smart agriculture in improving climate resilience and food security in agricultural value chains suggests that it may be acceptable in Palestine.

Moreover, there are already success stories in Palestine in the use of bio-digesters for the production of

biogas for electricity generation purposes. Hay agriculture will open new business opportunities for Palestinian farmers as well, which will increase its acceptability.

11.5 Economic feasibility

Implementing climate-smart agricultural practices will require financial support, in addition to capacity-building and technology development. Concerning bio-digesters, there is already a small-scale project developed in Hebron, in Junaidi dairy factory, which suggests that the technology may be economically feasible.

11.6 Potential replicability and scalability

Given there is a sufficient and existing agricultural practice in Palestine, a shift to low-carbon, climate smart agricultural practice is deemed replicable and scalable in Palestine.

11.7 Transferability to the country

Relevant policy support measures and incentives, capacity-building and awareness-raising actions will need to be carefully developed for a successful implementation of climate-smart agricultural practice.

11.8 Possible occupation related challenges

Some of the CSA technologies may require additional space, such as installation of water tanks and establishment of a greenhouse.

11.9 Potential for a pilot

Similar to the case of the Belle Vue Farmers' Cooperative, Palestine could implement a demonstration pilot for testing of product varieties and CSA technologies and practices for scaling purposes. This will also encourage engagement and involvement of large number of farmers.

5. Agriculture – Small scale manure management, bio-digesters: Biogas Sector Partnership (Nepal)

Land degradation and damages to vital watersheds due to the use of fuelwood, cattle-dung cakes and agricultural residues for cooking, and kerosene for lighting, is a major challenge in Nepal, especially in rural areas. An innovative model for the installation and maintenance of domestic biogas plants has been proposed as a solution to this issue, and has been awarded the 2005 Ashden International Award.

1. Background

About 80% of the population in Nepal is using solid fuels for cooking, including 75.2% that is using fuelwood (2018, Clean Cooking Alliance). Under this situation, demand for fuelwood is hugely exceeding the rate of regrowth, leading to important land degradation and bringing damages to vital watersheds. In addition to environmental impacts, there are also economic and social impacts. Women and young children are the first victims of Household Air Pollutants (HAP) as they spend much of their time indoors. Women are also in charge of collecting fuelwoods, which takes several hours, preventing them to get involved in other revenue-making activities instead.

In order to tackle this issue, the Government of Nepal, in cooperation with the Netherlands Government, started support activities to promote the use of biogas in Nepal by launching the Biogas Support Program (BSP) in 1992. The objective of the program was to promote a wide-scale use of biogas as a substitute for fuelwood, agricultural residues, animal dung and kerosene that are mainly used for cooking and lighting in rural areas households.

2. Description of the technology

Nepal addressed the issue of fuelwood, cattle-dung cakes and agricultural residues for cooking, and kerosene for lighting through the installation of domestic biogas plants that use cattle manure to provide biogas for cooking and lighting.

The biogas systems that are used in Nepal includes the following three steps:

- ① Biogas systems uses organic material such as manure into an air-tight tank, where bacteria break down the material anaerobically (without oxygen) and release biogas – a mixture of mainly methane (60 to 70%) and carbon dioxide.
- ② The gas is piped to the kitchen inside the house, where it is used for cooking on specially designated burners, and sometimes for lighting as well.

The gas pressure pushes digested residue out from the base of the digester into a reservoir tank, from where it is collected and used as fertilizer.



Figure 5 Domestic biogas plant and stove installed under BSP scheme

3. Justification

The lack of clean cooking and lighting systems is a major issue in Nepal and presents, among others, immediate health hazard risks. Cooking habits by using solid fuels in Nepal involve indoor cooking over open fires, which exposes households to dangerous air pollutants and high risks of fire. 18,000 deaths per year are attributable to Household Air Pollutants (HAP), with about 4,500 of them being children (2018, Clean Cooking Alliance). Women and children are the most affected by this as they spend much of their time inside the house. Lighting with kerosene also exposes the population to air pollutants and high risks of fire.

Women and girls are also heavily involved in collecting fuelwood, which typically takes about three hours a day. This practice does not only have disastrous consequences on their health, but also has disastrous consequences on their financial situation. Women could use the time saved from not collecting fuel for income generation.

4. Rationale

The use of fuelwood, cattle-dung cakes and agricultural residues for cooking, and kerosene for lighting leads to GHG emissions, mainly methane (CH₄) and nitrous oxide (N₂O), and black carbon. Additionally, these cause severe health and environmental problems, and represent a missed opportunity from a development and economic perspective.

5. Concrete application of the technology

BSP is a non-governmental organization established in 1992 to manage the biogas programme in Nepal. BSP does not directly install the domestic biogas plants, but provides training to users and biogas companies, ensures the quality and long-term reliability of the plants, and manages the programme of subsidies to purchasers.

Digesters used in this project were developed in Nepal based on the Chinese fixed-dome plant. The digester, which is an underground cylindrical tank build from bricks and mortar, is built in a pit in the ground near the house. The fixed hemispherical dome, which acts as a gasholder, is made from concrete, cast over an earth mould on top of the tank. The inlet to the digester is a cylindrical brick-built tank with a hand-operated rotator, used to mix cow dung and water which is fed in through a pipe. The design of the digesters needs the dung from at least two cattle (24kg per day) to function properly. All digesters are supplied with a second inlet pipe to be connected to toilets, so that it is available when/if a toilet is added later.

The manure and toilet waste are decomposed without oxygen by bacteria in the digester and produce biogas, which is a mixture including 60-70% of methane and 30-40% of carbon dioxide. The gas is then piped to the kitchen inside the house, where it can be used for cooking on specially designed burners, and in some cases for lighting as well. The gas pressure pushes digested effluent out from the base of the digester into a reservoir tank, from where it is collected and used as fertilizer.

In Nepal, the digesters are made in four sizes, with total volume from 4 to 10m³, and each produces between 1.2 and 1.5m³ of biogas per day. This represents enough energy capacity to burn a stove for about 3.5 hours. The capacity and gas production depends on the number of cattle supplying dung, and also on the location of the biogas plant. In cooler places gas is produced slower, and a larger volume tank is needed.

BSP model is transposable in larger scale project, as it has also provided design guidance and advise for the installation of about 100 larger biogas plants (50m³) in school and hospitals in Nepal.

The cost of the plant varies depending on its location, with additional costs for an installation in remote and hilly areas mainly due to transportation costs. In order to correct this difference, BSP established a subsidy programme by providing higher subsidies to remote areas households. This allows all households to acquire domestic biogas plants at the same cost no matter where they are located.

Through the BSP program, the household pays one third of the total cost in kind by providing labor and materials. The remaining two thirds of the cost are paid by the household on a cash payment basis or by contracting a loan, as it is seen as a useful and beneficial long term investment. Indeed, over 80 banks and micro-finance organizations in Nepal are ready to finance domestic biogas plants as it is seen as a safe investment. The majority of loans related to biogas plants are paid back within eighteen months.

Another important role of the BSP is the provision of training and quality control, leading the project to operate and grow successfully. Even though installations are operated by private construction companies, BSP provides quality control by monitoring constructions and accrediting, and by providing subsidies to companies that have good performance. A three year guarantee period with free maintenance is provided as an incentive for companies to install high quality plants from the beginning.



Figure 6 Domestic biogas plant using BSP scheme in Nepal

6. Enabling factors

Some of the enabling factors for this technology and approach to be operational in Nepal include the following:

- *Economic factors:* At the proposed low cost and financing options, domestic biogas plant is affordable for almost all households.
- *Social awareness:* Awareness of the issue using fuelwood for cooking at household level.
- *Governmental support:* Through its National Rural and Renewable Energy Programme (NRREP) adopted in June 2012, the Government of Nepal set the focus on strengthening the promotion of biogas in the household market and expanding promotion into the institutional market, especially in remote districts of rural areas.

- *External support:* The role of BSP in coordinating and ensuring good installations, affordable finance and quality checking.

7. Gaps needs and challenges

Some of the gaps related to implementing the model include the following:

- Cost reduction. Even with the subsidy, the cost is still too expensive for some families.
- Lack of a viable business plan with a medium and long term vision. Need to think of alternatives for subsidy support in order to ensure affordability and quality control.
- Lack of market demand for biogas systems.
- Weak Nepalese biogas institutions

8. Sustainability and exit strategy

Some of the strategies used to ensure the sustainability of the technology in Nepal include the development of an enabling environment, which includes policy support, economic and employment benefits, as well as the guarantee of a good, affordable and high quality plant.

9. Stakeholder analysis

9.1 Lead agency and partners

The project is implemented by the BSP, under the biogas programme launched by the Government of Nepal in cooperation with the Netherlands Government.

9.2 Role of the public sector

The Government of Nepal provides funding for the subsidy of biogas systems. The Government also plays a significant role by allowing tax exemptions for biogas appliances and materials, and supporting the development and promotion of biogas technologies in Nepal.

9.3 Role of the BSP

The BSP coordinates the whole installation process, provides training to users and biogas companies, ensures domestic biogas plants 'quality and long term reliability, and manages the programme of subsidies to purchaser.

9.4 Role of the private sector

Private construction companies ensure the installation of the domestic biogas plants. Private banks and micro-finance organizations ensure the financial aspect by providing loans to households.

10. Opportunities

The proposed technology and approach introduced bring the following opportunities:

- Considerable reduction of fuelwood consumption, leading to the re-growth of forests.
- Additional income generation by women due to the time saved by not having to collect fuelwood. Girls also have more time to devote to education.

- Health benefits for women and young children, due to lower emission and cleaner kitchens, and less risk of accidents due to safer lighting.
- Additional long term jobs from the development of a private biogas business sector.

11. Relevance to Palestine

11.1 Relevance to the Palestinian context

This case study is highly relevant to the Palestinian context. Although the electrification rate in Palestine is much higher than in Nepal, Palestine heavily relies on importations from neighboring countries. For rural households, the installation of domestic biogas plants would bring a number of benefits, including cost-savings in energy.

For households which are not yet connected to the grid, this represent an immediate and low-cost solution.

This technology is especially suitable for small isolated populations, which live without access to electricity but close to cattle. The technology may bring considerable benefits to them. Taking into consideration the Palestinian authority target to support isolated populations to keep living in their lands, this type of access to energy through biogas seems highly relevant.

This would also enable Palestine to decrease its GHG emissions. This would be possible by enabling Palestine to import less energy, and by transforming organic material into biogas, which if left unused would produce methane.

11.2 Linkages to Palestine’s NDC

This case study is strongly linked to Palestine’s NDC, as the use of waste for electricity generation / waste to energy is one of the mitigation priorities identified. Domestic biogas plants are small-scale examples of waste to energy solutions.

11.3 Co-benefits

Installation of domestic biogas plants in Palestine will bring various co-benefits.

Sector	Co-benefits
Mitigation (as per the NDC)	<ul style="list-style-type: none"> ● Reduction in energy imports ● Reduction in ozone from methane ●
Financial/ Economic	<ul style="list-style-type: none"> ● Additional revenue streams ● Cost savings ● Potential for the creation of new businesses
Social benefits	<ul style="list-style-type: none"> ● Job creation ● Poverty reduction and better living conditions ● The use of domestic biogas plants would increase the number of households that have access to an independent and stable source of electricity

Environmental	<ul style="list-style-type: none"> ● Reduction of air pollution, ● Reduction in odor, ● Improvement of soil conservation and biodiversity conservation.
Health	<ul style="list-style-type: none"> ● Reduction of health problems of women and young children

11.4 Acceptability

The proposed technology will support Palestinian isolated populations, which may not be connected to gas and electricity. Under the right conditions, with incentives and awareness programmes, the technology may be acceptable for isolated populations and especially cattle / herd owners.

11.5 Economic Feasibility

In Nepal, the investment required to kick-off the installation of domestic biogas plants has been financed through subsidies, in-kind payment and loans. The system's is proposed at a low cost price, thus a large proportion of households can afford it.

11.6 Potential replicability and scalability

The proposed case study can be easily implemented in areas where citizens own and raise animals, such as Tubas, Hebron, Jericho, and other rural areas.

11.7 Transferability to the country

The technology does not require any complex technology transfer. Biogas technologies are well developed and could be transferred to Palestine. Formulating the relevant policy and financing environment, and raising awareness to the benefits of this system on the long term will be extremely important to support the transfer and replicability of the technology in the country.

11.8 Possible occupation related to challenges

The domestic biogas plants are easy to construct and do not require high skills and/or experience. As the proposed technologies does not consider large scale scenarios and grid-connected electric generation, the Israeli restrictions and/or obstacles are expected to be minimum.

11.9 Potential for a pilot

A pilot project can be proposed in a remote rural area in Palestine.

6. Water – Renewable desalination in Middle East and North Africa (MENA)

Water desalination is a major challenge in all semi-arid and coastal/islands areas, especially the MENA region, which is already facing water scarcity at an unprecedented level. There are already examples of desalination of seawater and brackish water (brackish water being water having less salinity than seawater but more than freshwater). However, this is a very energy intensive process which mainly uses fossil fuel. Innovative models for desalination using renewable energy have been proposed as a solution to this issue.

1. Background

The MENA region will face growing water scarcity in the following years. Projections forecast a rise in temperatures, causing higher evapotranspiration demand, combined with a significant precipitations decrease (IPCC 2007, AR4). Social, economic and budgetary consequences will be dramatic if MENA countries do not adapt to meet these challenges. There are a number of efforts already conducted. However, most of the current interventions focus on reducing the physical water scarcity and improving adaptation towards scarcity instead of implementing additional basic economic and institutional reforms (World Bank, 2007). The water gap in the MENA region is expected to grow fivefold by 2050.

In an attempt to close their growing water gap, MENA countries turned to desalination technologies, as most of MENA countries have access to seawater as a source of water. The Gulf region accounts for around 40% of the world's desalinated water production (Masdar, 2018). Desalination appears to be a technically feasible supply solution to the region's water gap and will continue to be in the future. However the conventional desalination technology relies fully on fossil fuel (mainly oil, but most recently also gas), thus it does not constitute an environmentally acceptable and a sustainable solution. The increase of desalination plants also involves the increase of MENA countries 'energy demand. Desalination is needed to meet MENA region water demand, but as for now it is not sustainable in the long term. However, the introduction of renewable energy technologies to power desalination plants make them more sustainable, and represent a good alternative to conventional desalination plants, making them an important priority for MENA's climate change adaptation strategy.

2. Description of the technology

There are a number of desalination technologies used. Some of them are presented below.

2.1 Solar Thermal Desalination (most widely used)

Also called concentrating solar power (CSP) plant. It collects solar radiation and provides high temperature heat for electricity generation. The CSP plant is very often combine with thermal storage system or with conventional desalination plant to extend operation even when the solar radiation is not available. This technology is the most suited for medium to large scale desalination plants, in region with high direct solar irradiance.

2.2 Photovoltaic Desalination

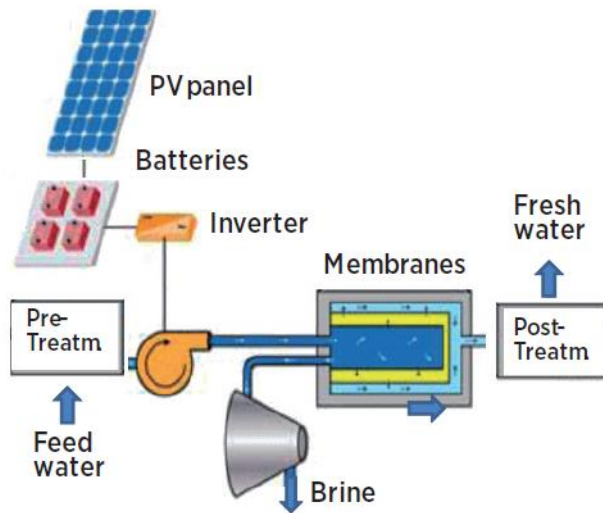


Figure 7 Photovoltaic desalination plant

The solar power plant is directly connected to the desalination plant, and provide energy needed for its operation. This solution is mainly used to power small scale desalination plant.

2.3 Wind Power Desalination

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 the best suited technology for seawater desalination, especially in coastal areas with high wind potential.

Several renewable energy technologies can also be combined to provide continuous power to the desalination plant. A conventional desalination plant can also be combined with a renewable energy source making it a hybrid desalination plant.

3. Justification

Desalination is a major issue in all MENA countries, and presents, among others, immediate GHG emissions and negative environmental impacts, thus it is not an environmentally sustainable solution on the long term. However, desalination is an immediate solution to the growing water gap in MENA countries. The installation of renewable desalination plants, therefore, makes sense to respect each country's engagement towards climate change mitigation.

Conventional desalination plants require a considerable amount of energy, which can lead to negative economic impacts for fossil fuel producing and exporting countries as they are counting on it to generate revenues. The shift towards renewable desalination plants allow the generation of incomes through the exportation of fossil fuels while continuing the desalination process.

4. Rationale

Conventional desalination plants leads to GHG emissions due to their full reliance on fossil fuel such as oil and gas. Additionally, it doesn't constitute a sustainable solution from an economic, social and environmental perspective.

5. Concrete application of the technology

(Example of Saudi Arabia – large scale project)

Saudi Arabia is in possession of the largest proven oil reserves in the world, as well as important gas resources. Under the current situation, Saudi Arabia exports a large part of its oil, benefitting of significant oil export revenues. However, the country's domestic energy consumption has been on the rise over the last few decades, and will triple over the next decades. Thus Saudi Arabia has to improve its energy efficiency in order to maintain its economic stability due to its oil export revenues. This situation, combined with a huge potential for solar energy, has let the Government to recognize the importance of increasing the part of renewable energy share in its energy mix, and established the King Abdullah City for Atomic and Renewable Energy (KA-CARE) to lead renewable energy (focusing on solar, wind and geothermal energy) development in the country. In addition to this measure, the Government is also strongly investing in the technological and human capacity development, with the aim to establish a new economic sector focused on renewable energy. In addition, the Government is looking at providing incentives to encourage investment in renewable energy through the implementation of feed-in-tariffs and central procurement approach.

In the meantime, as conventional desalination plant is consuming a significant portion of Saudi Arabia's domestic oil production, which could bring revenues by exporting it, the Government is also actively developing renewable energy powered desalination plants.

The King Abdulaziz City for Science and Technology (KACST) is currently building the world's largest solar-powered desalination plant. It produces 30,000m³ of desalinated water per day (under phase 1) and will meet the needs of 100,000 people. The plant is powered by concentrated solar photovoltaic technology and is operational since 2012. Phase 2 will see the renewable desalination plant capacity fivefold.

(Example of Masdar Initiative in the United Arab Emirates – small scale pilot project)

UAE has embarked on a two-decades program to transform its economy from an over dependent economy on natural resources to one based on knowledge, innovation and export of cutting-edge technologies. The Abu Dhabi Economic Vision 2030 provides a comprehensive plan in order to guide this transformation. The goal is to decrease the oil share in the economy, diversify the scope of economic activity, and emphasize value-added knowledge-based industries including renewable energy technologies.

Masdar, a commercially driven enterprise established in 2006 and mandated to expand UAE's energy portfolio, aims to cover the broad boundaries of the renewable energy and sustainable technologies industry.

It launched a Renewable Energy Seawater Desalination program, including five pilot plants located in Abu Dhabi and that will be operated over 18 months with a total capacity of 1,500 to 2,500m³/day of water production. This capacity represents the demand for about 500 households. All of them are power generated by solar power plants. The project was sponsored by the Abu Dhabi Government and co-funded by industry partners. Masdar was mainly in charge of leading the project management and coordinating the programme with key stakeholders. The implementation of these pilot projects allowed UAE to strengthen its energy and water security, enhance energy efficiency of water desalination, reduce cost of water desalination and reduce the environmental impact of desalination.

The same trend can be seen in the other MENA countries, Governmental action by implementing policies aiming to develop and increase the share of renewable energies in their energy mix.

6. Enabling factors

Some of the enabling factors for this technology and approach to be operational in MENA countries include the following:

- *Political factors:* providing price signals to consumers by gradually removing subsidies on fossil fuels encourages being energy efficient on the demand side and using the more competitive renewable energy technologies on the power generation side.

- Economic *factors*: Creation of a transitional incentive scheme until development and cost reduction of renewable energy technologies. Additionally, the use of renewable energy leads to a decrease in the costs used for energy, leading to important cost savings related to desalination.

7. Gaps needs and challenges

Some of the gaps related to implementing renewable desalination include the following:

- Technological challenges. Components suitable for smooth and efficient coupling of existing desalination with renewable energy technologies are not easily available, most renewable desalination systems are not developed as a single system but as a combinations of components developed independently.
- Renewable energy technologies provide intermittent power supply, whereas desalination plants require stable energy supply. It needs to be associated with energy storage systems.
- Significant capital investment is required. The technology remains very expensive.
- Renewable desalination technologies require advanced skills and strong institutional capacity to operate, and strong coordination between energy and water policies.
- Some conventional desalination plant's environmental issues remain, such as the brine disposal with chemicals that harms the environment.

8. Sustainability and exit strategy

Some of the strategies used to ensure the sustainability of the technology in MENA region include the development of an enabling environment, which includes policy support and economic incentives towards the development of renewable energies to the detriment of energies from fossil fuel sources.

9. Stakeholder analysis

The key stakeholder for the implementation of renewable desalination plant is the Government. Political and economic policies, as well as incentives have to be implemented in order to make renewable energy technologies more attractive than conventional sources of energy. By doing so, the Government can create a new industry focused on renewable energy. The private sector will be more involved when the industry has emerged, in developing renewable energy technologies at competitive cost.

10. Opportunities

The proposed technology and approach introduced bring the following opportunities:

- Diversification and strengthening of energy and water security
- Additional revenues from the exportation of fossil fuel (for fossil fuel producing countries)
- A step toward energy independence (for fossil fuel importing countries)
- Job creation through the emergence of a new economic sector

11. Relevance to Palestine

11.1 Relevance to the Palestinian context

This case study is highly relevant to the Palestinian context. The West bank is frequently confronted to

water shortage due to its high dependence on Israel regarding this resource. This is mainly due to Israeli occupation and the full control of Palestinian water resources by Israel. Additionally, the country is located in the Middle-East with access to sea water, area in which the water scarcity is projected to strongly increase in the next decades.

Many small Palestinian villages in the Jordan valley, especially those are close to Tubas, Jericho, and Dead sea suffer from water scarcity and high salinity. A number of pilot projects have been implemented using different desalination technologies. Reverse Osmosis seems to be the most suitable solution. In addition to that, a large proportion of the water available in the Gaza strip is not suitable for drinking, making desalination essential in providing the population of Gaza with clean source of water. As desalination technologies are energy intensive technologies, combining these technologies with proven feasible renewable energy technologies such as PV would be a promising solution for Palestine.

11.2 Linkages to Palestine’s NDC

This case study is strongly linked to Palestine’s NDC, as water has been identified as one the highly vulnerable issues for adaptation there. One of the adaptation actions identified include the building of a large desalination plant for Gaza. While achieving this project, Palestine will also be able to get closer to its objective to generate 5% of its total electric energy consumption by utilizing renewable energy technologies by the year 2020. The implementation of renewable water desalination plants can also be a solution to the water scarcity in the West Bank, as some of the water requires treatment to be consumable.

11.3 Co-benefits

Implementing renewable desalination plants in Palestine will bring various co-benefits:

Sector	Co-benefits
Adaptation (as per the NDC)	<ul style="list-style-type: none"> The building of a large desalination plant for Gaza is already included in the Palestinian NDC, however the project has a negative score as there will be a carbon cost associated with the development of the plant. By building a renewable desalination plant, Palestine will be able to achieve its NDC regarding this point with a lower carbon cost than planned and will also be able to increase the renewable energy share in its energy mix.
Financial/ Economic	<ul style="list-style-type: none"> Cost saving (no need to import fossil fuel for the operation of the desalination plant) Emergence of a new economic sector
Social benefits	<ul style="list-style-type: none"> Job creation
Environmental	<ul style="list-style-type: none"> Reduction of air and water pollution

11.4 Acceptability

This case study would help Palestine in meeting its sustainable development goals. The use of renewable energy to provide clean water sources for citizens living in areas like Gaza, Jericho, dead sea, and Tubas is crucial, where these communities suffer from high water salinity or pollution concentration. This is directly linked to its NDC. This technology will help in reducing national CO2 emissions generation.

11.5 Economic feasibility

The cost of renewable energy is expected to decrease while the cost of fossil fuel is expected to increase in the coming years. Capital investment at the beginning will be more expensive than conventional desalination plants, but on the long term renewable energy based desalination plants may be less

expensive and more sustainable.

11.6 Potential replicability and scalability

Given the situation of water demand and government awareness levels, the technology appears replicable and scalable to Palestine.

11.7 Transferability to the country

The technology itself does not require any complex technology transfer. Desalination and renewable energy technologies are well known and could be transferred to Palestine. Formulating relevant policy environment for the development of renewable energy, which define the pre-conditions to the implementation of renewable desalination plant, will be extremely important to support the transfer and replicability of the technology in the country. As the Palestinian Government was able to obtain written consent from Israeli Authorities to allow the Palestinian Government to import all related equipment needed for the implementation of renewable energy based desalination plants, they seem transferable to Palestine. In addition, the Government obtained confirmation that this type of projects would not be threatened by Israeli Military Forces.

11.8 Possible occupation related to challenges

Limited challenges are expected as the Israeli Government granted consent to the Palestinian Government.

11.9 Potential for a pilot.

Although the technology is still relatively expensive, it is extremely relevant in Palestine. A small / Medium scale pilot could be introduce in the West Bank or in Gaza.

7. Energy – Mini-grids (Lao PDR)

Lao PDR aims at providing access to electricity to more than 90 per cent of households in Lao PDR by 2020. In order to achieve this in rural areas, Lao PDR has chosen to establish mini-grids, which focus on providing electricity to rural communities, tourism, agricultural facilities, health centers, and schools and literacy centers.

1 Background

Energy demand has significantly increased in Lao PDR. In 2010, about 73 per cent of the households had access to electricity compared with only 15 per cent in 1995. However, power demand is not uniform across provinces. The top three power consuming provinces accounted for 62.8 per cent of nationwide power demanded, whereas the bottom three power consuming provinces were responsible for a mere 3.9 per cent of the power consumed nationally.

Electricity demand on the national grid is met by the domestic electric power plants and imports from neighboring countries. Almost all the electricity generated in the Lao PDR comes from hydropower plants.

Since almost all national power production is hydro based, the domestic facilities are not able to cover domestic demand for power all year round. To match the seasonal fluctuations in electricity production, power has to be imported from neighboring countries during the lean seasons. Imports of power are continuously rising: from 183.8 GWh in 2001, imports of power increased to 904.3 GWh in 2011.

In Lao PDR, off-grid rural electrification is the preferred options in cases where grid extension is not cost effective. Mini-grids are also seen as a good option to integrate other sources of renewable energy in Lao PDR, such as solar PV.

2 Description of the technology

Rural electrification is both addressed through the extension of the National grid system and through the development of local mini-grids in Lao PDR. A model for the development of mini-grids has been developed as Nationally Appropriate Mitigation Actions (NAMA) in Lao PDR. The NAMA focuses on the implementation of mini grid solutions based on renewable energies.

Mini-grids are integrated energy infrastructure with loads and energy resources. The core functionalities for mini-grid technologies are: power generation; power storage; control, manage and measure (CMM); convert and consume. Mini-grids can be categorized based on their connection to the grid and the level of service provided. A renewable mini-grid can be interconnected to the main grid or independent from neighboring grids, in which case it is considered autonomous. Renewable mini-grids can provide different levels of service, from basic services such as only lighting to higher levels of service, such as satisfying commercial energy demand.

Types of mini-grids¹⁵

	Lower tier of service	Higher tier of service
Autonomous	<p>Autonomous Basic (AB mini-grids) Generation Sources: PV, hydro and biomass Tier of service: Less than 24-hour power End-users: Remote community without major commercial or industrial activity Added value: > Enable enhanced energy access</p>	<p>Autonomous Full (AF mini-grids) Generation Sources: PV, hydro and wind Tier of service: 24/7 power End-users: Remote communities with major commercial or industrial requirements; industrial sites disconnected from grid Added value:</p>

¹⁵Innovation outlook, renewable mini-grids, IRENA, 2016

	<ul style="list-style-type: none"> ➤ Alternative to grid-extension ➤ Improve quality of life ➤ Cost savings 	<ul style="list-style-type: none"> ➤ Alternative to expensive polluting imported fuels ➤ Diversification and flexibility of supply ➤ Cost savings
Interconnected	<p>Interconnected Community (IC mini-grids) Generation Sources: PV, wind and biomass/biogas Tier of service: High critical/interruptible End-users: Medium to large grid-connected community, such as university campus Added value:</p> <ul style="list-style-type: none"> ➤ Community control ➤ Improved reliability ➤ Response to catastrophic events ➤ Cost savings 	<p>Interconnected Large Industrial (ILI mini-grids) Generation Sources: PV, wind and biomass/biogas Tier of service: Very high: Critical/uninterruptible End-users: Data centers, industrial processing or other critical uses Added value:</p> <ul style="list-style-type: none"> ➤ High reliability for critical loads ➤ Enhance environmental performance ➤ Resiliency

A key element of the NAMA is its focus on providing key conditions for the creation of income-generating opportunities in rural areas and on the involvement of the private sector as much as possible in the delivery of mini-grids. The sectors identified for the NAMA include rural productivity zones, public buildings and literacy centers.

Most of the potential mini-grids identified in Lao PDR are based on hydro-power generation, hybridized with solar PV and / or diesel.

3 Justification

Connecting isolated communities in rural Lao PDR to the grid may be more expensive than setting-up mini-grids based on the production of renewable energy.

Additionally, although the main grid runs mainly on hydro-power generation, domestic facilities are not able to cover domestic demand for power all year round which leads to the importation of energy throughout the year. This adds to the cost of energy in Lao PDR.

Moreover, setting-up mini-grids in rural areas enables to reach out quickly to potential productivity zones and to prepare a tailored energy system and the infrastructure which will provide power for a range of activities leading to income enhancement. This leads in turn to the repayment of the investment and of operation and maintenance costs for the infrastructure. This also has important social co-benefits in terms of education and health.

4 Rationale

In the absence of the development of mini-grids, isolated rural villages would rely on fossil fuel-based off-grid electricity generation systems only. This would lead to GHG emissions under the baseline scenario. The climate rationale to install mini-grid system is therefore to limit the increase of GHG emissions in rural areas.

5 Concrete application of the technology

Sunlabob, a private Laotian company licensed in 2001 and a member of the Alliance for Rural Electrification (ARE), provides commercially-viable energy services for remote off-grid areas. Sunlabob provides a range

of products such as solar PV systems, solar heaters, lighting systems, and hybrid systems, among others.

One of Sunlabob's mini-grid systems combines a 12 KW small hydro generator with a 2kWp PV system and a 15 kVA diesel generator. The mini-grid mainly operates on the hydro generator and feeds 105 households with a daily peak load of 8kW, for 3-4 hours per day. The system works almost entirely on renewables, since the energy from hydro and solar PV is large enough to cover the needs. Hydro power covers night loads and solar PV covers the dry season. The diesel generator mainly covers any unexpected demand.

For this system, Sunlabob has designed a PPP in which public partners financed the fixed assets, such as the public infrastructure and village grid. The ownership has been transferred to the village community, and Sunlabob only financed moveable assets. The company is therefore responsible for the power generation system and charges a fee to each household based on its consumption. The company employs two villagers to operate the system and collect the fees.

This helped Sunlabob to reduce their administrative costs and increase their efficiency since the salaries of these employees is linked to the fees they collect. Even though the mini-grid is officially owned by the villagers, the maintenance is also carried out by Sunlabob. Through this project Sunlabob has committed itself for a 25-year PPA with the village. The internal rate of return¹⁶ (IRR – a metric used to evaluate the attractiveness of a project or investment) of the project is estimated at approximately 15 per cent.

Sunlabob experienced a number of challenges during implementation. The rise in demand for electricity did not happen as expected by the project developer. This resulted in the non-optimal performance of the system, and hence the commercial viability of the project suffered. Moreover, the power generated from the mini-grid system was costlier than grid power. This resulted in dissatisfaction among consumers.

As the demand originally planned has been overestimated by the Sunlabob, the company expects to eventually connect the mini-grid to a grid from a larger utility. The utility will be able to use the local provider as additional generation capacity, while end-users will benefit from a subsidized social tariff that exists for grid users. Finally, Sunlabob will be able to increase its revenues by using the full capacity of its installations and sell the surplus to the utility.

6 Enabling factors

Some of the enabling factors for this technology and approach to be operational in Lao PDR include the following:

- *Earlier experiences with mini-grid approaches:* Existence of early adopters (donor supported projects and private based) to support the business case.
- *Financing and support instruments for rural electrification:* Lao PDR has established a number of schemes to support managing the costs of rural electrification services and projects.
- *Policy factors:* Lao PDR has established a very supportive tax environment for rural energy/renewable energy projects.
- *Economic factors:* At the proposed cost, mini-grids are less expensive than connecting to the main grid.

7 Gaps needs and challenges

¹⁶ The Internal Rate of Return (IRR) is the discount rate that makes the net present value (NPV) of a project zero. It is the expected compound annual rate of return that will be earned on a project or investment.

Some of the gaps related to implementing the NAMA include the following:

- *Policy gaps:* the Electricity Law in its current form does not address rural off-grid electrification projects.
- *Market risks:* The rise in demand for electricity may be complex to forecast and might result in non-optimal performances of the system.
- *Economic factors:* At the proposed tariff, the power generated from the mini-grid system may be costlier than grid power.
- *Organizational risk:* Sole ownership by a private entity may present risks too high for the private sector to engage.

8 Sustainability and exit strategy

Some of the strategies used to ensure the sustainability of the technology and approach in Lao PDR include a clear targeting of the markets where the mini-grids are installed. For example, the NAMA has identified pilot sites which all include economic activities with a potential for growth and therefore for a growing demand in power. This type of economic activities lead to income streams being generated, which in part goes into paying the investment, ensuring the sustainability of the mini-grid.

9 Stakeholder analysis

9.1 Lead agency and partners

The NAMA is implemented under the supervision of the Government of Lao PDR, through the Ministry of Mines and Energy, which oversees its activities, approves the eligibility criteria for the interventions and supervises financial flows.

9.2 Role of the Government

The Government oversees all activities under this NAMA and leads all interventions. This includes the promotion of private sector engagement in the operation of mini-grids, approving application for funding, developing technical standards for equipment and installations used under the NAMA and providing capacity development for mini-grid operators, engineering companies and equipment suppliers, among others.

9.3 Role of the private sector

The private sector takes the lead in installing and operating mini-grids.

9.4 Role of donors and international organizations

Donors and international organizations, such as the NAMA facility and UNDP provide technical assistance and financing for the implementation of the NAMA. NAMA donors are expected to contribute to 90 per cent of the investment costs, USD 90,000 for an additional fund and to the majority of funding for capacity building.

10 Opportunities

The proposed technology and approach introduced bring the following opportunities:

- Costs for electrification significantly decrease;

- Additional opportunities for the development of renewable energies that will complement hydro power generation, such as solar PV and biogas;
- Additional revenues generated by zones electrified;
- Additional opportunities for the private sector in the energy sector.

11 Relevance to Palestine

11.1 Relevance to the Palestinian context

Although Lao PDR uses much more renewable energy than Palestine and Palestine's electrification rate is higher than Lao's rate, the case study is relevant to the Palestinian context. Both countries rely on energy importations from neighboring countries. The case study shows how renewable energy can be integrated in mini-grids.

In Palestine, the integration of renewable energy into the main grid is complex because of the grid's specifications and of the grid operator requirements. Mini-grids could therefore represent an alternative to provide energy for productive sectors, such as agriculture, without being constrained by the limitations of the grid or of the operator. This may be especially feasible for small communities and villages of less than 50 households, which are not electrified due to Israeli restrictions.

It is also important to emphasize that the main grid in Palestine require upgrading to accommodate renewable energies. Adopting mini-grid practices could thus enable Palestine to achieve cost savings on updating the grid.

This would also enable Palestine to decrease its GHG emissions, which are not currently under its own control. On the long term, the power generation capacity of mini-grids could also be integrated in the main grid.

11.2 Linkages to Palestine's NDC

This case study is strongly linked to Palestine's NDC, as renewable energies including hybrid applications, have been prioritized to reduce energy import and provide reliable energy supply.

11.3 Co-benefits

Using mini-grids and renewable energy in Palestine will bring various co-benefits.

Sector	Co-benefits
Mitigation	<ul style="list-style-type: none"> ● Cost savings of imported energy ● Increased energy security ● Less exposure to shocks in international energy markets ● Improved balance of payments
Financial/ Economic	<ul style="list-style-type: none"> ● Reduction in need to upgrade the transmission grid and therefore cost savings ● Reduction in losses and theft of electricity
Social benefits	<ul style="list-style-type: none"> ● Income generation ● Job creation

Environmental	● Improved air quality
Health	● Health (human and environmental) benefits from improved air quality

11.4 Acceptability

Considering that Palestine electric network suffer from power shortage, limited capacity, and relatively old components. The case study is highly valuable to support Palestine overcome its electric grid problems. Installing such systems will help in electrifying distant small communities, and provide increasing load in specific areas with electricity without an expensive investment in the grid.

11.5 Economic feasibility

In Lao PDR, the investment required to kick-off the development of mini-grids has been financed through grants, concessional loans and commercial finance. In addition to this, the NAMA focused on providing funds to cover risks of customers not paying their bills. The fund also aims at bridging the gap between the costs/kWh in the specific mini grid and the electricity tariff charged by the national grid operator to the different classes of consumers.

Investments for each mini-grids in Lao PDR were estimated at USD 100,000. Annual costs per kWh generated amount to approximatively USD 0.13.

In Palestine, as mentioned above, most of the energy is imported and upgrading the grid may require significant financing. The government buys energy from Israel at a price of approximatively USD 0.11 per kWh .The electricity is then sold USD 0.17 per kWh. Given diesel generation costs, the price per kWh could be set higher than this for mini-grids, but should not be set too high compared to the main grid. Developing mini-grids based on renewable energy for productive sectors, such as agriculture, may result in cost savings for the consumers compared to the main grid.

11.6 Potential replicability and scalability

The illustrated case study can be replicated in Palestine, especially to support small communities in keeping their lands against Israeli pressure, especially in households which are kept away from the grid.

11.7 Transferability to the country

Depending on the type of mini-grids, the technology does not require any complex technology transfer. Although experience in mini-grids in the Middle East is still limited, mini-grids are well known technologies, which start to be mature technologies for autonomous mature basic services in some markets.

11.8 Possible occupation related challenges

The proposed solution seems to be suitable for the Palestinian situation. Israel usually has objections against connecting new power generation systems to the grid. However, in this situation, mini-grids are isolated from the main grid. However, Israeli occupation might prevent or at least obstruct installing such systems in area C.

11.9 Potential for a pilot

In Lao PDR, the technology was introduced through the implementation of pilots. A similar approach is proposed to be followed in the case of Palestine.

8. Energy – Energy efficiency in buildings (Armenia)

Armenia is a small, poor, land-locked country in the heart of Eurasia, and is highly vulnerable to the impacts of climate change. Unsustainable energy use in buildings underpins Armenia's closely intertwined development, security and climate-related challenges.

1 Background

Energy poverty is a stringent challenge in Armenia. Average electricity tariffs for residential customers increased by a factor of 1.8 between 2008-2014, and natural gas tariffs by a factor of 2.6 between 2007-2014. A decision on 17 June 2015 by the Public Services Regulatory Commission to raise electricity prices further by 17-22% led to protests in Yerevan and other cities. The extensive unrest demonstrates the significance of fuel poverty and has raised the issue to the top of the Government's agenda.

The buildings sector is one of major energy consumers in Armenia. According to the 2010 GHG inventory, almost 28% of primary energy resources are consumed in buildings, mostly in the residential sector. Due to Armenia's continental climate, with a long heating season and average winter temperatures around -5°C, energy consumption and GHG emissions in the Armenian building sector are primarily associated with space heating.

Armenia's UNFCCC Technology Needs Assessment (2003) identifies heat supply to buildings as one of the main sources of GHG emissions and as having a large potential for energy saving and emission reduction.

Improving energy efficiency (EE) in the building sector has been assigned a high priority in Armenia's climate, energy and housing strategies. In particular, achieving thermal modernization through energy efficiency retrofits is outlined as a national development priority, particularly for multi-apartment buildings.

2 Description of the technology

Achieving energy efficiency by targeting only new buildings would take several decades. In most countries, residential buildings and commercial buildings have been built before the development of energy efficiency codes, if any available. Retrofitting older buildings, rather than re-building them, may be the only sustainable path, both economically and environmentally, to reduce the energy footprint of the buildings in some countries.

Retrofitting includes a variety of technologies, which can be installed after the building has been built. Those include installing energy efficient heating, ventilation, and air conditioning (HVAC) systems; LED lighting; and building controls that can help building managers lower the levels of energy consumption of building systems.

Retrofits often involve the following key steps:

1. Energy audit of the building: the energy used in the building is analyzed. It is required to understand how energy is consumed in the building and allows a target approach for all processes and technologies.
2. Building simulation: This allows to compare the energy performance of the building under a number of design options, including with LED and HVAC. This information enables to select the best cost-efficient option.
3. Installation and monitoring

The strategies, technologies and equipment used for retrofits depend on the specific situation of a city and a building. Some technologies used may for example include:

- Energy efficient insulation for outer walls: Insulation refers to an energy savings measure, which provides resistance to heat flow. Naturally, heat flows from a warmer to a cooler space. By insulating a house, one can reduce the heat loss in buildings in cold weather or climate, and reduce the heat surplus in warmer weather or climate. Wall, roof and floor insulation may be done by fixing insulation material to the wall, roof or floor, either on the inside or outside, e.g. by using insulation plates¹⁷.
- Energy-efficient windows and doors: Windows and exterior doors have a large impact on the heating and cooling requirements of a building. New materials, coatings, and designs have led to significantly improved energy efficiency of new, high-performing windows and doors. Improved windows include multiple glazing, the use of two or more panes of glass or other films for insulation, and low-emissivity coatings reducing the flow of infrared energy from the building to the environment. Attention needs to be paid not only to the window itself, but also to the window frame, which can significantly impact a window's insulation level¹⁸.
- Thermostatic valves for the heating system: The use of thermostatic valves in heating systems enables a more effective thermal balance not only within a single living unit, but within the whole building. The purpose of balancing is to guarantee the correct flow of water (flow rate) to the different terminals (radiators, fan coils and radiant panels), in order to obtain the optimal thermal yield in any situation.

The thermostatic valve head goes on top of the valve body. And as the room temperature changes, the valve head expands, adjusting a pin in the valve body so that it opens or closes. Expansion as the room heats blocks the valve body to receive less hot water into the radiator.

Contraction as the room cools opens the valve body to receive more hot water into the radiator.

3 Justification

The buildings sector is one of major energy consumers in Armenia. It not only leads to major costs for the country in terms of energy production and imports, but also to social unrest when the prices of energy increase. Providing solutions to this issue will not only support the achievement of climate goals in Armenia, but also the access to energy security for a larger number of people at the base of the pyramid.

4 Rationale

The buildings sector is one of major energy consumers in Armenia. According to the 2010 GHG inventory, almost 28% of primary energy resources are consumed in buildings, mostly in the residential sector. Globally, GHG emissions from the building sector have more than doubled since 1970 and now represent 19% of all global GHG emissions. Middle-income countries in Eastern Europe & Central Asia (EECA), such as Armenia, account for almost 40% of all non-OECD GHG emissions in the buildings sector.

5 Concrete application of the technology

United Nations Development Programme (UNDP) developed the De-risking and scaling-up investment in energy efficient building retrofits project in Armenia under the Green Climate Fund financing. The project aims at scaling-up investment in EE building retrofits in the cities of Armenia, and reducing the overall investment risk profile of EE building retrofits to encourage private sector investment and alleviate poverty.

The project has four main components:

¹⁷<https://www.ctc-n.org/technologies/insulation-buildings>

¹⁸<https://www.ctc-n.org/technologies/insulation-buildings>

- Component 1 - Establishment of building sector MRV: Robust MRV for the building sector established
- Component 2 – Policy de-risking: National, sub-national and local authorities adopt and implement an enabling policy framework for EE retrofits
- Component 3 – Financial de-risking: Access to affordable capital for EE retrofits provided
- Component 4 – Financial incentives: Affordability of EE retrofits for the most vulnerable households ensured through targeted financial incentives to building / apartment owners (directly or via private-sector ESCOs)

Investments in energy efficiency building retrofits face different risks and barriers for each building category. The main building categories targeted in this project are public buildings (schools, hospitals, municipal / government offices) and, in the residential sector, individual houses and multi-owner apartment buildings.

These categories have been selected for this project due, on the one hand, to the specific barriers they face in investing in EE retrofits, the removal of which will increase the paradigm shift potential of the project; and, on the other hand, because the target population will include vulnerable groups such as low-income households.

Technically, the measures for residential buildings are **thermal cladding of outer walls, window replacement, roof insulation, and the use of thermostatic valves with hydraulic balancing**; for public buildings, measures will include **thermal insulation of walls, window replacement, roof insulation, new doors, efficient lighting (compact fluorescent or LED lighting), and the replacement of electrical heating systems with a natural gas heating systems** (where demand-side measures are addressed).

These measures reduce the need for heating or improve the efficiency of heating and lighting, thus saving energy and reducing GHG emissions by at least 50% compared to baseline. For each targeted building stock, a package of relevant policy and financial de-risking instruments will be implemented to address the specific circumstances and barriers in the country and in the targeted building sub-sector. This specificity will create an easily scalable model for subsequent replication of energy efficiency retrofits and market growth.

6 Enabling factors

Some of the enabling factors for this technology and approach to be operational in Armenia include the following:

- *Economic factors*: Compared to the cost of energy, cost-savings made from energy-saving measures are more interesting for the stakeholders. Energy costs constitute a large share of annual expenses incurred by public buildings.
- *Country ownership*: Improving energy efficiency in the building sector has been assigned a high priority in Armenia's climate, energy, and housing strategies.
- *Social awareness*: There is awareness within the population that saving money on electricity will also support a sustainable access to energy.
- *External support*: Financial support from the GCF to incentivize and de-risk investments in energy efficiency.

7 Gaps needs and challenges

Some of the gaps related to implementing the project include the following:

- At least one-fifth of households are not able to afford the upfront costs of EE retrofits.
- The Government of Armenia and municipalities are fiscally constrained in terms of available budgets necessary to invest in public building EE retrofits.
- Whilst some local banks provide credit lines for building EE investments, there is an overall lack of depth and history in the local capital market for finance products in EE building retrofit finance.

8 Sustainability and exit strategy

Some of the strategies used to ensure the sustainability of the technology in Armenia include the development of an enabling environment for the involvement of the private sector. Long-term sustainability of the project is embedded in the project design, which aims at overcoming systemic barriers and creating market conditions for energy efficiency investment.

The project will create a favorable market environment and scalable business model for investment in energy efficiency retrofits, leading to sizeable energy savings and accompanying GHG emission reductions. It will address legislative barriers, put in place arrangements for long-term sustainable provision of affordable finance for EE building renovation and kick-off the market by providing initial investments.

It will catalyze additional private and public sector financing of approximately USD 100 million.

9 Stakeholder analysis

9.1 Lead agency and partners

The leading agencies for this project are the executing partner in Armenia, the Ministry of Nature Protection (MoNP), and the Accredited Entity (AE), UNDP. MoNP is responsible for managing the project, including the monitoring and evaluation of project interventions, achieving project outcomes and for the effective use of GCF and UNDP resources. MoNP works closely with the Municipality of Yerevan.

UNDP provides oversight and quality insurance.

9.2 Role of the Government

The Government oversees and manages all activities under this project and leads all activities. The Government and the municipality of Yerevan are actively involved in the development of the enabling environment for a stronger involvement of the private sector.

9.3 Role of the private sector

The paradigm shift potential for the proposed project lies in the project's focus on the private sector as the driving force for investment and implementation of EE retrofits, as opposed to current models which are primarily based on (scarce) public finance and lack repayment mechanisms (i.e. accumulated energy savings are not monetized and stay with building owners).

9.4 Role of donors and international organizations

The GCF provides financing for the project. UNDP provides oversight, technical assistance and financing for the implementation of the project.

10 Opportunities

The proposed technology and approach introduced bring the following opportunities:

- The capacity that will be built in Government and in financial institutions for encouraging and financing EE retrofits will enable the development of a market that will continue to exist beyond completion of the intervention.
- New market developed for retrofits in Armenia, with new business opportunities.

11 Relevance to Palestine

11.1 Relevance to the Palestinian context

This case study is highly relevant to the Palestinian context. In Palestine, buildings consume 34,061.68 Tera-joules per year, which constitutes approximately 43 per cent of the total energy consumption per year¹⁹. Palestine total electrical energy consumption reached 3324 GWh in 2010, which equals 70 per cent of the Palestinian national electrical consumption. This number is expected to double by 2020, while it will keep the same proportion of the national electrical consumption²⁰. At the same time, buildings and construction is the fastest growing sector in Palestine, with 2585 building licenses issued in the last quarter of 2017 in the West Bank. 82 per cent of Palestinian families use energy for heating purposes. These number emphasize the important of energy consumption, and thus energy efficiency, in Palestine.

The Palestinian Energy and National Resources Authority (PENRA) set an indicative target in energy efficiency and rationalizing electric energy consumption by end user that aims at achieving 5% saving in overall electricity demand by 2020. Approximately 95 per cent of energy saving are targeted at buildings. Despite the development of this target, the efforts towards developing Palestinian buildings and constructions codes and standards are still insufficient.

As most buildings in Palestine have been built without compliance to Energy Efficiency standards, retrofits are a good option to encourage energy efficiency at the least-cost possible.

11.2 Linkages to Palestine's NDC

This case study is strongly linked to Palestine's NDC, as energy efficiency has been identified as one of the priority interventions for mitigation. Some of the actions identified are:

- 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

11.3 Co-benefits

Improving energy efficiency practices in Palestine will bring various co-benefits.

Sector	Co-benefits
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¹⁹Mohammed F. Alsayed, Rawan A. Tayeh, Life Cycle Cost Analysis for Determining Optimal Insulation Thickness in Palestinian Buildings, 2018

²⁰Mohammed F. Alsayed, Rawan A. Tayeh, Life Cycle Cost Analysis for Determining Optimal Insulation Thickness in Palestinian Buildings, 2018

Mitigation	<ul style="list-style-type: none"> ● Reduction in energy use (less GHG emissions) ● Reduction in imported energy (less GHG emissions)
Financial/ Economic	<ul style="list-style-type: none"> ● Cost savings (reduction in energy use, reduction in imported energy) ● Potential for the creation of new businesses
Social benefits	<ul style="list-style-type: none"> ● Energy security ● Job creation
Environmental	<ul style="list-style-type: none"> ● Reduction of air, water, and soil pollution
Health	<ul style="list-style-type: none"> ● Reduction of health problems of citizens (Improved temperature regulation)

11.4 Acceptability

Some of the measures are highly feasible and acceptable. For example, in Palestine, there are no mandatory standards for insulation yet. Although building insulation helps in reducing space heating and running costs, it also increases the initial investment for buildings. However, considering that the average Palestinian energy prices are among the highest internationally compared to local average individual income, energy retrofits in buildings should be highly acceptable in Palestine.

11.5 Economic feasibility

In Armenia, the average cost for single-family individual buildings has been set to USD 10,000, while multi-family apartment building retrofits had a cost of USD 120,000. Although this is a significant investment for families and building owners, this could be replicated in Palestine with concessional financing and the development of an enabling environment, such as regulations requiring compliance. It is important to emphasize that the level of interventions, and thus the cost, may change depending on the specific needs of Palestine, which may be slightly different from Armenia.

Given energy costs in Palestine, technologies aiming at achieving energy savings are likely to achieve higher benefits compared to their costs.

11.6 Potential replicability and scalability

Given the number of building in Palestine and level of energy imported, the technology appears replicable and scalable in Palestine.

11.7 Transferability to the country

The technology does not require any complex technology transfer. Energy efficiency technologies are well known and could be transferred to Palestine. Formulating the relevant policy environment for energy efficiency, which define the standards for each buildings, will be extremely important to support the transfer and replicability of the technology in the country. It will also be important to design incentives that support the development of the market, while they should not become a burden on public finances.

11.8 Possible occupation related challenges

Given that retrofits would target existing buildings in Palestine, there are no specific occupation related challenges identified to this date.

11.9 Potential for a pilot

In Armenia and other countries, energy efficiency technologies have been introduced through the implementation of pilots. A similar approach is proposed to be followed in the case of Palestine.

9. Wastewater – Anaerobic treatment of wastewater and optional production of energy and reuse of treated wastewater (Philippines)

Wastewater management is a major challenge in Philippines, especially in Makati City, a first class highly urbanized city in Metro Manila. Innovative models for anaerobic treatment of wastewater, optional production of energy, and reuse of treated waste water have been proposed as a solution to this issue.

1 Background

Metro Manila improperly disposes of about 2,000 cubic meters of solvent wastes, 22,000 tons of heavy metals, infectious wastes, biological sludge, lubricants, and intractable wastes, as well as 25 million cubic meters of acid/alkaline liquid wastes every year (UNIDO, 2015). As a consequence, waterborne diseases remain a severe public health concern in the country, and about 4,200 people die each year due to contaminated drinking water (Environmental Management Bureau Region 3, 2015). Wastewater treatment plants currently operating in the Philippines release significant amounts of methane, among others, in the atmosphere as well as malodors, thus they do not constitute an environmentally acceptable and a sustainable solution. The technology presented below allows to tackle these issues by significantly decreasing the amount of methane released in the atmosphere and collecting the biogas to generate electricity for on-site use.

In the Philippines, water supply and sewage treatment falls under the responsibility of different agencies, both public and private. The Department of Environment and Natural Resources (DENR) is in charge of the activities related to wastewater management across the country. It is mainly responsible of the compliance, monitoring, regulating wastewater discharge, issuance of discharge permit, monitoring of effluent and ambient water quality. Maynilad Water Services Inc. and Manila Water Company, Inc., are the two private concessionaires that are supplying metropolitan Manila's water needs. These two concessionaires abide by the Clean Water Act of 2004 providing for a comprehensive Water Quality Management and constantly follow discharge parameters and environmental regulations enforced by the DENR. They are also maintaining the region's sewage treatment and have established the only organized network of sewers in the Philippines. Given that on national level, the responsibility for wastewater disposal is given to consumers, these two concessionaires are running the best sewage treatment plants in the country. Through this project, the concessionaires aim to upgrade and improve the existing, standard setting, sludge management systems. On the long term, this project aims to point out how the Philippines may develop to improve its wastewater treatment capability and promote further sustainable development at the national level.

2 Description of the Technology

The issue of wastewater management in Makati City is addressed through the installation in existing sewage treatment plants of a Covered In Ground Anaerobic Reactor (also called CIGAR®) and the capture and utilization of biogas for electricity generation.

➤ Sewage treatment plant

Wastewater coming into the sewage treatment plant involves a primary sedimentation process to separate the solids from the supernatant stream. The predominantly low solids liquor then flows to a secondary treatment stage, called activated sludge process, which generates a biological sludge. The treated effluent is then discharged to watercourse after being treated with chlorine.

The high solid sludge stream is treated in a parallel process, which generates a significant volume of biogas every day. The sewage treatment plant sludge management includes three components:

- Two anaerobic digesters, which are designed to stabilize the sludge, reduce odor and organic volatility, and generate biogas (high concentration in methane).

- An open settling tank used to hold sludge after release from the anaerobic digesters, and prior to treatment in the drying beds.
- Open drying beds, where the stabilized wet solids are dried in the open during the dry seasons, and under cover during the rainy season. This can be used as soil conditioner or fertilizer, and is often removed by farm owners.

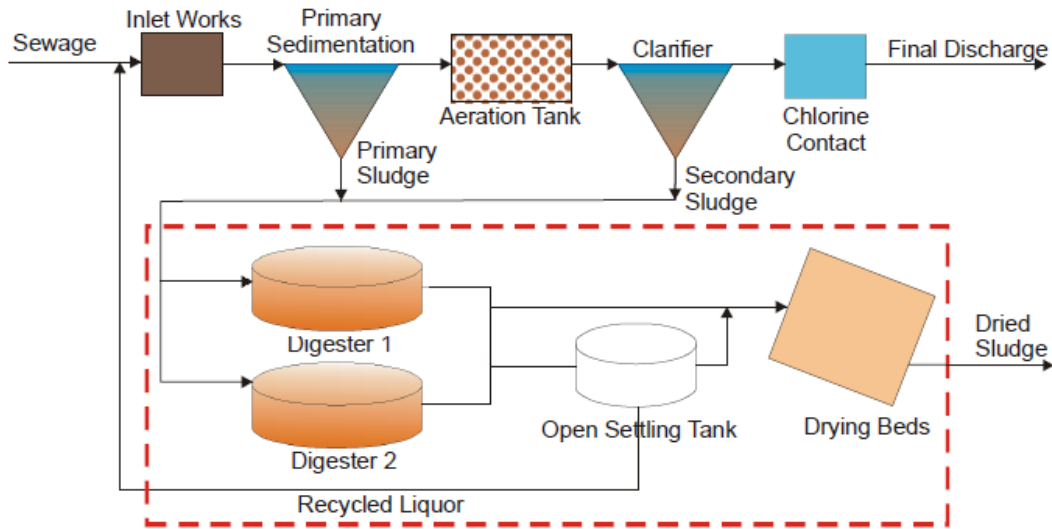


Figure 8 Sewage Treatment Plant layout

➤ Covered In Ground Anaerobic Reactor (CIGAR®)

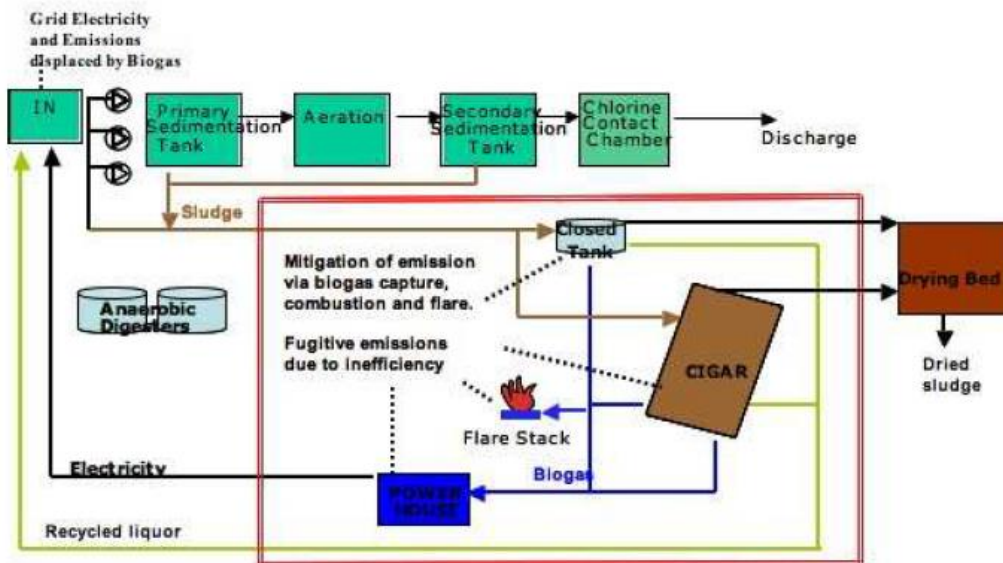


Figure 9 Plant layout including CIGAR system

CIGAR is an alternative sludge treatment system that enables to recover methane gas emissions from existing digestion tanks, and open settling tanks, that continuously emit methane. It replaces the existing sludge treatment system. The anaerobic reactor breaks down the organic components of the sludge in the

absence of oxygen in a highly efficient process. High density polyethylene (HDPE) liners and covers are used during the construction of a bioreactor to provide a gas seal and ensure the full integrity of the system. This technology can reduce biochemical oxygen demand and chemical oxygen demand by as much as 95% and biochemical oxygen demand by 80%, converting the biodegradable carbon compounds to carbon dioxide and methane (biogas). It also reduces the suspended solids, color and dissolved solids.

CIGAR functions as a bio-treatment facility, equalization tank and gas holder. The low solids effluent from CIGAR is returned to the inlet works of the sewage treatment plant and fed back to the plant treatment process. Then, it passes through screening, primary sedimentation, secondary treatment and disinfection with the incoming sewage.

In addition to the reactors, the existing open settling tank is retrofitted in order to ensure the collection of biogas. Collected biogas can be used to generate electricity for the sewage treatment plant operation.

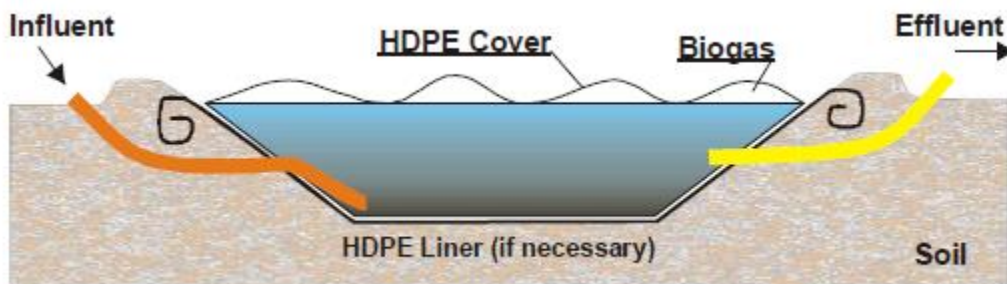


Figure 10 CIGAR layout

3 Justification

The implementation of this technology supports the Philippines in meeting its sustainable development goals (SDGs) as stated in the Philippines Agenda 21, including the below:

- Introduction of the latest technology both in sludge treatment and in renewable energy generation will be demonstrated and will act to drive replication throughout the country's water industry as well as in the Asian region;
- Energy self-sufficiency is increased with the use of renewable and indigenous energy resources, which correspondingly decreases dependence on imported fossil fuels;
- Environmental protection is improved by the capture of fugitive GHGs, specifically methane and reduction in the pollution load of potential leachates that would otherwise pollute ground and surface water;
- A New Financial Mechanism for funding in the renewable energy and waste management sectors via the Clean Development Mechanism (CDM) improves the financial viability of marginal projects (see below);
- A healthier and safer work place is developed, with improvements in local air quality, odor and the control of combustible methane emissions.

Over 90% of the generated septage in the Philippines remains untreated, most of the households have their own septic tanks, which are being emptied by septic haulers who dispose the collected septic waste in the waterways of the city. This is the cause of a number of issues, such as health hazards and the pollution of water sources. Using the technology helps reducing the risk of pollution of water sources.

In addition, traditional sewage treatment plants emanate malodorous gases, which would be reduced by implementing this technology.

Due to the highly unreliable power supply in Makati City, the local community has to run emergency diesel generators during the frequent power cuts. The implementation of this technology also allows the production of energy with the biogas system and supply the local community during the power cuts.

4 Rationale

Existing sewage treatment plants lead to GHG emissions, mainly methane (CH₄), and odors. Additionally, it causes severe health and environmental problems and represents a missed opportunity from a development perspective, as biogas can be used as a potential source of energy.

5 Concrete Application of the Technology

The Makati South Sewage Treatment Plant was established in 1960's, and has been serving municipal wastewater generated by around 700 hectares of residential and commercial districts of Makati City. It is estimated that approximately 900m³ of sludge with a chemical oxygen demand of 20,770 mg/L is treated anaerobically on a daily basis. The Makati South Sewage Treatment Plant is the largest operated by Manila Water Company, Inc..

In this project, the technology has been only applied to the existing current sludge treatment system of the already existing sewage treatment plant. The CIGAR system optimizes the biogas recovery process from the degradation of sludge. Biogas contains about 65% methane by volume, while the remainder is almost entirely carbon dioxide, also including some traces of hydrogen sulphide, nitrogen, mercaptans, etc. The CIGAR process will capture the biogas, which is used to generate electricity for use on-site. Three units of biogas fuel 300kW engines, which produce 1,990MWh of electricity per year, which is enough to satisfy the energy requirements of the sewage treatment plant.

By the third year of operation, it is estimated that there will be sufficient biogas to operate an additional 100kW engine.

Under the scope of this model, any electricity produced that exceeds the demand of the site will be sold to the closer community, Magallanes Village. On the long term the plan is to sell the surplus energy to the national grid, once a viable mechanism is established.

The project is estimated to reduce GHG emissions by an average of 28,729 tCO₂e per year.

The project experienced several financial barriers before obtaining the necessary funding. As the existing sludge treatment system in the sewage treatment plant is already above DENR standards, its upgrade did not constitute a priority for public and private finance. Sewerage provision in the Philippines is limited and the available investment finance to the Manila sewage concession is dedicated to the expansion of the existing networks. Local banks were not interested in financing this project mainly because of a lack of knowledge and experience with the technology.

The Government of the Philippines also declined to accept the risk and invest in this project, because of the perceived risks. The project included construction risks and risks associated with the ongoing management of a biogas system that required skilled management. In addition to these risks, the project also constituted a significant technical challenge, as that the project had to be retrofitted onto a 1960's vintage sewage treatment site, located in an area with a limited land availability.

The project developer then approached an international investor to invest in the project, Trading Emissions PLC (TEP), whose mandate is to invest in Certified Emission Reductions (CER) generating opportunities. The use of the CDM scheme for this project was the key element that led TEP to accept to invest 100% of the required capital for this project, through the SPV established for the investment,

Magallanes BioEnergy Corporation, with a build-operate-transfer (BOT) based contract. The Project would not have been able to meet TEP's investment hurdle without CERs. TEP's internal hurdle rate for this kind of investment encompasses risks such as country and technology risk. TEP acquired access to CER via an Emissions Reduction Purchase Agreement (ERPA).

6 Enabling factors

Some of the enabling factors for this technology and approach to be operational in the Philippines include the following:

- *External support:* the Clean Development Mechanism. The project was only possible due to incentive created by the CDM, which allowed the operator to conduct the whole project without any risks or financial commitment, thus without any repercussions on the water bills.
- *Organization capabilities:* Manila Water Co., Inc., operator of the sewage treatment plant, was aware of the issues related to malodor and air pollution caused by the sewage treatment plant and decided to act by upgrading it,
- *Engineering capabilities:* The participation of Magallanes Bio-Energy Corporation and Philippines Bio-Sciences Co., Inc., the two companies contracted for the project design and engineering made the project possible.

7 Gaps needs and challenges

Some of the challenges met by this technology and approach to be operational in the Philippines include the following:

- Lack of technical know-how of the local operators, which held back the development similar projects in other sewage treatment plants across the country.
- Constant risk of chemical reactions, especially in Manila, where the disposal of industrial and commercial waste include engine oil, paint and other substances, and that can have dramatic negative effects on anaerobic digestion activities.
- The technology is more expensive than the conventional sludge treatment system, as open air settling of septic sludge costs less since it can be done through the use of locally manufactured steel tanks.
- Lack of social awareness. As this project is not a common practice in the Philippines, there is a lack of awareness and knowledge from local communities, who were skeptic at the beginning.
- Lack of national investors. As the plant had already passed national standards, its upgrade was not perceived as a priority. The plant was seen as being above industry standards. In addition, the Government refused to invest in the project due to perceived risks, including project construction risks and risks associated with the ongoing management of a biogas system that required skilled management. One of the most significant technical challenges is that this project had to be retrofitted onto a 1960's vintage sewage treatment site, located in an area with limited land availability.
- National policies and regulations. Since the already existing sludge treatment system was already above the DENR standards, the need for an upgrade with a provision for methane recovery and electricity generation was not a priority for the DENR. As the available budget for sewage is limited in the Philippines, it is mainly used for the expansion of the existing network. The priority is given to water supply investments that bridge the significant gap in unserved demand for safe and reliable water over sanitation investments. This led to a delay between project first proposal and its implementation (4 years).

8 Sustainability and exit strategy

Some of the strategies used to ensure the sustainability of the technology in the Philippines include the development of an enabling environment, which includes policy support, economic and health benefits, as well as the guarantee of a good and high quality technology.

9 Stakeholder analysis

1.1 Lead agency and partners

This project is implemented under the supervision of Manila Water Co., Inc., operator of the sewage treatment plant. Magallanes Bio-Energy Corporation (special purpose vehicle for the investment) and Philippines Bio-Sciences Co., Inc. are the two companies in charge of the project design and engineering.

1.2 International financing scheme

None of the above companies took any risks or financial commitment for the implementation of this project, as the Clean Development Mechanism (CDM) enabled the provision of the financial incentives by providing certified emission reduction (CER) credits to this project. Trading Emissions PLC, an international investor whose mandate is to invest in CER generating opportunities, is the one who has invested 100% of the capital required for the project and bore all the financial risks.

1.3 Government of the Philippines

The DENR issued an amendment to the already existing Environmental Clearance Certificate, including the construction of a waste-to-Energy system, allowing the project to be implemented.

10 Opportunities

The proposed technology and approach introduced the following opportunities:

- Increase of energy self-sufficiency due to the use of renewable and indigenous energy resources, which automatically leads to the decrease in imported fossil fuels' dependence. At plant level, this leads to cost savings in energy and additional revenues when surpluses of energy are created and sold.
- Improved environmental protection by the capture of fugitive GHG, including methane, and reduction in the pollution load of potential leachates that would otherwise pollute surface and ground water.
- Development of a healthier and safer work place, with local air quality, odor, and control of combustible methane emissions being controlled.
- Reduce the need of local population to run emergency diesel generator during the frequent power cuts, as the grid supply is highly unreliable.

11 Relevance to Palestine

1.4 Relevance to the Palestinian context

This case study is highly relevant to the Palestinian context. Since the 2008-2009 Israel-Gaza conflict and the embargo on Gaza from Israel, the three existing wastewater treatment plants in Gaza are operating discontinuously, mainly due to the lack of electricity and fuel.

The West Bank is also facing a challenging situation, with four out of the five existing wastewater power plants are performing very poorly due to their poor efficiency and quality (World Bank, 2009). In small villages, there are no septic tanks and only cesspits are available.

The installation of the CIGAR system in the existing wastewater treatment plants could bring a continuous source of energy for the operation of plants, allowing their normal operation and preventing power shortcuts.

Moreover, the adoption of the Palestinian National Water Strategy from 2013 to 2032, emphasizes the importance of wastewater management and treatment in the Government policy, especially access to water and wastewater services, and sustainable wastewater management.

This would also enable Palestine to decrease its GHG emissions. This technology would enable Palestine to import less energy, by using biogas energy to run its wastewater treatment plants, and supply neighboring communities in electricity.

1.5 Linkage to Palestine's NDC

This case study is strongly linked to Palestine's NDC, as wastewater is one of the highly vulnerable issues identified, in both West Bank and Gaza Strip.

1.6 Co-benefits

Installation of a CIGAR system, retrofitting of the existing open tank, and biogas capture system in Palestine's wastewater treatment plants will bring various co-benefits.

Sector	Co-benefits
Adaptation (as per the NDC)	<ul style="list-style-type: none"> ● Reduction in energy import ● Reduction in ozone from methane ● Improved water supply
Financial/ Economic	<ul style="list-style-type: none"> ● Technological replicability in the whole country
Social benefits	<ul style="list-style-type: none"> ● Better working environment
Environmental	<ul style="list-style-type: none"> ● Water quality and quantity ● Air quality
Health	<ul style="list-style-type: none"> ● Reduction of health problems of citizens

1.7 Acceptability

While there are currently no similar practices in Palestine, water availability is crucial for Palestine. In small villages, there are no septic tanks and only cesspits are available, which makes the application of this technology preferable. Finally, the technology also allows to achieve cost-savings in power supply, as the installation of the CIGAR system in the existing wastewater treatment plants could bring a continuous source of energy for the operation of plants.

1.8 Economic Feasibility

In the Philippines, the implementation of the project was made possible only due to the utilization of the CDM scheme, but this was because neither the national Government, nor national investors were willing to take the financial risks and commitments.

In the case of Palestine, the government high awareness level shown by the adoption of the Palestinian National Water Strategy suggest that the Government would be willing to invest in this technology. If not, Palestine could follow the Filipino's example and request international support through carbon markets and climate finance mechanisms.

1.9 Potential replicability and scalability

Given the situation of water demand and wastewater management, and government awareness levels, the technology appears replicable and scalable to Palestine.

1.10 Transferability to the country

The technology itself does not require complex technology transfer, with the participation of a project developer in possession of the right technology, and already existing sewage treatment plant. In the Philippines, the project developer succeeded in retrofitting the technology onto a 1960's vintage sewage treatment site, into an area with a limited land availability, thus the technology appears to be transferable to Palestine.

As the Palestinian Government was able to obtain written consent from Israeli Authorities to allow the Palestinian Government to import all related equipment needed for the implementation of wastewater treatment plants, they seem transferable to Palestine. In addition, the Government obtained confirmation that Israeli Military Forces would not threaten this type of projects.

1.11 Possible occupation related to challenges

Limited challenges are expected as the Israeli Government granted consent to the Palestinian Government.

1.12 Potential for a pilot

Similar to this case study, Palestine could undertake pilot projects based on climate financing.

10. Transport – Upgrade of the existing vehicle fleet (India and Uganda)

The transport sector is essential to emerging and developing economies. However, growing fleets of old vehicles in emerging economies and developing countries also constitute a major source of greenhouse gas (GHG) emissions. For example, in Uganda, transport accounted for 64 percent of GHG emissions in 2011. Vehicle emissions (particulates) are a major contributor to poor air quality, particularly in urban areas, in addition to GHGs contributing to global warming and climate change.

In India, over the last decades, a growing middle class, demographic change, higher disposal income, higher ambition of consumers and easy financing have resulted in increase in vehicle ownership. India is adding close to 18 million vehicles annually and by 2020, India is expected to have a vehicle population of nearly 350 million registered vehicles. In parallel, this growth has contributed to a significant increase in overall GHG emissions.

This case study will look at the approaches implemented in India and Uganda to greening the automobile industry.

1 Background

India has added over 174 million vehicles over the last twenty years, with approximately 128 million of them being added in the last 10 years²¹. Road density in India is now nearly 1.42 km per sq. km²². Cities have witnessed increasing usage of private vehicles, as they are yet to develop adequate public transport systems to meet increased travel requirements. The share of buses has declined to 1.1 percent of all registered vehicles in 2011 while growth in two-wheelers and cars significantly grew across metropolitan cities.

Many cities in India have been ranked among the most polluted in the world. Emissions from vehicles are responsible for the majority of urban nitrogen oxide (NO_x) emission and 30 to 50 percent of particulate matter (PM) emission, in addition to significant hydrocarbon (HC) and carbon monoxide (CO) emission. The problem is exacerbated by the preference for diesel cars in India due to diesel subsidies. Many of the cities have air pollution levels far above the legal limit, and have been in non-compliance with the national standard for many years, and have no tangible plans to drastically improve air quality in the short-term.

In India, on average, cars are used for 15-20 years until they can no longer be driven²³. With a rapidly increasing population of vehicles and users, the National Green Tribunal (NGT) mandated the scrapping of 10-year old diesel and 15-year old non-diesel cars in Delhi. The NGT, established in 2010 under the National Green Tribunal Act, disposes civil cases relating to environmental protection and conservation of forests and other natural resources, including enforcement of any legal rights related to the environment²⁴. The Act was enacted through the Parliament of India, under the provision of Article 21 of the Constitution of India, which emphasizes the right to live in a clean and healthy environment.

With the new vehicle scrapping requirement, approximately 9 million vehicles are due for scrapping by 2020, and 28 million by 2030. Under the "Guidelines for Scrapping of Motor Vehicles in Delhi 2018", issued by the Delhi Transport Department, all impounded vehicles, including two-wheelers, will be sent directly to licensed scrap dealers for dismantling and a scrapping charge will be paid to the owner. In preparation for the introduction of this new mandate, in 2011, the Ministry of Heavy Industry launched a vehicle recycling

²¹Indian Automobile Material Recycling Management, International Journal of Innovative Research in Science, Engineering and Technology, 3(3), 2014

²²India Transport Report: Moving India to 2032, Vol. 1 Executive Summary, Government of India

²³ Indian Automobile Material Recycling Management, International Journal of Innovative Research in Science, Engineering and Technology, 3(3), 2014

²⁴ National Green Tribunal of India – an observation from environmental judgements, Environmental Science and Pollution Research, 2018, 25(12), page 11313 – 11318.

facility in Chennai to recycle and recover materials from old cars and used cars²⁵, which reached their end-of-life (EOL). In addition, a study on “Development of scientific recycling of end of life automobiles in India and the role of research and technology” was commissioned by the office of the Principal Scientific Advisor to Government of India. It studied the status of disposal of automobiles which had reached the end of life in India, current numbers, future projections and issues related to disposal²⁶.

A similar situation is seen in Uganda. Uganda is experiencing high rates of growth of vehicle ownership, with the number of newly registered vehicles having increased by almost three times in 2014 compared to 2012 levels. The share of the overall used/old passenger vehicle population in 2014 was around 66 percent (for diesel vehicles) and 95 percent (for petrol vehicles). Despite the introduction of the environmental levy by the Uganda Revenue Authority (URA) in 2009, the average vehicle age has been rising for all categories of engine capacity. Over time, the average age of diesel vehicles has increased from 8.1 years in 2005 to 16.4 years in 2014. The average age of petrol vehicles has increased from 10.4 years to 15.4 years over the same period. All these developments have led to a significant increase in GHG emissions from the transport sector.

Identifying the best possible response to the challenge of reducing CO₂ emissions from road transport is a major priority for Uganda. It is a key focus of the country’s ongoing policy development in the context of the 2030 Climate and Energy Framework and is also important in relation to the continuing international climate change negotiations. This has led to a proposed Nationally Appropriate Mitigation Actions (NAMA) to promote sustainable development in the energy sector through the implementation of a Fuel Efficiency Initiative (FEI) that includes the development of policies and regulations to promote the adoption of cleaner and more fuel-efficient vehicle strategies.

2 Description of the technology

The elements of the recycling of vehicles can be divided into three major steps: pretreatment, dismantling and shredding. During the pretreatment stage, the dismantler removes all hazardous parts and fluids²⁷. The fluids typically removed include engine oil, coolant, refrigerant, steering oil, washer fluid, anti-freeze, transmission oil, brake fluid, fuel, coolant and any remaining fuel. These fluids are either removed by gravity or using pumps and they are reused once stored in a tank or secondary containment.

At this stage, the dismantler typically also removes the tires, batteries, airbags and all parts presenting a potential hazard; this is called dismantling. The parts that can be recycled or reused in other vehicles are typically removed during this process. After that, the vehicle is typically crushed and is transported to the next step, the shredder. The shredder takes the compacted car through hammer mills. These hammer mills shred the vehicle. The metal recovered from these mills becomes raw material feedstock for steel mills, electric arc furnaces, aluminum and other non-ferrous metal smelters to manufacture a variety of products, including new vehicles²⁸.

The recycling of vehicles is usually complementary of the introduction of standards for running vehicles. Such an approach has been adopted by the NAMA on green transport in Uganda, which emphasizes the need of standards in improving and enforcing fuel efficient initiatives and vehicle strategies. For example, the NAMA in Uganda focused on the introduction of regulatory norms for vehicle emissions and on their enforcement. The NAMA encouraged the following interventions:

²⁵Old cars are defined as cars which are in the range of 10 to 15 years old, while used cars are defined as pre-owned (second hand) vehicles, usually with less than 10 years old.

²⁶Indian Automobile Material Recycling Management, International Journal of Innovative Research in Science, Engineering and Technology, 3(3), 2014

²⁷Indian Automobile Material Recycling Management, International Journal of Innovative Research in Science, Engineering and Technology, 3(3), 2014

²⁸ Automotive Recycling Industry: Environmentally Friendly, Market Driven, and Sustainable, Automotive Recyclers Association, Institute of Scrap Recycling Industries Inc., & Auto Alliance.

- **Import vehicle inspection:** The NAMA proposes the establishment of domestic import vehicle inspection sites in Uganda to confirm compliance with domestic standards;
- **Labeling:** The NAMA proposes that all imported vehicles are labelled for compliance upon completion of vehicle import inspection. Labeling provides consumers with a better understanding of fuel economies;
- **Periodic vehicle inspection:** Keeping vehicle GHG emissions in check requires that vehicles are subject to regular inspection that will guarantee that only vehicles emitting GHGs within prescribed limits are on the road. Additional elements have been added to the existing periodic vehicle inspection process, such as the recording of mileage, CO2 emissions and other GHG emissions values;
- **Introduction of fuel standards:** By improving fuel standards, significant emission reductions can be achieved;
- **Introduction of a vehicle age limit:** A vehicle age limit is a good proxy for vehicle emission level control, as manufacturers in the EU, USA and Japan are required to meet particular sets of stringent emission standards at particular periods of time;

Other technical interventions, such as the development of a vehicle recycling industry, vehicle assembly in Uganda and production of electric motor bikes are considered under the NAMA.

3 Justification

India and Uganda both face the challenge of securing safe transport, in terms of health and vehicle at an affordable price, while also having to reduce GHG emissions from the transport sector.

4 Rationale

A vehicle recycling industry will support the reduction of GHG emissions from road transport, by scrapping old vehicles that contribute to higher GHG emissions. The industry will also adopt recycling practices, by using used vehicles parts for other vehicles.

5 Concrete application of the technology (India)

The 340-acre facility in the south-west of Chennai, in Oragadam, was established in partnership between the Society of Indian Automobile Manufacturers (SIAM), National Automotive Testing and R&D Infrastructure Project (NARTRIP) and the Ministry of Heavy Industry. This facility was set up to help develop methods for its reuse and recovery when the vehicle reaches its EOL appropriate to India. The industry donated a large number of cars and two-wheelers to help to identify materials that are recyclable and reusable.

Findings from this facility supported the development of the first authorized vehicle recycling unit in Delhi in 2018. The five-acre facility was set up by Mahindra & Mahindra (M&M), a car manufacturing corporation, through a joint venture with government-owned company MSTC. M&M and MSTC have chosen an equal partnership to set up these recycling facilities under a joint-venture company called CERO. CERO acquires vehicles directly from owners and at auctions. The facility evaluates the vehicle and recycles steel, batteries, electronics, engine parts and other metals.

CERO handles the entire process from towing vehicles to dismantling, deregistration and recycling. The owner of the vehicle gets a certificate of destruction with details of the vehicle and the date of recycling. The owner of the car receives a price for the scrap depending on type, age and condition of vehicle. Owners also have the option of donating the vehicle to CERO, who, in turn, supports a Mahindra NGO dedicated to supporting in providing education to underprivileged girls. If donated, the NGO provides the owner 80G

certificate for tax exemption.

6 Enabling factors

The enabling factors for the establishment of a vehicle recycling industry in India include the below:

- *Economic factor:* the proposed solution offered new business opportunities and revenue streams for the private sector.
- *Access to alternative option:* The industry provides access to alternative source as inputs to other industries using metals that have been recycled or recovered instead of having to produce new metals.
- *Government support:* In preparation of the introduction of vehicle scrapping requirement, the Government of Delhi supported in the establishment of a demonstration facility to further understand the potential of this industry.
- *Industry support:* Strong support was provided by the industry in setting up and executing the demonstration facility operation, such as donation of large number of used vehicles.

The enabling factors for the adoption of the NAMA in Uganda include:

- *Economic factor:* The NAMA provides new employment and business opportunities through establishment of vehicle assembly plants, production of electric bikes, and vehicle recycling facilities.
- *Access to alternative options:* Vehicle recycling would provide another option to purchasing an old vehicle, by reusing parts from old vehicles and improving maintenance of the vehicle.

7 Gaps, needs and challenges

Upon setting the demonstration facility in India, the following barriers were identified:

- Unavailability of adequate collection systems for certain waste materials
- Lack of technology to cost-effectively separate and recover materials at high enough quality for recycling (separating and cleaning materials in high quality for recycling can be complicated and costly)
- Incompatibility of different materials
- Market value of recovered materials

For the proposed NAMA in Uganda, the following challenges were noted:

- Regulations are in place but they are not sufficiently enforced
- Lack of access to an alternative to old vehicles

8 Sustainability and exit strategy

In India, the proposed solution is carried out by the government in collaboration with the private sector participation. Additionally, a demonstration center was developed in support of this solution, in which key findings and barriers were identified and applied in the introduction of the scrapping requirement in Delhi. This solution supports the growth of the industry, as well as creation of job opportunities and long-term business opportunities.

In Uganda, the sustainability of the proposed solution is ensured by developing the enabling environment, such as policies and regulations for fuel, labeling and inspections. The NAMA also promotes private sector engagement in the recycling industry, which ensures better sustainability.

9 Stakeholder analysis (India)

9.1 Lead agency and partners

- **India:** The lead agency is the government of Delhi, working in collaboration with the industry group as well as the private sector. Vehicle recycling was proposed as a solution in addressing the estimated 200 million vehicle population in India and its related GHG emissions.
- **Uganda:** The lead agency of the implementation of the NAMA will be the Ministry of Energy and Mineral Development (MEMD) and the Ministry of Works and Transport (MOWT). They will be supervised and guided by the Supervisory Board consisting of key transport sector stakeholders, including the MEMD and MOWT, the Uganda National Bureau of Standards, the Ministry of Finance, Planning and Economic Development, the Ministry of Trade, Industry and Cooperatives, the Ministry of Water and Environment, donors, and other relevant stakeholders.

9.2 Role of the Government

- **India:** The government of Delhi has initiated in the creation of this industry, to support the introduction of its vehicle scrapping requirement in 2018.
- **Uganda:** The government will oversee the overall implementation of the NAMA. Additionally, the government will provide support for establishing the regulatory framework for the recycling business. The government will also engage in capacity-building and awareness raising initiatives.

9.3 Role of the private sector

- **India:** The private sector leads the process of vehicle recycling in India, from towing to recycling of vehicles.
- **Uganda:** The private sector will entirely lead and drive the vehicle recycling initiative.

9.4 Role of the external stakeholder

- **India:** The National Automotive Testing and R&D Infrastructure Project (NARTRIP), working with the vehicle manufacturing industry, also supported in the set-up of the demonstration facility and in testing of the vehicle recycling industry in India.
- **Uganda:** International firms will provide consulting support to the private sector in establishing vehicle recycling industry in Uganda.

10 Opportunities

The establishment of a vehicle recycling industry will provide the following opportunities:

- Creation of business opportunities and job
- Reduction in GHG emissions
- Access to alternative option to purchasing a vehicle through repair and reuse of parts

11 Relevance to Palestine

11.1 Relevance to the Palestinian Context

The transportation sector is considered as one of the most important and vital economic sectors in Palestine, for transporting individuals and goods. Transportation networks and modes provide access to jobs, healthcare, education, and social facilities. However, reducing CO₂ emissions is a growing challenge for the transport sector globally. In Palestine, road transport is by far the most important mode of transportation in the West Bank and Gaza²⁹. However, the vehicle population is aging, resulting in low fuel efficiency and excessive pollution. This is similar to the conditions experienced in India and Uganda.

11.2 Linkages to Palestine's NDC

This case study is highly relevant to Palestine's NDC. One of the priority interventions identified in Palestine's NDC is the improvement of the efficiency of road vehicles by updating the vehicle fleet, disposing of old vehicles, and promoting and encouraging the use of efficient vehicles. Encouraging a recycling industry in Palestine will contribute to achieve these goals.

11.3 Co-benefits

Co-benefits identified in this case study include the below:

Sector	Co-benefits
Financial/Economic	<ul style="list-style-type: none">● Creation of jobs● Less fuel used and cheaper fuel source● Additional revenue streams
Environmental	<ul style="list-style-type: none">● Improved air quality● Reduced GHG emissions
Health	<ul style="list-style-type: none">● Improved health of the population from improved air quality

11.4 Acceptability

The road transportation services in the sector is provided by the private sector in Palestine. The Ministry of Transport (MoT) supervises the registration and licensing of private vehicles, commercial vehicles, and tractors. According to available statistics, 68 per cent of these vehicle is 20-30 years old, including 11% above 20 years and 21% ten years³⁰. This makes the maintenance cost of vehicles high and limits the availability of spare parts. In addition, GHG emissions from these old vehicles contribute to overall climate change and environmental pollution. In this sector, the Palestinian population is faced with problems such as high prices of vehicles, especially for citizens with low income. This case study, hence, is acceptable in the context of Palestine as it is providing an alternative option of vehicle recycling which will address these barriers.

However, it is important to emphasize that although the Palestinian authority already passed a law banning importing cars based on their age after production, high prices for imported cars still encourage the population to depend on their old cars, some of which are more than 30 years old.

11.5 Economic feasibility

²⁹West Bank and Gaza Transport Sector Strategy Note 2007, the World Bank

³⁰Transport Sector Strategy 2011 – 2013, Local Development Forum (LACS)

The case study in India is driven by a strong collaboration between the government and the vehicle manufacturing industry. The demolition facility identified that the vehicle recycling industry in India has the potential to generate revenues of RS. 1500 crores, (approximately USD 211 million), increasing to RS. 2,700 crores (approximately USD 380 million) by 2020 and beyond. This is in addition to the environmental benefits the industry offers. This provides significant economic opportunity for the country, providing jobs to its population and growth in the private sector.

In Uganda, policy development components, such as the introduction of labeling and of fuel standards, are affordable, and include awareness components. The establishment of a recycling facility has been estimated to USD 1.2 million, with the private sector contributing most of the capital. This could therefore also be applicable and feasible in Palestine.

11.6 Potential replicability and scalability

In all Palestinian cities, there are areas where old cars are scrapped and stored. There is therefore a high potential for the replication of recycling technologies in Palestine, as this would help to deal with solid waste. The recycling industry can help in generating a number of new job opportunities and enhancing Palestinian economy. Shredded metals can be sold to Palestinian factories. Heavy metal could be sold to a factory in Jericho and aluminum to a factory in Nablus.

Moreover, shredded and compacted (pressed) material can be exported to neighboring countries such as Jordan, where there are more developed industries which can then recycle it.

11.7 Transferability to the country

Palestine could start with standards to renew the fleet as well as a small plant to enable shredding and / or compacting. The Palestinian local industry and industries in neighboring countries can buy the material either shredded or compacted, as well as spare parts for vehicle maintenance. The next step will be to engage with investors to establish a local recycling plant. This type of phased approach would allow the required technologies to be transferred when business models are more mature, therefore enabling the scaling-up of the plant and the use of more complex technologies.

11.8 Possible occupation related challenge

A small-scale recycling facility will need to be developed. This may require securing of an area near by current scrapyards. It might be complex to secure this type of land in area C.

11.9 Potential for a pilot

Similar to India, Palestine could develop a demonstration facility, as a pilot, to understand the opportunities and challenges in scaling the vehicle recycling service within the automobile manufacturing industry.

It seems appropriate to first design a pilot project in one of the largest cities, as the number of accumulated cars is high.

11. Water – Rainwater harvesting for irrigation (Philippines, Tanzania and China)

Climate change is disrupting global rainfall patterns, making some parts of the world vulnerable to drastic decrease in precipitation. This is resulting in an overall decline in water levels in many reservoirs and rivers. Rainwater harvesting has been applied as a strategy for people living with high rainfall variability, livestock and other forms of agriculture in areas such as Tanzania, Philippines and China.

1 Background

Agricultural economy is the backbone of most poor and vulnerable communities, thus, sustainable approach to farming is important in reducing significant long-term impacts on food security and livelihoods³¹. Recently, rainfall variability has emerged as one of the most challenging issues among climate change events. Water scarcity in rain-fed systems can be so severe as to force many of farmers to cease planting. All of these farmers experience extremes in water scarcity at the farm level, resulting in loss of food production and other farm related livelihoods. Among these farmers are those whose production is critical to sustain national and local food security and to the reduction of household food insecurity, especially in poor rural communities³². The entire well-being of the farming community is integrally linked with the capacity of these populations to access the right amounts of water at all times to ensure yields from the crop or livestock. Accordingly, during a period of drought farmers must have adequate amounts of water in storage to meet the needs of the farm.

A number of case studies and feasibility assessments have been completed and demonstrate that the capture and storage of rainwater runoff for later use significantly reduces risks of losing harvest each year from soil erosion and water scarcity. This strategy also provides additional benefits such as reduction of risks associated with flooding and soil erosion during the increasingly high rainfall intensities.

2 Description of the technology

Rainwater harvesting is a technology to collect and store rainwater runoff for reuse in activities such as, agriculture and sanitation³³. Rainwater for harvesting is collected from many types of surfaces including rooftops of houses, buildings and farm sheds, road surfaces, concrete surfaces and plastic surfaces including greenhouse coverings³⁴. Generally, rainwater harvesting systems are constructed from three principle components. These include, the catchment area, conveyance system, and a storage device. The catchment area is the area where the rainfall is initially captured and natural surfaces serving as catchments include slopes, the trunks and canopies of trees.

Rooftop

In the rooftop method, water from rainfall is collected in vessels at the edge of the roof or channeled to a storage system via gutters and pipes³⁵. This method is suitable for household level application and can provide freshwater for domestic purposes and small-scale farming.

³¹ Community Approaches to Sustainable Land Management and Agroecology Practices 2017, United Nations Development Programme (UNDP)

³² Feasibility Study of Rainwater Harvesting for Agriculture in the Caribbean Subregion 2014, the Food and Agriculture Organization (FAO)

³³ Feasibility Study of Rainwater Harvesting for Agriculture in the Caribbean Subregion 2014, the Food and Agriculture Organization (FAO)

³⁴ Feasibility Study of Rainwater Harvesting for Agriculture in the Caribbean Subregion 2014, the Food and Agriculture Organization (FAO)

³⁵ Rainwater Harvesting, Climate Technology Centre & Network (CTCN)

Ground surface

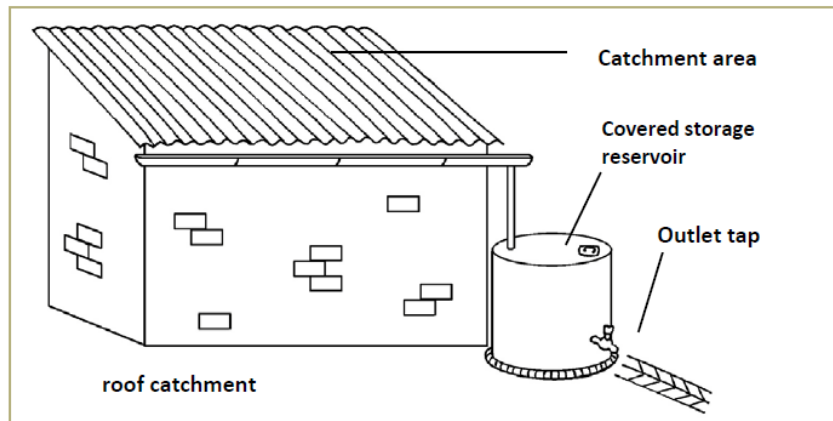


Figure 11 Rooftop Method of Rainwater Harvesting

In the ground surface method, water flowing along the ground during the rain is diverted toward a tank below the surface. Under this method, there is greater possibility of loss of water than the rooftop system due to infiltration to the ground. Additionally, the water is generally of lower quality than that collected directly from rainfall. This method is applicable for low topographic areas and is suitable for large-scale agricultural production as it allows for in-situ storage and usage of fresh water for irrigation.

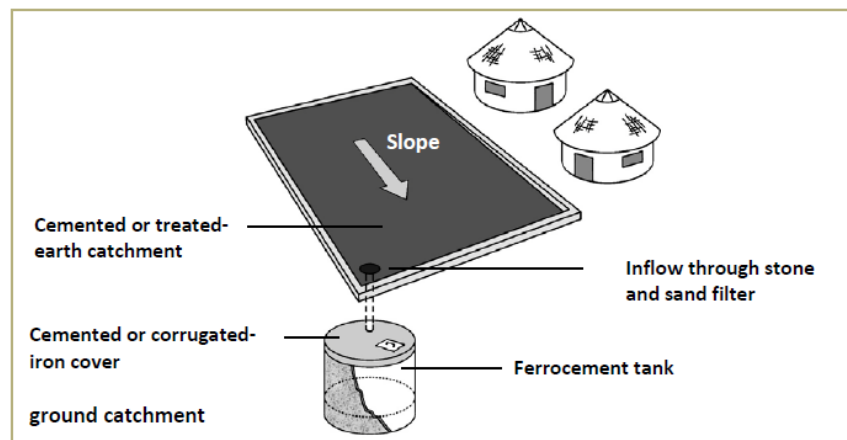


Figure 12 Ground Surface Method for Rainwater Harvesting

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 lower quality than that of direct collection of rainfall.

Once the rainwater is collected, conveyance systems are used to transfer the rainwater collected to the storage tanks. There are several ways to transport water to a storage device. These include use of gutters, pipes, glides, and surface drains or channels³⁶. For long distance transfers, conveyance systems may require pumps.

³⁶Rainwater Harvesting, Climate Technology Centre & Network (CTCN)

For storage devices in storing the water collected from catchments areas, there are two types: above-ground storage tanks or underground storage tanks. These units could range in sizes from as small as one cubic meter to up to hundreds of cubic meters³⁷. Commonly used units for small-scale water storage include plastic bowls, buckets, clay and oil drums. For storing rainfall from rock surface catchments, dam is the most common form of storage unit.

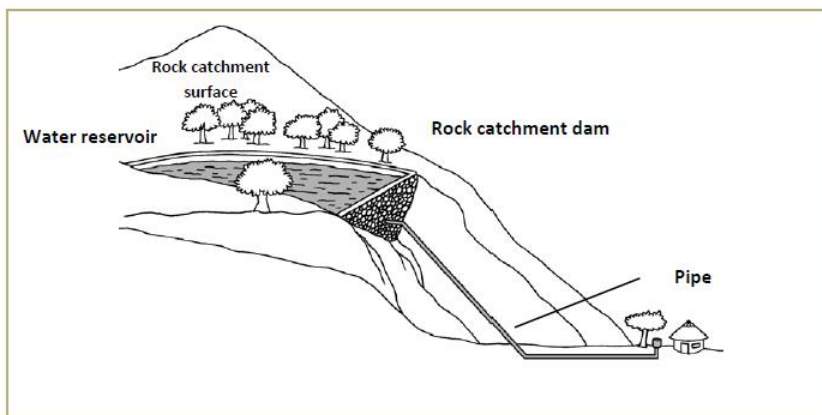


Figure 13 Rock Surface Method for Rainwater Harvesting

3 Justification

Low and variable productivity in rain-fed agriculture is the major cause of poverty of 70 percent of the world's poor. In agriculture, this water can be used to grow crops and to support small livestock³⁸. Therefore, it presents an opportunity to increase productivity in regions with low and irregular rainfall.

4 Rationale

Rainwater harvesting for agriculture is an important risk reduction measure against water scarcity and its potential negative impact on livelihoods and food security in small farming communities. It is a way to answer to changing patterns in rainfalls, such as more frequent droughts and less intense precipitations due to climate change.

5 Concrete application of the technology

Burgos and Divisoria Norte, Province of Quirino, Philippines

The Department of Agriculture identified the development of rainwater harvesting technologies, referred to as Small Water Impounding Projects (SWIPs), as priority to support the irrigation and inland fishery programs of the government. SWIPs are usually implemented in partnership with Local Government Units (LGUs) that have technical capability to implement these types of projects. LGUs provide counterpart fund, a scheme in which both the national and local governments share accountability to the project³⁹.

The Bureau of Soils and Water Management spent approximately PhP 3 billion (approximately USD 57.5 million) to establish the 2,060 SWIPs nationwide from 1974 to 2010, irrigating a total area of approximately

³⁷Rainwater Harvesting, Climate Technology Centre & Network (CTCN)

³⁸Feasibility Study of Rainwater Harvesting for Agriculture in the Caribbean Subregion 2014, the Food and Agriculture Organization (FAO)

³⁹Socioeconomic Impacts of Small Water Impounding Projects in Quirino Province, Philippines, Journal of Geoscience and Environmental Protection, 2014, 4, 101-106

84,168 hectares and benefitting 64,266 farmers⁴⁰. In Burgos, within the Province of Quirino, the project was completed in 1998 with a construction cost of PhP 1.22 million (approximately USD 23,000). It was designed to irrigate a service area of 30 hectares with 23 farmer beneficiaries. The project resulted in increase in mean annual crop yield by 2.14 tons per year, and increase of gross annual income of farmers by PhP 32,113,64 (approximately USD 62,000). Similarly, in Divisoria Norte of the same province, the project was completed in 2007 with a construction cost of PhP 800,000 (approximately USD 15,000). and designed to irrigate a service areas of 46 hectares with 35 farmer-beneficiaries. The project also resulted in significant increase in both mean annual crop yield and gross annual income by 2.08 ton per year and PhP 31,303,60 (approximately USD 60,000), respectively⁴¹.

Some of the challenges that were experienced related to the absence of Irrigators' Association, resulting in lack of training and capacity-building activities being provided on the operation and maintenance of the system.

Talugton, Nueva Ecija, Philippines

In Talugton, Nueva Ecija, an upland municipality located in Central Luzon, Philippines, a cluster of rainwater harvesting facilities were implemented in previous years through the initiative of the local government unit and national government agencies. As of June 2013, the municipality had eight SWIPs in operation and one under construction. With a total storage capacity of 3,258,120 m³, the eight SWIPs have the potential to provide supplemental irrigation to about 324 ha during the rainy season, 293 ha during the dry season, and 5 ha as third crop⁴². The eight SWIPs generate an annual production of about 3,125 tons of palay, a form of rice at any stage prior to husking, which is equivalent to about 2,030 tons milled rice that can feed about 18,500 people⁴³. Fish production is another revenue stream of SWIP, in which the revenue from total harvest is divided between the land owner of the reservoir area and the Small Water Impounding System Associations (SWISA). Maintenance related to canal and canal structures are regularly maintained by SWISA members and the costs are covered through SWISA funds, which is supported from the partial revenue from harvesting of fish production.

The challenges in the project implementation are related to relationship between active and inactive members both at the farmer-level and association-level, resulting in negative influence over the overall system operation and maintenance.

Tanzania

In recent years, residents of Tanzania's Kilimanjaro region have experienced climate change induced water shortages. The region is already the driest in Tanzania, receiving less than 400 mm of rainfall annually⁴⁴. The United Nations Development Programme (UNDP) supported a local NGO – the Same Agricultural Improvement Project (SAIPRO) – in constructing micro-dams. This dam can store up to 220,000 liters of rain water. It is owned and managed by a group of community members, who are responsible for cleaning the mud from the pools and managing the distribution of the water. Once a week, the residents open the dam's valve and manually transfer water to community' farm plots, which cover 200 acres of farmland and serve up to 150 households. These local communities have significantly benefitted from this dam project in the region. The small-scale farmers are not only able to feed their families, but also earn extra income

⁴⁰ Socioeconomic Impacts of Small Water Impounding Projects in Quirino Province, Philippines, Journal of Geoscience and Environmental Protection, 2014, 4, 101-106

⁴¹ Socioeconomic Impacts of Small Water Impounding Projects in Quirino Province, Philippines, Journal of Geoscience and Environmental Protection, 2014, 4, 101-106

⁴² Rainwater harvesting, its prospects and challenges in the uplands of Talugtog, Nueva Ecija, Philippines, International Soil and Water Conservation Research, 2013, 1(3), 56- 67

⁴³ Rainwater harvesting, its prospects and challenges in the uplands of Talugtog, Nueva Ecija, Philippines, International Soil and Water Conservation Research, 2013, 1(3), 56- 67

⁴⁴ Rain water harvesting improves lives of Tanzanian farmers, United Nations Development Programme (UNDP)

<<https://www.undp.org/content/undp/en/home/ourwork/ourstories/water-harvesting-improves-lives-tanzanian-farmers.html>>

through sale of their products at local markets. This additional income has allowed many of them to send their children to school, raise poultry and cattle, and make improvements to their houses.

China

In the Gansu province of China, which is one of the driest provinces in the country, a rainwater harvesting project, the 1-2-1 project, was initiated. Under the project, each household acquired 1 catchment area, 2 large underground water tanks, 30 – 50 m³ in volume, and 1 piece of land with approximately 670 m² in size for micro-irrigation. The project was funded by the government, which only provided funding for cement, and the households themselves. The original target of providing one million rural people with the rainwater harvesting systems was achieved within the first 18-months of the project. With the launch of the project, agricultural production had increased significantly. Locally appropriate irrigation method was developed in which water was directly applied to only the root zone in order to minimize the evaporation losses. To reduce costs, wherever possible, the rainwater harvesting systems used catchments such as paved highways and tanks were built relatively close to the crops.

6 Enabling factors

For case studies mentioned above, enabling factors include:

- *Awareness*: Farmers were significantly aware of the challenges posed by shortage of rainfall.
- *Internal and external support*: Support from international agencies and local governments are needed in the initiation of rainwater harvesting projects by providing partial funding and capacity-building activities.
- *Technology adoption*: Rainwater harvesting technologies are simple to install and operate, with minimum maintenance required.
- *Economic factor*: Rainwater harvesting technologies provided opportunities to farmers to earn additional income.

7 Gaps, needs and challenges

Some of the challenges that were presented in the case studies include:

- Not enough awareness raising and capacity-building activities were provided to teach the farmers on benefits of use of harvested rainwater for irrigation.
- Lack of understanding around risks related to rainwater, such as limited supply and uncertainty of rainfall, hence there is a need for careful management on the use of the resource.

8 Sustainability and exit strategy

Rainwater harvesting technologies are convenient as they provide water on as-needed-basis and farmers have full control of their own systems. Additionally, use of the technology promotes self-sufficiency and provide minimal impact on the environment. Running costs are low and construction, operation and maintenance of the technology are not labor-intensive. Maintenance is generally related to structure of the technologies and this will be required as the units age. Application of the technology achieves higher crop yields, which encourages farmers to diversify their enterprises, such as increasing production, upgrading their choice of crop, purchasing larger livestock animals or investing in crop improvement inputs. However, government support is needed to ensure that appropriate training and capacity-building activities are implemented. Poor management of the local communities' understanding of the benefits and challenges of the technologies could result in lack of protection, care and maintenance of the technologies, which makes follow-up important. Government support will also be required to cover the initial construction costs. Lack

of subsidy, especially for poorer households, may result in low adoption of the technologies.

9 Stakeholder analysis

9.1 Lead agency and partners

In the case study in the Philippines, local government initiated the project as a strategic priority for development. The government units provide the funding, capacity-building perspective as well, providing the necessary training and the tools to local farmers.

9.2 Role of the Government

For the case study in China, government played an important role in which a partial funding was provided to cover the cost of material in the construction of the technology.

9.3 Role of the community

In deployment of the rainwater harvesting technologies, local communities and farmers play a significant role in which the technologies are fully managed by the participating community members.

10 Opportunities

Rainwater harvesting technologies provide the following opportunities:

- Additional income to farmers
- Food security through increased crop yields
- Increased soil moisture levels and increased groundwater table
- Investment in crop improvement
- Improvement in crop choices

11 Relevance to Palestine

11.1 Relevance to the Palestinian Context

Rainwater harvesting for agricultural use is highly relevant to the Palestinian context. 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. Additionally, drought and growing population will also be challenging in meeting the agricultural needs of the country.

It is important to emphasize that a number of Palestinian households live isolated from the water network and could benefit from rainwater harvesting. Additionally, households living in area C are also limited in the water supply by Israeli authorities and may benefit from the technology.

11.2 Linkages to Palestine's NDC

The technologies highlighted in the case studies are directly linked to Palestine's NDC and sustainable development goals. Palestine has identified use of alternative water resources, such as rainwater, an important adaptation actions for its vulnerable sectors. These sectors include agriculture and water.

11.3 Co-benefits

The technologies provide the following co-benefits:

Sector	Co-benefits
Financial/Economic	<ul style="list-style-type: none"> ● Increased food production ● Improved family income
Environmental	<ul style="list-style-type: none"> ● Increased water resources ● Sustainable use of water resources ● Improved habitat connectivity of terrestrial ecosystems ● Reduced impacts of climate change in the water sector
Social	<ul style="list-style-type: none"> ● Improved food security ● Reduced social conflict ● Improved governance
Health	<ul style="list-style-type: none"> ● Improved health and well-being ● Reduced diseases

11.4 Acceptability

There are already similar practices implemented in Palestine. For example, in the governorate of Tubas, which is an agricultural one, the local government unit (LGU) provides incentives to people who build wells and underground tanks for rainwater harvesting. Tubas has the highest number of rainwater harvesting systems in Palestine.

Although this examples shows that the technologies can be applied in Palestine and is acceptable, it also suggests that it may require the development of an enabling environment, such as regulations and incentives, to work.

11.5 Economic feasibility

While the cost of rainwater harvesting technologies depend on the type of catchment, conveyance and storage tank materials used, in general, the cost of the systems is low. In addition, systems require minimum operational and maintenance costs. The provision of the storage tank is the most costly element, and represents about 90 percent of the total cost. However, storage units can be made cheaply with locally available materials, catering to the needs of the local communities.

It is important to emphasize that a number of Palestinian households live isolated from the water network and in area C. It would be expensive to connect these households to the water supply network provided by the Palestinian Water Authority (PWA). Remote households therefore have to buy water from local water tank distributors, which is more expensive than the water supplied from the distribution network.

11.6 Potential replicability and scalability

Given that the agricultural sector in Palestine is also presented with similar challenges from climate change as those countries in the case studies, implementation of rainwater harvesting technologies is replicable and scalable in Palestine.

11.7 Transferability to the country

Rainwater harvesting technology is simple to install and operate and does not involve any institutional or organizational requirements. Beneficiaries can be easily trained to implement such technologies, and construction materials are usually readily available. These facts support that the technologies is transferable to Palestine.

11.8 Possible occupation related challenges

The implementation of the technologies may require approval from Israel, mainly for construction of storage units and facilities due to the limited space availability. Allocation of the necessary land may be needed from Israel in Area C.

11.9 Potential for a pilot

Similar to the case studies presented, Palestine could undertake pilot projects with local small-scale farmers in implementing the technologies.

12. Transport – Public transportation (modal shift) (Palestine)

Traffic jams are one of the major challenges in Palestine’s road network, both inside and outside of cities. The City of Jerusalem has a unique situation in which, due to its religious significance, thousands of Palestinians and international tourists travel to and from it every day. Since it is still under the Israeli occupation, the Israeli government developed an innovative model to manage the traffic by reducing the number of on-road vehicles, specifically taxis, carrying visitors to-and-from the city.

1 Background

According to the Palestinian Central Bureau of Statistics (PCBS) 2018 report, there are 367,073 registered cars in the West Bank, with around 40% of them running on diesel engines. Approximately 117,464 cars are registered in Ramallah and Al-Berieh Governorate which represent more than 30 per cent of the total number of registered cars. Concerning public transportation, 9,913 taxis and 117 buses are in operation in the West Bank. There are 3.4 taxis available for every 1,000 capita. This is high compared with the official USA statistics. Figure -1- presents taxis per 1000 capita in the USA.

Ratio of taxicabs to population in cities with 1,300 or more cabs.

Taxis per 1,000 residents, 2005.

Source: U.S. Census 2004 population estimates

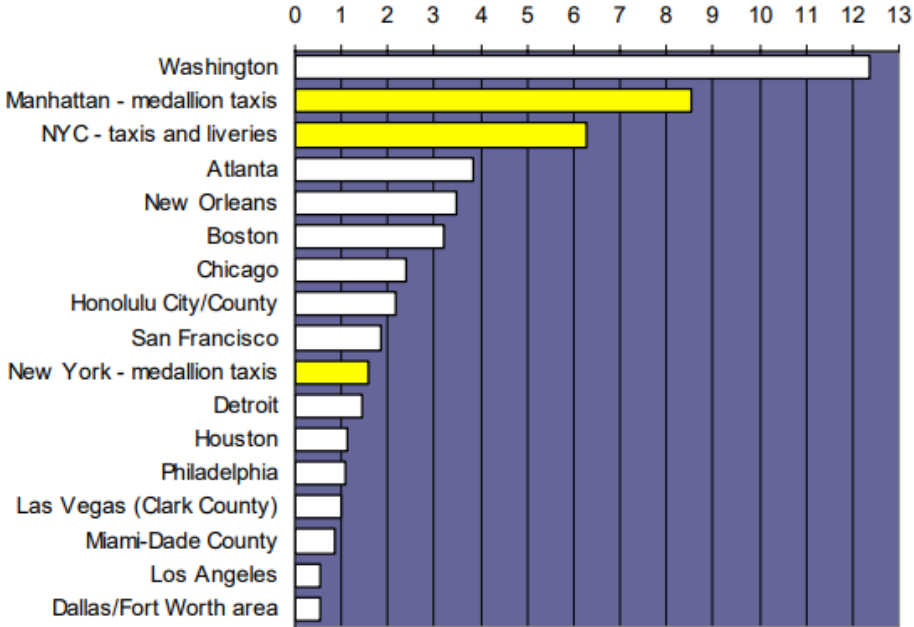


Figure 14 Taxi per 1,000 residents in the USA.

The number of on-road cars is increasing rapidly causing traffic jams and their associated pollution is problematic. According to the data published in the Palestine Economy Portal 2018, the number of cars increased by 168% in the last five years.

2 Description of the solution

The issue of traffic jams in Palestine became a serious challenge in the last decade. Given that the West Bank and Gaza Strip are under Israeli occupation since 1967, the infrastructure in general, and the road network specifically, have not been developed in an appropriate way. This has limited the ability for Palestine to have a more fluid traffic. However, since the Oslo Accord and the establishment of the

Palestinian Authority, many projects and strategic plans have been developed and implemented. Unfortunately, many of these projects face obstacles such as resources limitations, shortage of necessary legislations, and the Israeli occupation. Thus, these projects did not achieve their goals as planned.

In 1994, the Israeli government developed a model to reduce the number of taxis operating on Jerusalem routes. The model is described as follow:

- Replace every five taxis with a single bus.
- Allow those taxi drivers to run their own buses.
- Offer incentives to motivate taxi drivers to avoid operating their taxis.
- Offer financial compensation to taxi drivers to cover for their losses, including vehicles and any other estimated losses.

3 Justification

Traffic jams cause significant issues in Palestine as the number of cars on the road is increasing rapidly. All taxis in Palestine are powered by diesel engines which present immediate and long-term health and environmental hazards. A high percentage of traffic jams are caused by the large number of on-road taxis. Due to limited average income of the local citizens and high fuel prices, most of the taxis are operating based on the sharing principle.

The proposed model will help in reducing the number of cars on the road, thus, reducing hazardous risks. Both costs in purchasing the taxi vehicles and in operating these vehicles such as maintenance, fuel, asset depreciation, taxes, insurance and permitting will be reduced. Moreover, it would be more beneficial for the citizens as bus fees are usually lower than taxi fees. Additionally, reduction in the number of taxis on the road will enable travelers to reach their final destination faster, which is also a critical issue for most of employees today.

4 Rationale

Traffic jams caused by the large number of taxis operating in the city lead to GHG emissions. Public transportation users, specifically employees and those on the road during the rush hours, spend additional time in their cars and/or in their modes of public transportation due to traffic jams, thus, contributing to more GHG emissions. Addressing this issue will contribute to reducing GHG emissions, and resulting in a number of co-benefits such as cost savings for users.

5 Concrete application of the model

The model in Jerusalem was implemented initially in the 1990's. The model was based on providing incentives to taxi drivers and compensating them for the replacement of their taxis (5 cars) with one bus. However, since the project was implemented by the Israeli government before the Palestinian Authority was established, very little data is available regarding the incentives given, and the amount of financial compensation provided.

6 Enabling factors

Some of the enabling factors for this model to be operational in Palestine include the following:

- *Organizational capabilities*: The Palestinian government should establish a good and reliable data sets on all public transportation routes. These include, and are not limited to, the number of cars in operation, the condition of current cars, the average number of daily passengers, the average age of drivers, and running costs and estimated net profits of taxi services.

- *Economic factors:* To make this model profitable, only routes with high number of daily users should be considered for a pilot project.
- *Earlier success stories:* Although the Jerusalem model has been implemented, it has been more than 25 years since implementation when financial profitability was the prime driver. So, to successfully implement this model today, environmental, financial and social benefits should be highlighted clearly to convince taxi drivers, owners, and customers about the importance of supporting this initiative. Fortunately, knowing that the same project was previously implemented in Palestine means that, under careful model design and implementation, this success story can be replicated once again.
- *Social awareness:* Awareness on benefits of the well-organized public transportation at the community level should be enhanced by the media through dedicated campaigns.
- *External support:* the Palestinian government should financially support the model, and offer financial incentives and compensation to participating taxi drivers. Moreover, support on policy development should be offered as well.

7 Gaps needs and challenges

Some of the gaps related to implementing the proposed model include the following:

- For most taxi drivers, income from providing taxi services is the only source of income. Thus, convincing these taxi drivers on the profitability of the proposed model will be challenging.
- Based on the law of the Palestinian government, all taxi drivers are required to pay for permits, which give them access to operate on specific routes. These permits are limited in number on each route due to issues such as population growth and legal circumstances. Taxi drivers usually hold a couple of permits, and they are allowed to sell their permits to the drivers. However, under the proposed model, only one permit will be required instead of many. It will be challenging to compensate for this reduction in permits as taxi drivers are used to holding a number of permits.
- During the Second Intifada in Palestine, a complex economic situation, many Palestinians started to work as taxi drivers. They bought permits, which were 'loosely' issued by the government to help them through the economic situation. This resulted in a large number of on-road taxis which are owned and driven by relatively young citizens. Therefore, convincing these taxi drivers to participate in the proposed model will not be easy as they do have enough skillsets to occupy other jobs. Additionally, most of them now have families, which may make them feel financially insecure to adopt the proposed model.

8 Sustainability and exit strategy

The model implemented in Jerusalem was supported by the Israeli government by offering incentives to drivers if they participated. The Israeli government compensated them for their financial losses. Moreover, the implementation process was based on a phased approach to lower the risk and to modify the model based on practicality.

9 Stakeholder analysis

9.1 Role of the Government

The model was implemented under the supervision of the Government of Israel, established in collaboration with the Israeli Civil Administration, which is the Israeli government body responsible for operating the West Bank areas.

The Israeli government led the awareness-raising activities and developed the compensation program for

drivers who sold their cars and merged their permits. In addition, incentives were given to the drivers by lowering their taxes and enabling them to establish small companies or businesses.

9.2 Role of the private sector

The private sector, representing the taxi industry, established small groups of five drivers, or encouraged them to join a group, in order to access the benefits offered through the model.

10 Opportunities

The discussed model brought the following opportunities:

- Reduced number of on-road taxis;
- Reduced traffic jams into-and-from Jerusalem.;
- Offered an opportunity to taxi drivers to establish their own small businesses or companies.

11 Relevance to Palestine

11.1 Relevance to the Palestinian context

This case study is based in Palestine. In the 1990's, traffic jams were less problematic and the number of cars and passengers were much lower. Despite that, the model was successfully implemented and well taken by the participating population. However, in the last two decades, the number of on-road cars has been increasing rapidly. Re-implementing this model can thus be beneficial.

11.2 Linkages to Palestine's NDC

This case study is highly relevant to Palestine's NDC as reducing GHG emissions has been identified as one of strategic development priorities for Palestine in their NDC.

11.3 Co-benefits

Improving transportation sector in Palestine will bring the following co-benefits:

Sector	Co-benefits
Financial/ Economic	- Savings for taxi drivers from reduced operating and running costs
Social benefits	- Improvement in productivity and leisure from reduced travel time and time saved from travel
Environment	- Improved air quality
Health	- Improved health from improved air quality - Improved health from reduced stressed - Reduction in road accidents

11.4 Acceptability

Raising awareness on benefits of the model will be achievable through delivery of awareness campaigns. However, convincing taxi drivers to participate in the initiative is more complicated. The key focus here should be building compensation and incentive programs that ensure taxi drivers and owners that the

profitability of the new model will be, at least, as equivalent to that of current situation.

11.5 Economic feasibility

This model is a new one under the administration of Palestinian authority. It needs financial resources to develop and deliver new legislations, policies, awareness campaigns, studies on demand (number of passengers) and supply (number of taxis), compensation program and incentives. Therefore, given the current financial situation of the Palestinian authority, access to international funds is essential in making this model successful.

11.6 Potential replicability and scalability

Given a similar model was successfully implemented in Jerusalem more than 20 years ago, this proposed project has the potential to be replicated. The success of it depends on the design of the model itself.

11.7 Transferability to the country

The model does not require any new technology.

11.8 Possible occupation related challenges

A minimal occupation challenge exists as the targeted taxi drivers are Palestinians working mostly in the West Bank, classified as Area A.

11.9 Potential for a pilot

The model should be implemented as a pilot on specific public routes that are crowded with both cars and passengers. Through findings from pilot projects, the model can be modified and developed to be more suitable and successful for the region. Moreover, success of pilot projects would help in convincing drivers in other routes to participate in the initiative.

13. Agriculture – Low-carbon cold chain technology (Japan, Taiwan, India and Mozambique)

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. Cold chains are used in agricultural value chains, as well as for medical uses, such as vaccine transportation. However, most cold chain technologies are also energy intensive. In order to achieve development, climate adaptation and mitigation goals, it is important to encourage the use of low-carbon cold chain technologies.

1 Background

An estimated one third of all food produced globally, which amount to about 1.3 billion tons per year, is either lost or wasted. Food loss and waste (FLW) is a misuse of the labor, water, land and other natural that went into producing it. The carbon footprint alone of food produced and not eaten is estimated to be 3.3 Gtons of CO2 equivalent, which makes it one of the most energy intensive activities.

Food loss refers to any food that is lost in the supply chain between the producer and the market. This may be the result of pre-harvest problems, such as pest infestations, or problems in harvesting, handling, storage, packing or transportation. One of the major sources of FLW is the lack of solutions available in cold chains in developing countries. Developing cold chains is expensive in terms of infrastructure development, for solutions which are often not adapted to scale or issues faced in developing countries. Cold chain storage systems and transportation are also extremely energy intensive. For example, the overconsumption of diesel (for the refrigeration system) is considered to an additional 21 per cent compared to non-refrigerated goods . Additional GHG emissions due to refrigerants production and leakage also have to be taken into account.

The development of low-carbon cold chain systems is therefore crucial to support the development of agricultural value chains and food security, while at the same time mitigating their effects on GHG emissions.

2 Description of the technology

The cold chain is a logistical system which manages temperature. It is a series of distribution activities which continuously maintain a range of temperature in order to protect the temperature-sensitive cargo from the producers to the consumer. The agricultural value chain, from the producer to exportation, is usually described as in the figure below.

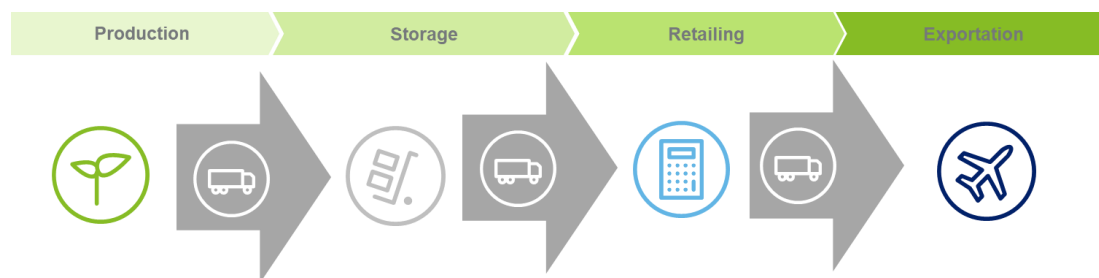


Figure 15 Agricultural value chain

The cold-chain for such an agricultural value chain needs to be maintained from production to exportation. This requires the introduction of cold storage technologies at each step of the value chain. In this type of value chain, cold-storage for transportation and cold storage facilities at producer and storage level are essential to ensure food security and avoid any food losses. However, most cold chain technologies are expensive and unaffordable for smallholder producers, traders and exporters in developing countries. The use of energy, which is often unstable in developing countries, is also seen as a major issue.

The IceBattery System (IBS) is a cold delivery system developed by Innovation Thru Energy (ITE) Co., Ltd., a Japanese company. Compared with conventional technologies such as dry ice, IBS can provide stable temperatures for delivery up to more than 150 hours. IBS can adapt the temperature depending on the product requirements, and has a temperature range between -25 and 25 degree Celsius. It also maintains the humidity, thus preventing further degradation of the product.

Type	8L		16L		32L		64L	
#of plate	Chilled +5°C	Frozen -20°C	Chilled +5°C	Frozen -20°C	Chilled +5°C	Frozen -20°C	Chilled +5°C	Frozen -20°C
1	16h	8h	18h	12h	12h	6h	8h	4h
2	32h	16h	36h	24h	24h	12h	16h	8h
3	48h	24h	54h	36h	36h	18h	24h	12h
4				48h	48h	24h	32h	16h
5					60h	30h	40h	20h
6					72h	36h	48h	24h
7							56h	28h
8							64h	32h

Figure 16 Examples of combinations and temperature maintenance time by using IBS

IBS uses a system combining 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. Palettes and bigger containers are also available.



IBS can also be used instead of compressors in trucks and in storage facilities. IBS keeps better constant temperature than the conventional frozen and chilled systems.

Environmentally, the main merits of using IBS is to reduce emissions due to compressors in trucks and storage facilities. As IBS is easy to adapt to transportation, it is easy to transport in dry trucks, which do not use additional diesel for compressors. It also allows to use the right temperature for each product, thus reducing the number of trucks required to transport different products.

In general, IBS is a very flexible system, which is relevant both at smallholder level and for large companies. For example, producers are first in line for the cold chain; their ability to usher perishable food into a safe, controlled pre-cooling phase is the key in reducing food losses. At producer level, IBS can be used by introducing a small number of plates with small insulation boxes, which can be used to store the products until the products are picked up by traders.

At a larger level, such as logistic companies or large food processing companies, IBS can be used in dry trucks instead of chilled / refrigerated trucks, but also in storage facilities and in planes.

IBS requires to be “charged” before every use. Although the system can last for more than 150 hours depending on the usage, the plates need to be refrigerated for about 10 to 12 hours before use. This is the only requirement in terms of electricity usage.

According to ITE, replacing the use of refrigerated trucks and dry ice with IBS results in cutting CO2 emissions by 40 to 50 per cent and costs by 70 per cent.

3 Justification

Reducing food losses due to the lack of cold chain solutions in developing countries is a major challenge. Achieving this will lead to improved food security in developing countries and emerging markets.

Adopting cold chain technologies also provides additional economic opportunities for the private sector. Some products can be exported if the quality of the cold chain is ensured. This is the case for fresh products for which the demand abroad is important, such as products from the sea, but also for products which require more efficient chilling and cooling techniques. Traditional cooling, based on dry ice and other techniques, may lead to a significant loss of quality for meat and fish, which reduces the value of such products for exports.

Having efficient cold chains therefore not only contributes to food security, but also to additional economic opportunities for the private sector.

4 Rationale

In the absence of the development of cold chains, food losses already lead to significant GHG emissions. Adopting low-carbon cold chain technologies would lead to further mitigate GHG emissions from conventional cold transportation and cold storage technologies.

5 Concrete application of the technology

ITE has applied IBS with a number of sectors. Some of those are presented below.

➤ Food industry logistics

ITE has applied its technology to the logistics sector in the food industry. IBS is used in dry trucks to transport food products from storage facilities to stores.

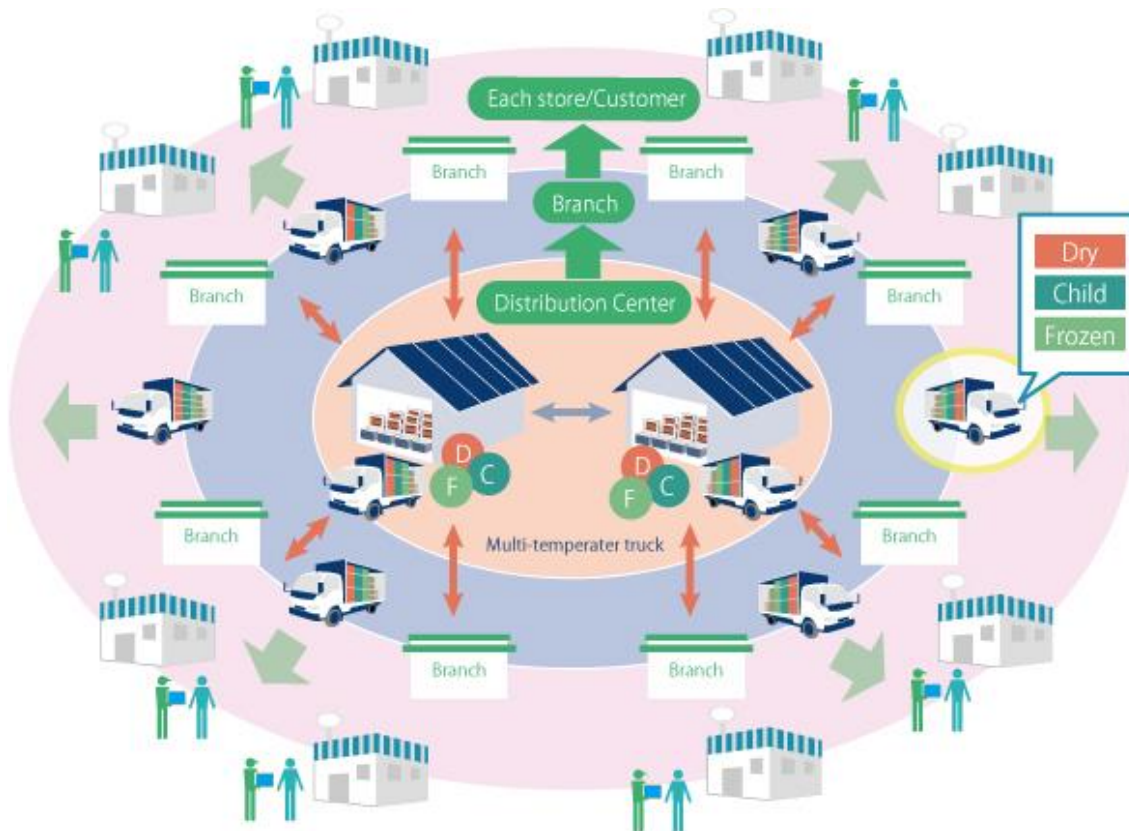


Figure 17 IBS applied to the food logistics sector

Often, different products are loaded into the trucks, which requires the use of different temperatures. While this cannot be easily arranged with conventional trucks, this becomes possible with IBS. The technology is used for these applications in Japan and Taiwan by major companies.

In India, Salad Days, an ITE customer, supplies salads and freshly squeezed juices to homes and offices in the Indian city of Gurgaon and neighboring New Delhi. Its motorcycles zip around with eye-catching silver boxes -- each equipped with an IBS -- and deliver 350 salad bowls a day. Inside, the temperature stays at 2 to 5 C, even during the summer, when the mercury soars past 40 degrees Celsius. Salad Days also plans to introduce an ITE-developed refrigerated truck⁴⁵.

➤ **Seafood industry**

In Japan, major players of the seafood industry also work closely with IBS. ITE also planned on introducing IBS in Mozambique for seafood industry players. The coast of Mozambique is home to a number of seafood products with a significant added value when exported in Asian market. To be exported, those products require a strict control of their temperature after being harvested or fished.

However, major transformation plants in Mozambique are located near the capital, Maputo, in the South of country, while sea resources are mainly located more than 1,000 kilometers up North in the country. Transportation from the production site to the transformation site is also complex, as sea currents are strong and road conditions are not good enough. The park of refrigerated trucks is limited in the country and their use is expensive. Even when secured, transportation may take up to two to three days. Transportation constitutes most of the production costs for seafood harvested or fished in Mozambique and would be

⁴⁵<https://asia.nikkei.com/Business/Food-waste-woes-call-for-cool-solutions>

important environmental challenge if it were to be developed.

The solution proposed by ITE was to provide IBS to company involved in seafood production, which would use it in dry trucks. The company planned on using it both on long-distance trucks, between the plant and the production site, and for smallholder fishers at production site, to improve the quality of the product.

For 48 hours of cold transportation, the cost for IBS for this application was estimated at USD 18 per month per 100 liters of cargo. This is a clear improvement for the companies involved in Mozambique in terms of costs.

However, before implementation, a number of challenges need to be cleared, such as legal arrangements between ITE and local companies and security management for the technology.

6 Enabling factors

Some of the enabling factors for this technology and approach to be operational in emerging economies and developing countries include the following:

- *Social awareness*: Food losses are impacting in a number of countries, and social awareness on the need to improve cold chains to improve the situation is an important factor for the introduction of the technology.
- *Limited availability of conventional logistics solutions*: The limited availability and cost of conventional logistics solutions related to cold chain management are a major factor in considering the introduction of the technology.
- *Economic factors*: At the proposed cost, the solution is less expensive than conventional solutions.
- *Availability of products with value-added potential*: The availability of products which can be sold or exported at a higher price if the cold chain is better managed is a major factor in considering the introduction of the technology.

7 Gaps needs and challenges

Some of the gaps related to implementing low-carbon cold chain solutions include the following:

- *Policy gaps*: Low-carbon cold chain technologies are often high-end technological products, even if provided at low-cost, and are protected by a number of patents. The private sector may be worried in the capacities of the country to protect the technology if introduced.
- *Security risks*: The technology is easy to steal, which might result in losses if not properly managed.
- *Infrastructure factors*: Even with the technology, the roads and provision of energy may not be sufficient to consider introducing the technology.

8 Sustainability and exit strategy

While the technology is a private-sector led solution and does not require an exit strategy per se, some of the strategies used to ensure the sustainability of the technology and approach in other countries include the business model and agreement adopted by ITE. ITE has chosen to work with a leasing model, which proposes to provide maintenance when required and imposes a monthly lease on the lessee. This enables the technology to remain affordable for companies in emerging economies while providing a stable revenue stream to ITE.

9 Stakeholder analysis

9.1 Lead agency and partners

Although the specific technology discussed in this case study is a private sector led solution, most cold chain technologies introduced in emerging economies are led by development agencies and National governments, given their costs.

9.2 Role of the Government

As mentioned earlier, there is no specific role for the Government for the specific technology discussed under this case study. However, the Government may take the lead to support the private sector in introducing cold chain technologies.

9.3 Role of the private sector

The private sector takes the lead in developing the technologies and implementing it in a number of value chains.

9.4 Role of donors and international organizations

As mentioned earlier, there is no specific role for donors and international organizations for the specific technology discussed under this case study. However, donors and international organizations may be driving forces for the implementation of pilots related to cold chains.

10 Opportunities

The proposed technology and approach introduced bring the following opportunities:

- Costs for energy usage significantly decrease (less diesel used for trucks and compressors);
- Additional opportunities for exporters to export value added products;
- Additional revenues generated for the producers;
- Additional opportunities for the private sector in the logistics sector.

11 Relevance to Palestine

11.1 Relevance to the Palestinian context

The case study is highly relevant to the Palestinian context. For example, the NAP identifies a lack of cold storage facilities in Palestine, as well as increasing costs in fisheries in Gaza related to the increasing costs for cold storage. The introduction of a low-carbon, low-cost solution would enable Palestine to have improve food security while, at the same time, reduce costs related to cold storage.

This would also enable Palestine to decrease its GHG emissions, related to the use of diesel.

11.2 Linkages to Palestine's NDC

This case study is strongly linked to Palestine's NDC, as cold storage has been prioritized as an adaptation action to the country's challenges.

11.3 Co-benefits

Using low-carbon cold storage technologies in Palestine will bring various co-benefits.

Sector	Co-benefits
Mitigation	<ul style="list-style-type: none"> ● Cost savings of imported energy ● Increased energy security ● Less exposure to shocks in international energy markets ● Improved balance of payments ● Less GHG emissions due to food losses and conventional cold storage
Adaptation	<ul style="list-style-type: none"> ● Improved food security
Financial/ Economic	<ul style="list-style-type: none"> ● Costs savings in diesel use
Social benefits	<ul style="list-style-type: none"> ● Income generation ● Job creation ● Better prices for food

11.4 Acceptability

The proposed technology can help Palestinian Government to reduce CO2 emissions and the dependency on Israeli and other sources for the importation of energy. The system beneficiaries are mostly business owners involved in the agricultural and food chain transportation and logistics sectors. As the technology can contribute to significant cost-savings, and to ensure a better refrigeration quality, the technology would be extremely attractive for Palestine.

11.5 Economic feasibility

In other countries, such as in Mozambique, the investment required to kick-off the deployment of low-carbon cold chains is planned to be partially financed through grants for a the implementation of a pilot. However, as the technology is provided on lease, the technology is affordable to any company producing products with enough value added and experience high running costs related to cold chain management, such as fuel costs.

In Palestine, energy and fuel prices are one among the highest in comparison to average income. This impacts the Palestinians in their ability to purchase essential products, such as food and agricultural products, which prices are relatively high. The energy consumption during transportation impacts product prices. The proposed technology will help business owners in reducing their transportation expenses, thus, improve their ability to reduce prices. These are factors which will improve the economic feasibility of the technology, both at producer level and at consumer level.

For the implementation of small scale solutions in Palestine, the technology seems economically feasible. For larger scale facilities, grant components and concessional loans may remain required for the private sector or Government to introduce the cold storage, as up-front costs may be too important for them to bear.

11.6 Potential replicability and scalability

The proposed technology does not require high tech experience or skills to be adopted. The available commercial system capacities will fit Palestinian market needs, especially for dairy and pharmaceutical factories, where there is a need to transport products at strictly regulated temperatures. Other sectors, such as meat, ice-cream and agricultural products in general may also be interested.

11.7 Transferability to the country

The proposed technology is easy to transfer since it does not require any processing of advanced training in Palestine. Moreover, due to the fact that the proposed system does not contain heavy moving mechanical parts, refrigerant gas, or even high pressure compressors, its maintenance is relatively easy and can be offered inside Palestine.

11.8 Possible occupation related challenges

It should be kept in mind that this technology is most suitable for logistic transportation activities. Trucks will move between areas A, B, and C, which means that the trucks may be inspected at checkpoints. The system is easy to open and inspect, as it consists of ice boxes, which are used to store the products. There are no compressors and opening the boxes for a short time does not cause changes of temperature. It should therefore be acceptable.

11.9 Potential for a pilot

The technology could be first applied as a pilot project. For example, the ice-cream market would be easy to cover in Palestine, with the Al Arz ice cream factory covering more than 60 per cent of the Palestinian market. Ice-creams are transported all around the West Bank with the factory's own trucks, which is energy expensive and costly. Al Arz is a successful private business, which may be ready to adopt the technology and show-case it for other sectors if it can there are enough cost-savings to be made. By providing a success story to other businesses, spreading this technology in Palestine would be easier.

14. Energy – Grid upgrade assessment (Mongolia)

The global energy demand keeps rising as the population continues to increase. This growing demand is also driven by the improvement in living standards experienced in developing countries. Globally, many countries have aging energy infrastructure which require upgrade or replacement. Current infrastructure may have reached its maximum capacity or, in many cases, may have surpassed its capacity causing challenges in providing reliable supply of energy. Upgrading the energy infrastructure improves reliability of energy supply and enables higher level of integration of renewable energy sources in the power grid. As part of national energy development plan, Mongolia has conducted an assessment for grid upgrade. This case study will examine elements of assessments required for grid updating.

1 Background

In many countries, energy infrastructure was developed over decades ago, based on the needs at the time the infrastructure was developed. Hence, it was not developed to account for the current and growing demand or for the technical advances, which are leading to the increased electrification of transportation, manufacturing and home appliances⁴⁶.

Upgrading the power grid can add resilience to the electric power system, allowing for better preparedness to address and respond in cases of emergencies. It can also improve efficiency in how the energy is delivered, as improved power grids usually reduce overall losses in the electricity distribution system. The installation of advanced infrastructure can enable precise calculation of losses and locating areas with increased losses in the distribution network.

2 Description of technology

There are various types of technologies available for consideration when upgrading the power grid. These vary depending on project area and context, and often require a thorough assessment of the needs of the grid upgrade. In Mongolia, an assessment of the required power grid update was conducted and relevant technologies were identified and proposed as appropriate. Technologies used in the case of Mongolia are as below⁴⁷:

Power transmission		
Technology	Specification	Benefit
Laboratory of diagnostic tests of transmission lines and substations	Tests for abnormal signs of use of electrical insulating oil for equipment, such as transformers. <ul style="list-style-type: none"> ▪ Dissolved gas-in-oil analysis ▪ High voltage tests ▪ Protection relay tests 	<ul style="list-style-type: none"> ▪ Quality check is performed at international standard levels to confirm satisfactory and effective facility operations. ▪ Ability to detect equipment deterioration and perform appropriate repair.
Expansion of existing substations (Gas Insulated Switchgear (GIS)) in Balun and Umali areas	<ul style="list-style-type: none"> ▪ Upgrade power receivers to 100 kV 	<ul style="list-style-type: none"> ▪ Improves the reliability of power supply ▪ Reduces the number of power outages by

⁴⁶ Scenario Aggregation-Based Grid-Connected Photovoltaic Plant Design, MDPI, Sustainability, 2018

⁴⁷ City of Ulaanbaatar Power Transmission & Distribution System Assessment, Japan International Cooperation Agency, 2014

	<ul style="list-style-type: none"> ▪ Upgrade to air-cooled transformers ▪ Install distribution automation systems ▪ Install remote monitoring control devices (Substation Automation System: SAS) ▪ Install an emergency response substation for cases of power outage ▪ Install reactors to adjust reactive power ▪ Equip substations with fire alarm and emergency response equipment 	<p>improving the supply of power to substation equipment by upgrading the aging equipment and adopting highly reliable protection methods.</p> <ul style="list-style-type: none"> ▪ Reduces the number of accidents related to power distribution equipment.
Mobile substations	<ul style="list-style-type: none"> ▪ Purchase of mobile substation with transformers, switchgear equipment and switchboard. 	<ul style="list-style-type: none"> ▪ Improves response in case of emergency.
Replacement of existing transmission line	<ul style="list-style-type: none"> ▪ Install high-temperature low-sag (HTLS) conductors. 	<ul style="list-style-type: none"> ▪ Increases transmission capacity.
Power Distribution		
Technology	Specification	Benefit
Distribution Automation System (DAS)	<ul style="list-style-type: none"> ▪ Install automatic control system assisted by computer for distribution network operation. 	<ul style="list-style-type: none"> ▪ Improves supply reliability.
Automatic meter reading system	<ul style="list-style-type: none"> ▪ Install remote control system for energy meter reading. 	<ul style="list-style-type: none"> ▪ Reduces power distribution losses.
110 kV underground station (GIS substation)	<ul style="list-style-type: none"> ▪ Construct new underground substation in Ulaanbaatar city. 	<ul style="list-style-type: none"> ▪ Meets energy demand

3 Justification

The demand for electricity increases as countries experience significant economic growth. This becomes challenging as power grid infrastructure, in many countries, is aging, limiting its capacity to meet the growing needs. In the case of Mongolia, in Ulaanbaatar city, many facilities and transmission systems were over 30 years old. Additionally, even in its distribution system, many of underground cables in the city had surpassed their life expectancy. These conditions cause shortage of power supply and limited capacity, resulting in

frequent power outages⁴⁸. In order to respond to the growing demand for power, an upgrade of the infrastructure is required such as, installation of new transmission lines, rehabilitation of transformer substations and renewal of equipment. Improved and advanced upgrades of the power grid infrastructure will also support integration of renewable energy sources in the overall power grid.

4 Rationale

Upgrading of the power grid infrastructure is necessary in order to meet continued demand for electricity. As global population increases, securing access to reliable supply of energy is critical. The energy can also be supplied by renewable sources, supporting the development of low-carbon society. However, the power grid infrastructure needs to be enhanced and improved in order to accommodate for integration of renewable energy systems.

5 Concrete application of the technology

In the case of Mongolia, undertaking of an assessment of grid upgrade in the city of Ulaanbaatar, the capital city, helped to identify the needs and potential areas suitable for infrastructure upgrade.

This assessment was carried out by first conducting an overall analysis of Mongolia's power sector. This focused on the identification of related development policy, the understanding of current state of the power sector and its challenges, as well as confirming of future plans. Concrete items of the study included, among others:

- Study of the enabling environment and regulations for transmission and distribution lines
- Implementation structure of power supply projects
- Power supply and power demand data and forecasting
- Socio-economic analysis
- Confirmation of the equipment available

During this initial research phase, a number of missions were conducted to identify the current state and proposed future plans related to power system equipment in the project region of Ulaanbaatar city and surrounding areas. This helped in understanding the supply and demand of the area and in performing demand analysis for each segment based on social and environmental data. Furthermore, local transmission and distribution companies were identified.

To ensure the proposed grid upgrade components were relevant to the local context, the government of Mongolia submitted a longlist of high priority projects related to new development and renovation plans for the power system.

6 Enabling factors

In the case of Mongolia, enabling factors can be identified as below:

- *External support:* Japan International Cooperation Agency (JICA) provided technical assistance support to assess the grid upgrade, providing professional and technical advice and support.
- *Social awareness:* There was a strong understanding and awareness of the need of grid upgrading from a number of power outage occurrences.

⁴⁸City of Ulaanbaatar Power Transmission & Distribution System Assessment, Japan International Cooperation Agency, 2014

- *Economic factor:* JICA proposed a loan package adapted to Mongolia's needs and capacities, enabling the implementation of the project.

7 Gaps, needs and challenges

Some of the challenges experienced in Mongolia include:

- Lack of appropriate training in place for the technicians related to maintenance of the grid and of equipment required to ensure the stability of the grid.
- Limited available space for large-scale expansion or upgrade as the project area is located in the center of the city.
- Lack of data on projected demand for electricity.
- Limited technical capabilities available (e.g. only one of the two types of automatic switchgear software is available for commercial use; one is still in the development stage in Japan).

8 Sustainability and exit strategy

For Mongolia, the assessment as well as the proposed grid upgrade work were structured through thorough integration of local context and trends. This ensures that aspects proposed in the assessment are strongly relevant to the case of Ulaanbaatar city and the surrounding areas. These were guided by the engagement from the National Power Transmission Grid State Own Stock Company (NPTGC), Ulaanbaatar Electricity Distribution Network Company (UBEDN) as well as the Ministry of Energy (MOE).

9 Stakeholder analysis

9.1 Lead agency and partners

- NPTGC and UBEDN were responsible for power transmission and power distribution component of the upgrade, respectively. The upgrade will be overseen by the MOE.

9.2 Role of the Government

- The Government of Mongolia is the donor recipient of the loan. This places accountability on the government in executing the grid upgrading work.

9.3 Role of the private sector

- The private sector will provide the required technologies for grid upgrading.

9.4 Role of donors and international organizations

- JICA is the donor, with TEPCO providing technical expertise.

10 Opportunities

The case study offered a number of opportunities including:

- Reliable supply of power
- Cost savings
- Reduced risk of power loss from distribution and outage

- Efficient power distribution

11 Relevance to Palestine

11.1 Relevance to the Palestinian Context

The case study is relevant to the Palestinian context as Palestine is also experiencing challenges related to the grid. Palestine has a joint grid with Israel. The grid is managed by Israel, except for the distribution in Palestinian cities, which is managed by Palestinian distribution companies. Connecting to the grid is therefore an important issue, and the transmission grid operator is unwilling to provide connection to renewable energy providers in Palestine, for stability reasons. The infrastructure itself is significantly old and has been degrading⁴⁹.

Upgrading the grid is therefore crucial in order for Palestine to develop renewable energies which can be connected to the grid. A number of private investors are interested in investing in PV and other sources of renewable energy but are discouraged by the technical issues with the grid connection.

Assessment and upgrading of the national grid system is a first priority to energy sector in order to enable connection to the grid for different sources of electricity generated especially for RE sources.

11.2 Linkages to Palestine's NDC

Palestine has identified decentralized power network, generation of solar electricity for medium-large scale commercial and industrial application, among others, as its adaptation and mitigation actions. However, all these activities are eventually linked to having a reliable grid system. Further, reduction in reliance on imported energy fuels is a critical mitigation action for Palestine. Finally, electricity grid upgrading is identified as one of its adaptation options in the NDC.

11.3 Co-benefits

The co-benefits presented from power grid upgrading and use of renewable sources for energy generation include the below:

Sector	Co-benefits
Financial/Economic	<ul style="list-style-type: none"> ● Cost savings from reduced need to upgrade the transmission grid ● Reduction in electricity loss and theft ● Increased security of energy supply
Environmental	<ul style="list-style-type: none"> ● Improved air quality
Social	<ul style="list-style-type: none"> ● Job creation ● Income generation

11.4 Acceptability

For long-term energy security, Palestine will need to upgrade its power grid infrastructure for reliable supply of energy. Additionally, this can be further improved once Palestine becomes independent of Israel's control over its joint-grid, which is currently controlled by Israel, as long as the transmission network and power

⁴⁹World Bank, West Bank and Gaza Energy Sector Review, 2007

distribution outside Palestinian cities is concerned. The case study presents an opportunity for Palestine to engage in grid upgrading assessment to plan and to develop its long-term roadmap in upgrading its grid system.

11.5 Economic feasibility

Conducting both the assessment and grid infrastructure upgrades are significantly costly, which will require international financial support for technology deployment and capacity-building. Palestine will need external donor support to execute this work.

11.6 Potential replicability and scalability

A similar grid upgrading assessment can be initiated in Palestine to understand the needs related to power grid infrastructure to meet the future energy demands, following the approach presented in the case of Mongolia.

11.7 Transferability to the country

The assessment on grid infrastructure upgrade is easily transferable to Palestine. Local context and trends will be used as factors to identify relevant projects, technologies and areas most suitable for infrastructure upgrade. The upgrade of the grid itself may be more complex, as it will require either the approval of the current grid operator, or to replace the current grid infrastructure, which will be complicated under the current conditions. The technology may be transferrable on the longer term.

11.8 Possible occupation related challenges

The upgrade of the grid itself will require either the approval of the current grid operator under the status-quo situation. Replacing the current grid infrastructure seems complex on the short-term because of limitations imposed from the Israeli side and land availability issues. However, it is important to emphasize that grid assessment is extremely important for Palestine, as it will enable it to have a clear roadmap for upgrading its grid as soon as possible and unlock additional investments in renewable energy.

11.9 Potential for a pilot

Similar to the case in Mongolia, Palestine could undertake an assessment work on grid upgrading on a pilot basis, such as selecting an area currently experiencing frequent power outages and where the future demand projection is clear.

15. Summary of gaps, needs, challenges and opportunities for each case study

The table below summarizes key gaps and challenges identified for each case study.

CASE STUDY	GAPS, NEEDS AND CHALLENGES IDENTIFIED	OPPORTUNITIES IDENTIFIED	
1.	Waste – Municipal waste management, compost production and recycling (Kenya)	<ul style="list-style-type: none"> • Lack of waste sorting centers and a lack of awareness regarding waste sorting; • Lack of a market for organic waste. There is only one company currently composting organic waste in Nairobi; • Lack of awareness by farmers on the benefits and applications of compost (lack of sufficient demand for compost); and • Lack of a market for certain inorganic recyclable waste fractions. 	<ul style="list-style-type: none"> • Significant decrease in disposal costs; • Additional revenues from the sale of recyclable materials; • Additional revenues from the sale of compost; • Additional revenues from the payment of tipping fees; • Longer useful life for existing landfills as they do not get full as fast; • The budget used to expand existing landfills can be shifted to upgrade the recycling / composting facilities at national level; and • Decrease in the land degradation due to expansion of landfill.
2.	Water – Solar powered irrigation pumps (India)	<ul style="list-style-type: none"> • Low number of users benefitting from the scheme, despite subsidies and loans supported under the credit-linked subsidy scheme; • Lack of access to appropriate credit-linked subsidy instruments to purchase solar powered water pumps for the farmers; • Lack of change in the behavioral pattern of the farmers, who only use the water pump during a limited period of the day; and • The need of water for irrigation for the winter crops often remains unmet through the solar pump. 	<ul style="list-style-type: none"> • Decrease in annual spending on fossil fuel imports, electricity use, and reduction of CO₂ emissions, improved crop productivity and energy access; • Additional business opportunities in the international market for the private sector; • Additional revenue streams, under the 'pay-as-you-go' model; and • New job creation and opportunities
3	Agriculture – Climate smart agriculture (St. Lucia and	<ul style="list-style-type: none"> • Lack of basic infrastructure (greenhouse/protected structure, irrigation system, storage shed); 	<ul style="list-style-type: none"> • Cost savings and additional income for farmers; • Increased productivity;

	Uganda)	<ul style="list-style-type: none"> • Lack of basic knowledge on good agricultural practices to improve water use and better care for soil; • Need for additional skills such as improved record keeping; • Lack in understanding of the benefits of CSA technologies; • Lack of policies and standards; • Lack of facilities for storage and collection; • Lack of proper treatment of livestock manure; and • Lack of control of the informal market of the milk products. 	<ul style="list-style-type: none"> • and • Improved local diet.
4	Agriculture – Small scale manure management, biogas (Nepal)	<ul style="list-style-type: none"> • High cost for some farmers even with the subsidy; • Lack of a viable business plan with a medium and long term vision.; • Lack of market demand for biogas systems; and • Weak Nepalese biogas institutions. 	<ul style="list-style-type: none"> • Considerable reduction of fuelwood consumption, leading to the re-growth of forests; • Additional income generation by women due to the time saved by not having to collect fuelwood. Girls also have more time to devote to education; • Health benefits for women and young children, due to lower emission and cleaner kitchens, and less risk of accidents due to safer lighting; and • Additional long term jobs from the development of a private biogas business sector.
5	Water – Renewable desalination (Middle East and North Africa (MENA))	<ul style="list-style-type: none"> • Lack of availability of components suitable for smooth and efficient coupling of existing desalination with renewable energy technologies; • Lack of access to stable energy supplied by renewable energy technologies; • High cost of capital investment; • The need for advanced skills and strong institutional capacity to operate, and strong coordination between energy and water policies; and 	<ul style="list-style-type: none"> • Diversification and strengthening of energy and water security; • Additional revenues from the exportation of fossil fuel (for fossil fuel producing countries); • A step toward energy independence (for fossil fuel importing countries); and • Job creation through the emergence of a new economic sector.

		<ul style="list-style-type: none"> • Environmental issues, such as the brine disposal with chemicals that harms the environment. 	
6	Energy – Mini-grids (Lao PDR)	<ul style="list-style-type: none"> • The Electricity Law in its current form does not address rural off-grid electrification projects; • The rise in demand for electricity may be complex to forecast and might result in non-optimal performances of the system; • At the proposed tariff, the power generated from the mini-grid system may be costlier than grid power; and • Sole ownership by a private entity may present risks too high for the private sector to engage. 	<ul style="list-style-type: none"> • Significant decrease in costs for electrification; • Additional opportunities for the development of renewable energies; • Additional revenues generated by zones electrified; and • Additional opportunities for the private sector in the energy sector.
7	Energy – Energy efficiency in buildings (Armenia)	<ul style="list-style-type: none"> • Inability to afford the upfront costs of EE retrofits for at least one-fifth of households; • Limited availability of financial resources as budgets necessary to invest in public building EE retrofits; and • Overall lack of depth and history in the local capital market for finance products in EE building retrofit finance. 	<ul style="list-style-type: none"> • Ability to development a market that will continue to exist beyond completion of the intervention; and • New development of market for retrofits in Armenia, with new business opportunities.
8	Wastewater – Anaerobic treatment of wastewater and optional production of energy and reuse of treated wastewater (Philippines)	<ul style="list-style-type: none"> • Lack of technical know-how of the local operators; • Constant risk of chemical reactions that can have dramatic negative effects on anaerobic digestion activities; • High cost associated with the technology when compared to conventional sludge treatment system; • Lack of social awareness and knowledge among local communities; • Lack of national investors as the plant had already passed national standards and was seen as being above industry standards; and • Lack of national policies and regulations for an upgrade with a provision for methane recovery and electricity generation. 	<ul style="list-style-type: none"> • Decrease in dependence on imported fossil fuels, resulting in cost savings in energy and additional revenues when surpluses of energy are created and sold; • Improved environmental protection by the capture of fugitive GHG, including methane, and reduction in the pollution load of potential leachates that would otherwise pollute surface and ground water; • Development of a healthier and safer work place, with local air quality, odor, and control of combustible methane emissions being controlled; and

9	Transport – Upgrade of existing vehicle fleet (India and Uganda)	<ul style="list-style-type: none"> • Unavailability of adequate collection systems for certain waste materials; • Lack of technology to cost-effectively separate and recover materials at high enough quality for recycling (separating and cleaning materials in high quality for recycling can be complicated and costly); • Incompatibility of different materials; and • Market value of recovered materials. 	<ul style="list-style-type: none"> • Reduction in the need of local population to run emergency diesel generator during the frequent power cuts. • Creation of business opportunities and job; • Reduction in GHG emissions; and • Access to alternative option to purchasing a vehicle through repair and reuse of parts.
10	Water – Rainwater harvesting (Philippines, Tanzania and China)	<ul style="list-style-type: none"> • Lack of awareness and capacity-building activities to teach the farmers on benefits of use of harvested rainwater for irrigation; and • Lack of understanding around risks related to rainwater. 	<ul style="list-style-type: none"> • Additional income to farmers; • Food security through increased crop yields; • Increased soil moisture levels and increased groundwater table; • Investment in crop improvement; and • Improvement in crop choices.
11	Transport – Public transport (modal shift) (Palestine)	<ul style="list-style-type: none"> • Lack of ability to change behavior of most taxi drivers, as income from providing taxi services is the only source of income; • Lack of ability to successfully reduce the number of permits held by each taxi driver as this will limit access to operate on specific routes; and • Lack of ability to engage relatively young taxi drivers of Palestine to participate in the proposed model as they lack in enough skillsets to occupy other jobs.. 	<ul style="list-style-type: none"> • Reduced number of on-road taxis; • Reduced traffic jams; and • Creation of opportunity to taxi drivers to establish their own small businesses or companies.
12	Agriculture – Low-carbon cold chain technology (Japan, Taiwan, India and Mozambique)	<ul style="list-style-type: none"> • High cost associated with the technology; • High risk of the technology being stolen, which might result in losses if not properly managed; and • Insufficient roads and provision of energy for introduction of the technology.. 	<ul style="list-style-type: none"> • Costs for energy usage significantly decrease (less diesel used for trucks and compressors); • Additional opportunities for exporters to export value added products; • Additional revenues

13	Energy – National grid upgrade assessment (Mongolia)	<ul style="list-style-type: none"> • Lack of appropriate training in place for the technicians related to maintenance of the grid and of equipment required to ensure the stability of the grid; • Limited available space for large-scale expansion or upgrade as the project area is located in the center of the city; • Lack of data on projected demand for electricity; and • Limited technical capabilities available (e.g. only one of the two types of automatic switchgear software is available for commercial use; one is still in the development stage in Japan). 	<p>generated for the producers;</p> <ul style="list-style-type: none"> • Additional opportunities for the private sector in the logistics sector. • Reliable supply of power; • Cost savings; • Reduced risk of power loss from distribution and outage; • Efficient power distribution.
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