Pilot Project Proposal

Decentralized Renewable Energy Solutions for Climate Security in Protracted Crisis in Yemen

Decentralized renewable energy pilot grant in Yemen under regional SDG Climate Facility project: Climate Action for Human Security[1]

- $500,000 grant
- Timeframe for implementation 24 months
- Implementing partner: UNDP Yemen
- Required focus on cross-cutting 'climate security'

Project Objective and Vision

The objective of this pilot project is to enhance climate security of vulnerable and marginalized communities in Yemen by demonstrating innovative off-grid waste-to-energy models that create jobs and enhance livelihoods while providing sustainable energy supply from treatment of local waste. This will contribute to enabling cleaner and healthier living conditions whilst providing increased energy supply to essential public services in underserved communities prone to climate-induced displacement. It is expected that the demonstration effect of this initiative will lead to replication and upscaling within Yemen and beyond.

[1] The 'SDG Climate Facility project: Climate Action for Human Security' (Sida: $8.8 million; UNDP: $600,000) is a multi-stakeholder partnership comprising League of Arab States, Arab Water Council, UNDP, UNDRR, UNEP-FI, UN-Habitat and WFP. The regional project includes regional Arab-wide as well as national-level activities.

I. Interlinked challenges – Background and Context

Development, climate, and humanitarian (conflict, crisis, disasters) challenge

In Yemen, the intersection between the impacts of climate change, water scarcity, violent conflict, diseases, displacement and unemployment are evident. Yemen is highly vulnerable to the impacts of climate change with increasing climate-induced disasters including extreme drought and flooding, sea level rise, changes in rainfall patterns and increasing temperatures. These threats are intensified by the fact that Yemen was considered to be one of the world's most water stressed countries even before the war with currently 91% of the population living in water scarce areas.[2]

These trends are thought to be one of many critical factors underlying the country's instability, and prolonging and worsening its conflict[3] - although it is important to state that conflict is a result of many complex factors, of which natural resources and climate insecurity are one factor exacerbating the existing instability. Reduced access to water and extreme weather events not only impact on food security, but they undermine livelihoods, particularly of vulnerable rural based households. Highly vulnerable populations are facing displacement, as a direct result of the conflict, but also due to the lack of employment opportunities, constricting agricultural land and resultant inability to purchase basic food and water supplies.

Climate change is here to stay and will have a year on year compounding negative impact on Yemen unless resilience is built into the fabric of communities and the public services that support these communities.

In addition, Yemen is suffering a catastrophic and devastating unemployment crisis that directly impacts on deepening poverty levels, and is threatening security, economic and social progress. Yemen's 2019 Humanitarian Response Plan (HRP) states that at least 600,000 jobs in Yemen have been lost since the onset of conflict in 2015; and the World Bank estimates 40% of Yemenis have lost their primary source of income. Poverty rates have dramatically increased, with an estimated 81 per cent of Yemenis now below the poverty line – an increase of one-third since 2014.[4]

Meanwhile, Yemen faces a set of rapidly evolving critical challenges which have a major impact on the unemployment crisis. The COVID-19 pandemic is rapidly spreading throughout the country, leading to devastating health consequences and exacerbating economic problems. The June 2020 OCHA Humanitarian update describes that the global downturn that follows the pandemic has led to two of the country's primary sources of foreign exchange drying up – remittances and fuel exports. It is estimated that 80 per cent of remittances sent by Yemenis working abroad is being lost. COVID-19 has also diminished Yemen's income from fuel exports, due to falling demand and prices.

Compounded with the devasting impacts of climate change and the protracted conflict is a breakdown of solid waste management capacities, leading to significant public health risks as well as extremely low supply of electricity to both households and the public services that serve the communities:

- *Energy shortage:* Although rural areas accounts for about 75% of the population, only around 23% have access to electricity compared with about 85% of the urban population. Despite the low access rate of electricity, only about one-half of those populations are connected to public

[2] World Data Lab (worldwater.io), September 2020
[3] https://climateandsecurity.org/2016/08/03/a-storm-without-rain-yemen-water-climate-change-and-conflict/
[4] https://www.worldbank.org/en/country/yemen/overview

grid, and the other one-half gain access through other private sources including diesel generator which usually operate for few hours for lightening, and less-intensive electric appliances. Alternative lighting devices are being used by non-grid electrified rural households including kerosene Lamps (about 67%) and Liquefied Petroleum Gas (LPG) Lamps (about 5%), which has severe environmental impacts.

- *Solid Waste Management:* Before the crisis, the GIZ waste management report in 2014[5] estimated waste generation to be 4 million tons, of which 2.3 million and 1.7 million tons were generated in rural and urban areas, respectively. Today, the lack of solid waste collection and sound disposal options in cities and towns of Yemenis has a direct link to health problems, with air and water pollution from poorly managed waste sites associated with high levels of allergies, asthma, skin irritations and gastrointestinal diseases in nearby communities[6]. Poor management also increases fires and methane emissions, which contribute to global warming. Research from a Yemeni landfill in Ibb in 2009 found that leachate – a liquid discharge from landfill – was escaping the site and leading to heavy metal contaminate and bacteriological contamination in borehole water nearby.

With this Pilot Project for Yemen, the SDG Climate Facility project seeks to address the following challenges with specific reference to solid waste management and energy supply:

	Development	Climate	Humanitarian
Root Cause	Minimal development opportunities due to: ➢ Protracted conflict ➢ Natural resource scarcity: Water and Soil ➢ Lack of energy supply ➢ Breakdown in solid waste management	Climate change leading to: ➢ Longer & more frequent droughts ➢ Increasing temperatures ➢ Rising sea levels ➢ Increasing frequency of storm surges	Constraints in supporting communities in the medium to long term out of conflict, crises and disasters.
Challenge	How to: ✓ Reverse rising poverty levels ✓ Provide stable energy supply ✓ Improve solid waste collection and disposal ✓ Facilitate sustainable access to water ✓ Improve soil quality ✓ Enable economic growth opportunities	How to: ✓ Enable vulnerable communities adaptation to climate change and enhance climate security ✓ Facilitate sound solid waste management in the face of climate change ✓ Foster improvements in agricultural efficiency	How to: ✓ Improve public health and provide healthier living environments ✓ Underpin small to medium scale economic activity amongst the most vulnerable ✓ Enable long term prosperity opportunities

Table 1: *Key challenges addressed by the proposed Pilot project.*

[5] Country report on the Solid Waste Management in Yemen, SWEEPNET, April 2014
[6] Disaster Waste Recovery's Emergency Waste Assessment for UNDP in 2015.

Supporting National Priorities

Yemen's government priorities are focused on the immediate survival needs of the population with a number of global agreements and national strategies existing to guide the proposed Waste-to-Energy approach of this Pilot Project. Yemen has ratified the UN Convention on Climate Change (UNFCCC) and the Kyoto Protocol and has signed the Paris Agreement on Climate Change in September 2016 but has not ratified the agreement. In its greenhouse gas inventory (GHG) it has identified projects to be implemented in the renewable energy (mitigation) field.

In Yemen's National Adaptation Plan of Action (NAPA), developed in 2009, major vulnerabilities are identified in implementing a climate change roadmap in the sectors identified. A lack of data, low capacity, and immediate humanitarian response needs being the focus and this has led to slow uptake in the priorities listed. UNDP has supported Yemen to undertake a Low-Emission Development Strategy (LEDS) in 2013, however this also identified many vulnerabilities including the lack of a government institution to administer climate change policies.

In terms of solid waste management, the Government has approved two main strategies: the National Strategy for Solid Waste Management (2009-2013) and the Investment Plan for Solid Waste

Management (2010 – 2013). The Strategy sets out the Government's overall plans to improve capacity, while the Investment Plan highlights the target of USD 270M to achieve the plans. The Strategy sets out 5 stages to achieve the strategy, in Stage 4 (the second to final stage), waste from energy is mentioned alongside active promotion of at-source segregation.

Within the more immediate term, the Humanitarian partners in Yemen have planned for continued emergency WASH interventions focused on providing access to water and sanitation systems including support to solid waste collection and disposal[7]. These immediate interventions are continuously developed with the respective Yemeni authorities.

Taking into account these Yemen current national strategies, the Pilot Project will demonstrate how the establishment of sustainable energy supply (derived from the treatment of waste that has been collected by communities) will contribute to progression on numerous national priorities and Sustainable Development Goals (SDGs) as presented in below table 2.

[7] "Humanitarian Response Plan: Yemen", June – December 2020, OCHA

	Contribution	
	Waste	Energy
Sustainable Development Goals	*SDG 1 No Poverty* through creation of jobs in waste management *SDG 3 Good Health & Wellbeing* from less decomposing solid waste in the community living environments *SDG 5 Gender Equality* through establishment of women's led cooperatives or MSMEs *SDG 6 Clean Water & Sanitation* from cleaner streets and protect groundwater from waste leachate *SDG 11 Sustainable Cities and Communities* by cleaner living environments *SDG 13 Climate Action* by reducing waste dumping leading to less methane generation and less black carbon from open burning *SDG 15 Life on Land* by less pollution and healthier environments	*SDG 7 Affordable & Clean Energy* from renewable WtE *SDG 8 Decent Work and Economic Growth* from WtE businesses *SDG 9 Industry, Innovation and Infrastructure* from WtE approach *SDG 11 Sustainable Cities and Communities* by renewable energy *SDG 12 Responsible Consumption & Production* by recovering waste as energy lowering demand for fossil fuel *SDG 13 Climate Action* by reducing methane & CO_2 from dumping & burning as well as enhancing climate security and supporting clean (low emission) energy *SDG 17 Partnerships for the Goals* by working together communities, businesses and public sector
Paris Agreement	Contribution	
	Reducing waste as well as recycling / recovery of waste contribute to climate solutions: ✓ Energy use and emissions related to fossil fuel and raw materials extraction are correspondingly reduced with recycling and reuse; ✓ Not disrupting ecosystems in extraction of natural resources means more forests, trees and other vegetation are left intact, allowing them to absorb carbon dioxide; ✓ Stopping the landfilling of organic materials eliminates a huge source of methane into the atmosphere; ✓ Composting organic waste creates a nutrient-rich soil amendment that helps store carbon in the soils; and ✓ Waste-to-energy means creating jobs and diversified livelihoods that enhance the resilience of the poorest and most vulnerable in Yemen which is considered a Least Developed Country (LDC) under the Paris Agreement.	
Sendai Framework	Priority areas for action include:	
	➢ Understanding disaster risk	✓ Converting risk into an opportunity for employment and sustainable energy
	➢ Strengthening governance for DRM	✓ Embedding climate change and resulting disaster risk into public services planning (waste) and community resilience (energy)
	➢ Investing in resilience measures	✓ Private sector investment in WtE for risk reduction
	➢ Strengthening preparedness for effective response	✓ Reducing potential negative impact of climate change and disasters on solid waste management and stabilizing energy supply
	➢ Strengthening the ability to 'build back better' during rehabilitation and reconstruction	✓ Providing communities with self-determining options for improving solid waste management and self-sufficiency in energy

Table 2: *How the WtE approach addresses global initiatives on climate change, disaster risk reduction and environmental management.*

Impact of Climate Change on Solid Waste Management

The effects of climate change on Yemen's management of solid waste will pose an increasing burden on the communities and public services. This is both from the increasing impact of climate change as well as the increasing quantities of solid waste generation projected globally where "Low income countries are positioned for the greatest amount of growth in economic activity as well as population, and waste levels are expected to more than triple by 2050."[8] The key impacts of climate change on solid waste management are highlighted in below table 3.

Climate Change Effect	Impact on solid waste management
Sea level rise	➢ Landfills in costal/low-lying areas more prone to flooding and storm surge ➢ Inaccessibility to some areas, restricted collection routes ➢ Infrastructure possibly permanently inundated and therefore inaccessible, such as waste collection points being inundated by floods resulting in waste escaping into the environment
Increased rainfall	➢ Increase in flooding events, making roads inaccessible and increasing collection times ➢ Increase in amount of leachate
Temperature increase	➢ Increase in mosquitos, flies, and other disease-carrying insects ➢ Requires increase in frequency of waste collection to prevent odour issues in local environments ➢ Alteration of organic waste decomposition rates, increasing methane generation

Table 3: *Key impacts of climate on solid waste management in Yemen.*

Coupling this rising burden of climate change on solid waste with the knowledge of how poorly managed solid waste in Yemen impacts negatively on human health and security as well as the natural environment underpins the necessity for this Pilot Project. The results of poorly managed solid waste on the communities of Yemen are presented in below Table 4.

[8] "What a Waste 2.0", World Bank 2018

Poor solid waste management in Yemen leads to:		
Aspect	**Impact**	**Specific for Yemen**
Public Health	Solid Waste left to **decompose leads to breeding ground for vectors** such as mosquitoes, thereby spreading diseases such as dengue and malaria, and leads to waterborne diseases, like cholera, from contaminated water. **Children playing** in solid waste leads to cuts and infections.	**Uncollected wastes** in streets and urban areas leads to public health risks. With **blocked drainage channels** there are occurrences of stagnant water in public spaces, especially after flooding.
Economic	Poor solid waste management leads to unhealthy working population who are **less productive**. The national/public cost of proper solid waste management is less than the cost of dealing with negative impacts from poor solid waste management.	Solid waste dumped into the drainage channels is a common occurrence and leads to **increased flood risk** with resulting economic impacts.
Environmental	Uncontrolled waste can contaminate soil and pollute surface and groundwater resources, affecting the land that food is grown on. When waste ends up in oceans, it affects marine life and humans up the food chain. Open Burning of waste leads to poor air quality affecting populations and the climate. Decomposing waste at uncontrolled dumpsites leads to methane production, a primary GHG.	Groundwater in Yemen is of high value and **contamination leads to water scarcity.** Yemen's coastal location increases risk of waste entering the **marine environment**. **Open Burning** in Yemen is common place. Widescale open dumping of waste contributing to **global warming**.
Communities	Poor communities tend to live in areas that have poor waste collection services. Coupled with these other impacts, poor communities suffer significantly more than communities in higher-income areas. Poorer communities are more likely to be exposed to waterborne diseases and less able to afford private waste collection.	There are numerous areas of poor households in Yemen who are **experiencing poor SWM and exposed to public health risks**.

Table 4: *Impact of poor solid waste management on communities and the environment in Yemen.*

Waste-to-Energy technology

There are numerous types of WtE technological systems and scale of plant where the gasification process has proven to be a reliable approach due to improved emissions control compared to mass burn combustion, and small-scale gasification plants are currently operational in several countries including India. By focusing on small-scale solutions then this fits better with the community approach adopted for this pilot project in Yemen.

The type of WtE plant planned for in the pilot project is small-scale, off-grid and decentralized system as presented in below figure 1.

Figure 1: *Typical small-scale gasification plant generating 5KW energy from the gasification of the waste.*

A range of household and agricultural wastes can be used to feed the gasification plant with resulting 'syngas' being generated that in turn runs a generator for generation of electricity. A by-product of the process is an ash (7-10% by weight of waste gasified) which can used as either a fertilizer (if no plastics are burnt) or if plastics burnt then can be used in the manufacture of building blocks when mixed with cement.

This plant will require import to Yemen with spare parts for typical 2 years operations and operational / maintenance training provided by the manufacturer. For additional spare parts the plant is relatively low-tech, and the majority of the spare parts can be sourced locally in Yemen. Maintenance and operation of equipment beyond project completion will be part of the sustainability strategy to be elaborated during project implementation, within the framework of the value chain analysis. The value chain analysis (Activity 1.1 in below Section III Multi-year Work Plan) will determine the optimal size/capacity for the WtE plant, number of employment opportunities, waste quality and quantity required per day and energy generation output. It will also elaborate on sustainability of project results, especially technology maintenance and operations, beyond project completion. This will be a critical part of the analysis.

Impacts on Vulnerable Communities

The WtE Pilot Project focusses significantly on vulnerable communities by ensuring that employment opportunities are directed to these beneficiaries to enhance climate-security on the ground. By making the WtE plants dependent on solid waste collected by community-oriented organizations (for example cooperatives) within the targeted vulnerable communities, there is longevity and sustainability built into these waste collection livelihoods for as long as the WtE plants operate.

In addition, by removing solid waste from the streets and public spaces of the target communities, the residents will be provided with cleaner and healthier living environments.

As regards the energy supply resulting from the treatment of the solid waste collected by vulnerable communities, this energy will be more stable and reliable to power key public services such as health clinics, schools and more.

For the selection of beneficiaries and target communities the two areas identified are Lahj in southern Yemen and Hodeidah in northern Yemen. An existing program with the title ERRY II[9] is being implemented in these accessible areas and thus the aim is to build on synergies with ongoing activities on livelihoods, solar energy, local governance and social cohesion. In these two locations ERRY partners include FAO, ILO and WFP and there is a strong willingness of the private sector to participate in the WtE pilot project. Furthermore, these two locations are worst affected by cholera, food insecurity, lack of access to energy, and waste management is not functioning optimally.

A gender sensitive vulnerability assessment will be conducted in the first phase of the project whereby the target communities for the project will be selected based on the principles of the already established "Monitoring and Evaluation Operational Guidance Document" which underpins the ongoing ERRY II program: Supporting Resilient Livelihoods and Food Security in Yemen. ERRY II adopts the 3x6 approach whereby beneficiaries are selected based on a household vulnerability scoring approach as detailed in the guidance document. The 3x6 approach is a blend of humanitarian and development approach where beneficiaries receive the immediate cash needed to meet daily needs, at the same time as being supported to diversify their livelihood opportunities. Example key parameters can include:

- Lack of job and employment opportunities within and adjacent to the community;
- Food insecurity within the households;
- Detrimental impacts such as having to withdraw children from schooling, lack of funds to buy food, etc.;
- Likelihood of displacement from home due to climate impacts, i.e. impacting agricultural subsistence, lack of access to water, etc.;
- High presence of uncontrolled household waste within public and private spaces within the community leading to human health risks;
- Proportion of female headed households within the communities;

[9] ERRY II is the second phase of the recently completed Enhanced Rural Resilience in Yemen (ERRY) programme, funded by the European Union, and implemented by the UNDP, ILO, WFP, and FAO.

- Systematic lack of, or reducing, supply of electrical power to both private and public functions and,
- Communities that could be participative in peace-building measures and opportunities.

The selection of target communities will also take into account the principles of 'Do No Harm' by ensuring that the following key aspects are considered in the selection of beneficiaries within the target communities:

- ✓ Understand the context in which the WtE project will operate including the gender dynamics and power relationships;
- ✓ Understand the interaction between the ambitions and scope of the WtE project with the context identified; and;
- ✓ Take that understanding into account in order to avoid negative impacts and maximize positive impacts on the community.

II. Pilot project Strategy

Pilot Project Objective

The objective of this pilot project is to enhance climate security of vulnerable and marginalized communities in Yemen by demonstrating innovative off-grid waste-to-energy models that create jobs and enhance livelihoods while providing sustainable energy supply from treatment of local waste. This will be achieved through implementing affordable and sustainable Waste to Energy (WtE) model(s) to promote employment creation in crisis context as well as facilitating healthier living conditions by both removal of human health risks from uncontrolled wastes in the streets and distribution of electricity for community facilities.

Integral to the objective and proposed activities is a focus on supporting the relevant local authorities with improved solid waste collection and management, where these authorities are financed through the City Cleaning and Improvement Fund under the Department for Waste Management within the Ministry of Local Affairs (MoLA). This support will be both in institutional strengthening for management of improved collection systems, developing public – private partnerships for waste management as well as engaging cooperatives to complement the waste collection services that are currently underserving the populations in the communities. Furthermore, by providing electricity derived from the waste gasification, and channeling the distribution of this electricity through community cooperatives for public sector benefit, the local authorities will benefit from this additional electricity supply.

Please refer to Section III on Multi-Year Work Plan for details on Outputs/Activities to be supported under the project.

Partnerships

To achieve the Pilot Project objective and underpin the strategy of multiple engagements within public, private and communities, the Project has been designed to work with the local authorities in linking cooperatives (solid waste collection and sorting as well as energy distribution) with considerable private sector investment (WtE plant establishment and operations) to support each other in an inter-dependent system. Coupled with this is the relationship with the public authority's delivery of public services through, amongst others, water irrigation, health clinics and schools.

Demonstrating that the WtE approach can work whereby micro, small and medium-sized enterprises (MSMEs) buy the solid waste from cooperatives will leverage private sector funding to invest alongside this project and promote economic growth and job creation to build back better and underpin a more resilient post-crisis community. UNDP has already made preliminary steps towards engaging with private sector entities as shown in "UNDP & Private Sector" to the right.

UNDP & Private Sector

UNDP has secured the interest of a private sector company in each of the target locations for WtE co-ownership and operations:

- ✓ *Comprehensive due diligence ongoing*
- ✓ *MOUs signed with clear roles & responsibilities*
- ✓ *Financial feasibilities being developed*

Furthermore, there is a relationship to be forged between those currently collecting waste for an income (i.e. waste pickers), the local authorities responsible for waste collection and those cooperatives looking to set up the waste collection and sorting activities as part of the WtE Pilot Project. The project will facilitate the opportunity for the waste pickers to be a key part of the waste collection and sorting process by integrating them into the applicable cooperatives for continued job and employment security.

The envisaged inter-dependency of waste and energy between the various parties is shown in the below Figure 2.

Figure 2. *Envisaged value chain for WtE Pilot Project showing inter-dependency of community cooperatives with private sector and underpinning the public services provided by the local authorities.*

One UN Approach

Considering the multi-faceted approach of the Pilot Project on waste management, livelihoods, energy and institutional strengthening across numerous community, private and public entities, the Pilot Project has been designed with a strategy to implement substantial linkages across the UN system, including learning from experience and joint implementation. This is specifically addressed by implementation of the WtE Pilot Project within the context of the ongoing ERRY II program where numerous UN actors collaborate including ILO, WFP, FAO and UNDP.

Furthermore, The FAO, World Bank, WFP and UNICEF have relevant initiatives underway in renewable energy generation, waste management, and livelihood programming. The project will link up with these other actors to gain insights from previous experiences and share knowledge and information throughout project implementation. The project will be coordinated through the UN Cluster System, with linkages to the WASH Cluster, Food Security and Agriculture Cluster and the Early Recovery Cluster.

Sustainability in Outcomes

With an implementation strategy for continued self-sustaining operations, the WtE Pilot Project has the potential to continue in a sustainable manner given the inter-dependencies between each main element:

- Energy supply needs the WtE plant to generate the electricity for which there is significant demand; and,
- The WtE plant needs the solid waste which has been collected and sorted by the community cooperatives.

The business models developed and adopted within the project will be designed to focus on long term sustainability of operations whereby the quality and quantity of the waste feedstock is set taking into account both the types of waste 'freely' available within the communities as well as fair pricing for the waste supplied by the cooperatives. Furthermore, the energy pricing from the WtE operators to the energy distributors will be fairly set to ensure a sufficient profit for the WtE operators and yet a fair price for the energy distributed to the end consumers (see below section on Fair and Equitable Pricing).

Once the WtE models are operational and determined successful in meeting the requirements of the project, these models will be clearly defined for optimal population numbers served as a function of waste generation needed to fuel the WtE plant, which in turn generates enough electricity to warrant buying the solid waste (feedstock). Once these optimal models have been demonstrated, they can be replicable for other cities and towns in Yemen, as well as options to scale up as required.

Strengthening Local Services

By facilitating energy security through WtE approach, as well as generating sustainable livelihoods and employment opportunities that are inter-dependent on the WtE plant, the resulting local services and living environment will be stabilized and contribute to enabling the permanence of recovery for communities. Support to the local services includes:

- ✓ Complementing and strengthening waste collection from the streets to reduce public health risks;
- ✓ Reducing waste for disposal which protects natural environment from negative impact of uncontrolled waste and leachate entering groundwater; and,

- ✓ Provision of electricity to supplement energy provision which is currently significantly below energy needs.

Furthermore, with the energy generation being directed into public services, such as water pumps, health clinics and schools, target vulnerable communities will be supported in resilience towards climate change and the protracted conflict. For example, increasing access to water for agricultural irrigation will underpin more stable food security in areas deeply impacted by drought.

Exit Strategy

A key process to achieve these sustainability outcomes is to ensure an appropriately designed and planned exit strategy whereby two WtE plants will have been established and operational in two target communities. These WtE plant will have been financed with private sector funding and will sell electricity to local public service-oriented demand and distributed through cooperatives. The WtE plant will continue to buy waste from the cooperatives to fuel the WtE plant, and the funds received by these cooperatives will pay salaries and costs for the solid waste collection and sorting. By integrating this inter-dependent relationship then each element of the system will support the other elements for as long as there is a demand for electricity.

The exit of UNDP from the project will be designed in from the start of the project and facilitated by ensuring that all cooperatives, MSMEs and WtE operations are established as functions independent to UNDP and reliant on each other for continued success.

It is noteworthy that UNDP has already engaged with relevant private sector companies that have shown interest in the WtE operations as an ongoing business opportunity tied into the waste selling cooperatives. Furthermore, the local authorities in the target areas have also been engaged and offered their support to the overall concept and approach of the WtE Pilot Project.

An agreement will be formulated with the stakeholders 9 months prior to project end to ensure that at project completion the installed plants will continue under operations and management of WtE operators, waste collection cooperatives and energy distribution organizations. There are several past project examples of 'handover' of operational assets from UN agencies to local public, private or public-private bodies which are often tied into obligations to serve the communities for a set period of time until full ownership is gained by the beneficiary.

Key Implementation Factors

The following factors are key to the design, planning and implementation of the WtE Pilot Project:

Regional Consultations

A key benefit of the SDG Climate Facility project development process is the consultation approach with key government counterparts including the focal points for the Arab Water Council and the League of Arab States Sustainable Development Focal Point, as well as the Sendai Framework and the Climate Change focal points. This allows for a wide capture of inputs to the finalized project design and implementation from a range of stakeholders to enhance the cross-cutting approach for multiple SDG benefits going beyond business as usual.

A list of all participants on the numerous consultations held during the development of this proposal are included in Annex A.

Fair and Equitable Pricing

The inter-dependent partnerships and relationships within the WtE Pilot Project support the longer-term sustainability of the project outcomes, i.e. continued waste to energy process, since each party in the chain of waste to energy flow are reliant on each other. This relationship will be formulated in appropriate agreements specifying:

- Quality and quantity of waste supplied by the cooperatives to the WtE operators;
- Parameters for the supply of energy from the WtE operators to the cooperatives responsible for the distribution of energy; and,
- Distribution agreements from the cooperatives buying the energy and then distributing to public sector and private sector 'customers'.

The process of determining fair and equitable pricing mechanisms will be a consultative approach, managed by UNDP's experienced staff, taking into account the current market prices for recycled wastes as well as the costs for waste collection incurred within the Cleaning Fund policy of the local authorities. The distribution of electricity will follow the same approach of ensuring market prices are respected. It is key to ensure that the prices and costs are commensurate to current market standards since the WtE initiative is not to deprive people of their livelihoods in, for example, waste collection and sorting. Thus, the waste pickers, often the most vulnerable, will be engaged in this process to ensure they can benefit from additional income generation, thus securing their livelihoods.

Providence of Grants

To support the start-up of the various cooperatives and MSMEs for waste collection and sorting, catalyst seed grants will be provided for up to $600 per grant. These grants will be provided based on a clear business proposition that would be reviewed by technical experts and the project management team in a gender-sensitive manner. The activities envisaged covered by the grants includes community waste surveys to assess current practices, tools & equipment purchase to implement household/market waste separation and collection, transport costs from community collection to WtE facilities etc.

Grants would be made in stages based on accepted plans, receipts for equipment, time spent by participants. In addition, technical experts of the Pilot Project provide continued support on technical, management and socio-economic aspects for the development of labor-based methods of waste collection, separation, transfer and WtE processing to maximize good quality, sustainable, job creation.

The project will only provide seed grants to private sector where it is necessary to enable business operations to be initiated, while continued operation and maintenance of the established WtE plants will have to be borne by the beneficiaries themselves.

The project will also develop and implement a financial sustainability plan that will ensure that a part of revenue from business operations will be set aside to meet operation and maintenance expenses in the medium term (i.e. beyond completion of the Piot Project).

Concerning the basis upon which grants are made, the following is envisaged:

- Grants provided to the cooperatives and MSMEs will be on a reimbursable basis whereby should the enterprise fail then there is no repayment due. However, if the enterprise succeeds then the enterprise is to repay the grant where such funds would then revolve to additional potential enterprises for the expansion of the services into new geographic environments; and,
- Financial support associated with the WtE plant will be based on similar terms as the MSMEs grants whereby if the WtE operations succeed then the WtE operating companies will be required to repay the funding either outright before the end of the project or on a financial agreement structured beyond the project end date. Again, any funds received would revolve to future similar enterprises.

Gender

Women are worst affected by the impacts of climate change, by violent conflict and displacement. As primary caregivers for children and elderly, women often undertake coping mechanisms in order to gain access to very basic needs, such as walking long distances to secure water and bargaining for food. These coping mechanisms can have a detrimental and negative impact on the role, health and livelihoods of women in communities.

Within this waste management and energy supply project there are significant opportunities to support women to become 'agents of change' such as:

- *Advocacy*: In past humanitarian waste management projects, women have often been the drivers for cleaner and healthier living environments for families within communities. Mothers are keenly aware of the health risks to children posed by waste and can be strong advocates for changes in waste management practice, especially when they are also leading the initiatives;
- *Business*: In Yemen, between March and August 2015, 26 per cent of businesses closed due to the war with women-headed businesses even harder hit, with 42 per cent of businesses closing. With waste management it has been shown that women can set up and lead business opportunities such as 'Trash for Cash' (already demonstrated by UNDP in Yemen), recycling waste into, for example fuel briquettes and other recycled products, and selling such products;

- *WtE*: The operations of a WtE plant and process is not limited to gender and thus women-led businesses will be prioritized to establish and operate the WtE plant; and,
- *Energy Distribution*: For the management of energy distribution, through the UNDP led consultative approach to fair and equitable price setting of energy including distribution, women will be included in the decision making process on where energy would best be supplied to for the benefit of communities as a whole.

Where waste is sorted already within the households, i.e. with separate bins in the kitchen which are then placed into separate collection bins in the street (one for the WtE system and one for disposal),

then there will be a reduced need for waste sorting within the cooperatives. This can be a benefit since the manual sorting of waste can lead to human health risk from contact with waste. Therefore, opportunities to sort waste at the household level will be investigated where women can be agents of change whereby sorted waste is more readily treated in the WtE process. Furthermore, experience from other countries have shown that women are often engaged in the 'informal' sector of waste management as waste pickers etc. As the waste management sector becomes more formalized and professional, then it is often men that take the 'new' more lucrative and safer jobs. This pilot project will address this when supporting the MSMEs / cooperatives in establishing the waste collection and sorting, as well as energy distribution organizations, and ensure that women and men have equal opportunities related to the WtE operations, and where possible, priorities given to women led cooperatives/MSMEs.

For the establishment of cooperatives in relation to gender then it is recognized that the cultural context in Yemen is such that men and women cannot be in the same cooperative or MSME group. UNDP will therefore ensure that a balanced number of MSMEs and cooperatives established in the Pilot Project are created with solely women.

UNDP's range of gender equality ethics, principles and project design procedures will be integrated into the project with applicable monitoring and evaluation procedures in place. As a first step a complete gender analysis will be undertaken in both pilot communities to identify gender power dynamics and options for employing women and consulting with women in the communities to ensure their engagement in project decision making. All relevant data collected for planning, design and monitoring purposes will be sex-disaggregated.

Risk Management

It is appreciated that Yemen is currently a politically, economically and socially fragile country in which to implement projects such as this WtE pilot project. However, the risks to achieving a successful project are relatively low since:

- There is a consistent supply of solid waste for the cooperatives to 'freely' collect and supply to the WtE operators;
- There is a keen interest in investment for WtE plants by private sector companies as informed to UNDP Yemen by various business communities;
- The WtE plants are relatively low-tech, small-scale and will be supplied with at least 2 years spare parts as well as operational and maintenance training; and,
- There is a consistent demand for energy in Yemen and thus the offtake of the electricity generated is secured.

A complete risk log will be developed as part of the detailed implementation plan during the project launch and initiation phase.

A key factor outside the control of the project is local political stability / hostilities and thus the project will adopt a robust "adaptive management" system where, for instance, in case of conflict impacting one of the target locations then the WtE will be designed to be dis-assembled and re-assembled in a more stable location. Alternatively, the risk of conflict can trigger a pre-determined exit strategy to which all parties are in agreement at point of contracting.

With reference to the 'investments' made in waste collection and sorting (i.e. the funding for this Pilot Project), then these are never 'wasted' investments since improved solid waste management has a direct positive public health benefit. For example, the sorting of waste into recyclables, be that

for gasification or sale as a recyclable material such as plastic, leads to an income which leads to increased waste collection for further sorting. This increased waste collection means less uncontrolled waste in the streets and thus reduces public health risks. Furthermore, demonstrating feasibility for waste recycling can open opportunities for additional waste recycling initiatives such as fuel briquettes (as implemented by UNDP Syria), composting and plastic recycling into paving blocks etc.

Related Activities in Yemen

Benefits can be realized during the design, planning and implementation of the Pilot Project when project activities are tied into other ongoing aligned initiatives and activities. For this specific Pilot Project there are a number of existing baseline reports, assessment and lessons from programs currently being supported that would inform the project. Some of these include:

- **EU supported**- Supporting Resilient Livelihoods and Food Security in Yemen (ERRY II);
- **Various donor supported under the Office of Special Envoy**- Peace Support Operations (PSO)-initiative under Stockholm Agreement
- **Government of Japan supported**- Crisis Support in Solid Waste, Water Supply, and Sewage Institutions

Furthermore, the project would use data from the Food Security and Livelihoods Assessment and Integrated Food Security Phase Classification[10] analysis to target locations and families in most need of support of the targeted actions.

The project will be implemented within the Humanitarian Response Plan (2020 Extension), particularly with regards to the Food Security and Agriculture Cluster targeting of food insecure households, potentially the food insecure rural families facing IPC phase three, four and five conditions. These phases categorize food security with phase 3 being "Acute Food and Livelihood Crisis", Phase 4 "Humanitarian Emergency" and Phase 5 "Famine / Humanitarian Catastrophe"[11].

The project would use data from the Cluster's Food Security and Livelihoods Assessments and Integrated Food Security Phase Classification analysis to determine the most vulnerable in need of livelihoods support. It will respond to the second line response of providing food- insecure families facing IPC phase three, four and five conditions to establish micro-businesses

Baseline assessments: Disaster Waste Recovery's (DWR) Emergency Waste Assessment in Yemen for UNDP in 2015 describes the status of waste management across five governorates, and the impact of conflict on waste management. The report describes specific challenges that face the solid waste management sector that would input to project design including the impact of the export blockades, high cost of fuel, power cuts and damage to infrastructure. It also has completed a stakeholder analysis (public and private sector), from Ministry Level (Ministry of Local Administration and Ministry of Local Affairs) to local authority level - but also describes the informal actors in the recycling sector, including informal waste pickers.

[10] YEMEN PARTIAL ANALYSIS: Integrated Food Security Phase Classification Snapshot | February - December 2020
[11] Integrated Food Security Phase Classification (IPC) for Global Acute Malnutrition

III. Multi-year work-plan

The project implementation contributes to two key regional project areas:

Key Area 1. **Building local leadership and capacities** including of governors, mayors, local councils for innovative and transformational change by integrating climate measures in development and crisis prevention/recovery policies and actions to make development and crisis prevention/recovery efforts more risk-informed and resilient, as well as integrating a gender sensitive approach; and

Key Area 2. **Actions at the local level to catalyze and accelerate innovative solutions for vulnerable communities** to take climate action in a way that promotes an integrated approach to mainstream climate action across SDGs and crisis prevention/recovery goals.

Below are the specific outputs for the project:

Project Outcome 1: Improved access to capital for the recovery of micro, small and medium enterprises with good potential for job creation and income generation within the sectors of solid waste collection, energy distribution and WtE operations.

Planned activities:

1.1. Energy and Waste value chain analysis to determine optimal model including financial system: Evaluate revenue from sale of electricity by the small-scale, decentralized WtE plant which in turn sets the fee payable to cooperatives collecting waste to facilitate the symbiotic relationship and provide energy to public and private consumers as determined by the community priorities. The analysis will determine employment opportunities based on quantity of waste generated in the target communities and subsequent electricity that can be generated from the waste quantity, where this balance between employment requirement versus waste quantity determines the size of community required to ensure sustainable continuation of the WtE plant beyond the duration of the pilot project.

1.2. Provision of technical support to private sector actors to build and/or improve a gender-sensitive, financially and environmentally sustainable business model for development of a WtE business, including, for example, analysis of waste volume availability, WtE type and capacity requirements, cost/benefit analysis over set period. Subsequent advice and support to the MSMEs to build technical and business plans to assist them in raising necessary capital beyond the limited provision of catalytic seed grants provided by UNDP (see below), as well as continued technical support on WtE establishment and operations.

1.3. Provision of catalyst seed grants to cooperatives, MSMEs and private sector based on reimbursable funds depending on success of the individual cooperative, MSME and company. Monitoring of grant expenditure and financial return attained to assess options for repayments.

1.4. Provision of catalyst seed grants (up to $600, based on a clear business proposition that would be reviewed by technical experts and the project manager) in a gender-sensitive manner to set up the cooperatives for energy distribution including purchase agreements with the WtE operators and subsequent sale of electricity to community selected public and private consumers.

<u>Project Outcome 2</u>: Enhanced collaboration of private sector networks, MSMEs and local authorities at district and national level under Connecting Business Initiative (CBI) for business resilience

Intended activities:

2.1. Providing clear entry points for private sector, MSMEs and local authority for collaboration, including fair working agreements on community benefit focus, supply / purchase, payment terms, quality standards and continued operations. This includes connecting the collaboration at district and national level for waste to energy value chain in a way that enhances climate-security of locals vis-à-vis potential climate-induced displacement and impacts of climate change on vulnerable livelihoods.

2.2. Working with local actors to ensure activities support local needs and existing priorities, where possible. This includes Local Authorities who are mandated to undertake waste collection (activities financed through the City Cleaning and Improvement Fund) under the Ministry of Local Affairs (MoLA), Department for Waste Management. It should be noted that a number of other Ministries are mandated to oversee functions that relate to WtE systems, however the impact of conflict on the government infrastructure has been devastating, at all levels. The project would take a pragmatic approach of working with authorities, and build their capacity where possible, and engage with informal actors where government is not functioning to the required capacity. Such capacity building in areas of solid waste management, operational systems and private-public partnerships relationships.

2.3. Developing and disseminating good practices on collaboration of private sector, MSMEs, MFIs and local authorities on waste-to-energy for climate-security and enhanced resilience of vulnerable people, drawing on the results of the pilot project and, where successful, disseminating models for replication and upscaling across Yemen and beyond.

Project Component/ Outcome	Outputs	Links to Key Area	Baseline and Indicator	Timeline (in months)	(in US$)	
					SDG Climate Facility Project Grant	UNDP Yemen Co-financing
Outcome 1: **Access to capital for WtE system establishment**	Output 1.1: WtE system design with economic model for waste collection, waste sale as feedstock, WtE operations and power purchase & distribution systems	Key Area 1: ☒ Key Area 2: ☐	*Baseline:* - "Technical Assessment for Small-Scale Waste to Energy Project in Lahj" UNDP ERRY2 (March 2020) - "Waste to Energy – The Piot Project", Ibrahim Shami 2020 *Indicator 1.1*: WtE System Model demonstrating socio-economic feasibility and benefits for climate security	0 -3	375,000	150,000
	Output 1.2: WtE procurement and operations based on waste purchase and sale of energy	Key Area 1: ☐ Key Area 2: ☒	*Baseline:* - "Technical Assessment for Small-Scale Waste to Energy Project in Lahj" UNDP ERRY2 (March 2020) - "Waste to Energy – The Piot Project", Ibrahim Shami 2020 *Indicator 1.2:* Two small-scale decentralized WtE plants in operation	3 – 24		
	Output 1.3: Seed funding for MSMEs / cooperatives in waste collection & sorting based on submitted fund applications	Key Area 1: ☐ Key Area 2: ☒	*Baseline:* - GIZ 2014 report on Waste management and DWR Waste Assessment 2015 showing extensive uncontrolled waste in Yemen. - Energy Supply status for Yemen *Indicator 1.3:* No. of MSMEs / cooperatives operational for waste collection and sorting to enhance climate security of vulnerable *Indicator 1.4:* ratio of women to men-led MSMEs or cooperatives operational in waste collection and sorting	3 – 24		

Project Component/ Outcome	Outputs	Links to Key Area	Baseline and Indicator	Timeline (in months)	(in US$)	
					SDG Climate Facility Project Grant	UNDP Yemen Co-financing
	Output 1.4: Seed funding for MSMEs / cooperatives in energy distribution based on submitted fund applications	Key Area 1: ☐ Key Area 2: ☒	*Baseline:* - Energy Supply status reports for Yemen *Indicator 1.5:* No. of MSMEs / cooperatives operational for energy distribution to enhance climate security *Indicator 1.6:* Ratio of women to men-led MSMEs operational in energy distribution	3 – 24		
Outcome 2: **Enhanced Public-Private collaboration**	Output 2.1: Working environment that enables cooperatives, MSMEs and WtE companies to operate aligned to public authorities	Key Area 1: ☒ Key Area 2: ☐	*Baseline:* - No current similar waste to energy systems *Indicator 2.1:* Set of working agreements / contracts for waste to energy value chain.	3 – 6	100,000	00
	Output 2.2: Government and Local Authority capacities for public – private initiatives in waste and energy	Key Area 1: ☒ Key Area 2: ☐	*Baseline:* - Limited current governmental capacity for establishment of WtE systems *Indicator 2.2:* Capacity building and institutional strengthening programme implemented	3 – 24		
	Output 2.3 Dissemination of WtE systems public-private collaboration in Yemen for replication and upscaling	Key Area 1: ☒ Key Area 2: ☐	*Baseline:* - No previous WtE experience in Yemen *Indicator 2.3:* Business and Operational Models for WtE in Yemen for dissemination	18 – 24		
		Subtotal			475,000	150,000
		General Management Support Cost (ca. 5% of GMS)			25,000	00
		Total Project Cost (= Subtotal + GMS)			**500,00**	**150,000**

Annex I: Organizations consulted during proposal development

- **Mohammed AlHawri, Chairman, Environmental Protection Agency, focal point for Sendai Framework, focal point for League of Arab States, national climate change focal point, GCF/GEF/Adaptation Fund focal point**
- **Shuaib Zaghir, Environmental Protection Agency**
- **Hadi Ali, Chairman, National Water Resources Authority**
- **Abdulkareem Al-Sufiani, Deputy Chairman, National Water Resources Authority**
- **Mohammed Al-Harith, Head of Coffee Department, Ministry of Agriculture and Irrigation**
- **Ezideen Al-Junaid, Deputy Head, Ministry of Agriculture and Irrigation**
- **Amin Al Hammadi, General Authority for Environmental Protection**
- **Naguib Mohamed Ahmed, Ministry of Water and Environment, Arab Water Council Board of Governors member**
- **Walid Saleh, FAO, Yemen**
- **Mohammed Al-Qasem, WFP, Yemen**
- **Tawfiq Jaber, ILO, Yemen**