



Female IDP cooking with biogas produced from anaerobic digestion of faecal sludge in Malakal PoC © Geophrey OYUGI / IOM 2021

SITUATION ANALYSIS

Universal energy access is essential for enhancement of livelihoods as it cuts across the entire 2030 agenda for sustainable development. Globally, about 2.8 billion people lack access to clean cooking fuels and technologies.¹ Traditional biomass largely used for cooking and lighting by energy poor communities contribute to household air pollution that directly causes about 2.8 million deaths per year.² The overarching importance of energy in development saw the UN make a landmark commitment through the Sustainable Development Goal 7, to provide modern, sustainable, reliable, and affordable energy for all by 2030. However, South Sudan ranks lowest in Africa in terms of electrification rates, with the World Bank indicating only 6.7% of its population had electricity access in 2019³.

In addition, only 2% of South Sudan population use non-solid fuels for cooking and heating, with charcoal use amounting to 8 kilo tonnes equivalent of oil in 2015.⁴ Energy poverty in South Sudan thus remains high, as much of the service infrastructure is still damaged, destroyed or not operational due to the prolonged protracted crisis in the country.⁵ Population displacement further compounds the energy access challenges mentioned above, given the complex operational dynamics in displacement contexts. For example, 80% of 8.7 million refugees and internally displaced persons in camps in Africa had minimal access to energy in 2015, with overreliance on traditional biomass for cooking and no electricity access⁶ – a trend that is likely to apply to the 1.6 million internally displaced persons and 2.2 million refugees in South Sudan, in 2021.⁷

Poor sanitation remains a challenge in South Sudan, with about 73% of the population practicing open defecation and only 17% reporting owning a latrine in their compound.⁸ Furthermore, collection, transportation and final disposal of liquid waste is inefficient or non-existent across the country, with lack of proper sewage systems and water treatment elevating the risk of water-borne illnesses such as cholera.⁹ Considering the geographical distribution of populations, the country's limited road infrastructure and protracted conflict, service improvement has been slow.

Interlinkages between energy access and WASH-related outputs are increasingly visible across businesses, the public and governments. Water is needed in all stages of energy production whereas energy is crucial for provision of treated water. It is estimated that 4% of global electricity consumption was used to extract, distribute, and treat water and wastewater in 2014.¹⁰ On the other hand, about 398 billion cubic meters of water was withdrawn for global power generation in 2014, with 2% of this volume used for generation of renewable energy.¹¹ Energy is also required to illuminate latrines

during the night and improve individual safety and security, most importantly to women.

Opportunities exist to adopt integrated solutions towards increasing energy access and WASH services for realization of the UN's Sustainable Development Goals on Clean Water and Sanitation (SDG 6) and on Affordable and Clean Energy (SDG 7). Anaerobic digestion technology¹² in particular, offers a low carbon pathway for effective sanitation and energy production with significant environmental, social, and economic benefits. Huge biomass resources (fecal sludge and food waste) in displacement contexts presents an opportunity for adoption of anaerobic digestion technology.

ACCESS TO ENERGY AND SANITATION IN MALAKAL PROTECTION OF CIVILIANS (POC) SITE

Malakal Protection of Civilians (PoC) is the second largest IDP camp in South Sudan. Established in December 2013 as a temporary site to protect South Sudanese civilians from an imminent threat of harm, the camp still hosts 34,056 Internally Displaced People (IDPs).¹³ Reliant on leaving the camp during the day to sustain their livelihoods, these individuals return to the perceived safety of the PoC at night, albeit enduring challenging living conditions, marked by congestion and overcrowding.

Malakal PoC is geographically isolated hence disproportionately affected by lack of energy and a potentially integrated sanitation system. It has zero electricity access, with traditional biomass (charcoal/firewood) and paraffin used to provide cooking and lighting energy, respectively. Smoke and particulate matter that emanates from combustion of traditional biomass and paraffin exposes households to harmful fumes and is strongly linked to several respiratory health complications. Lack of streetlight in communal latrines and spaces within Malakal PoC, coupled with unavailability of hand-held portable lighting products increases risk of attack to IDPs at night or in dark spaces.

Use of traditional biomass in Malakal PoC is particularly impactful on women. On one hand, it curtails their ability to attend school and/or engage in productive activities, since they are responsible for firewood collection which is a time consuming activity. On the other hand, firewood collection in this context happens in a remote and isolated forest tucked 3km away from the PoC, which offers a suitable hiding ground for sexual predators, increasing women's vulnerability to the risk of sexual gender-based violence.

Malakal PoC is serviced through a decentralized sanitation system, based on communal sanitation facilities (improved pit latrines) that are desludged on a regular basis. Untreated fecal sludge is regularly desludged from pit latrines by desludging tractors and transported off site for treatment in waste stabilization ponds (WSPs) located 4km away from the camp. Such modality of operation is unsustainable in the long run: transportation of untreated faecal sludge poses serious public health risks to the handlers, is laborious, expensive (given the cost of daily transportation fuel) and potentially harmful to the environment as waste stabilization ponds have been identified as sources of greenhouse gas emissions such as nitrous oxide and methane.¹⁴

¹ Daly, H. Walton, M.A., 2017. *Energy Access outlook 2017 from poverty to prosperity*. Paris: International energy agency. Pg 12

² Ibid., Pg. 14.

³ WORLD BANK, 2019. *Access to electricity (% of population) -South Sudan*. [online] Available at: <https://data.worldbank.org/indicator/EG.ELC.AC.SS.ZS?locations=SS> [Accessed 16 Sept 2021]

⁴ UNEP, 2015. *Energy profile: South Sudan*. [online] Available at: <https://www.unep.org/resources/report/energy-profile-south-sudan> Accessed 16 Sept 2021]

⁵ AFRICAN UNION, 2014. *Final report of the African union commission of inquiry on South Sudan*. [online]. Available at: <https://www.peaceau.org/en/article/final-report-of-the-african-union-commission-of-inquiry-on-south-sudan> [Accessed 17th Sept 2021]

⁶ Lahn, G. Grafham, O., 2015. *HEAT, LIGHT AND POWER FOR REFUGEES saving lives, reducing costs*. London: Royal institute of international affairs.

⁷ UNOCHA 2021. *Humanitarian Needs overview South Sudan, Humanitarian programme cycle*. [online]. Available at: <https://reliefweb.int/report/south-sudan/south-sudan-humanitarian-needs-overview-2021-january-2021> [Accessed 16 Sept 2021]

⁸ UNOCHA 2021. *Humanitarian Needs overview South Sudan, Humanitarian programme cycle*. [online]. Available at: <https://reliefweb.int/report/south-sudan/south-sudan-humanitarian-needs-overview-2021-january-2021>

⁹ UNEP 2018. *South Sudan First State of Environment and Outlook Report 2018*. [online] Available at: <https://www.unep.org/resources/report/south-sudan-first-state-environment-and-outlook-report-2018> [Accessed 21 Sept 2021]

¹⁰ Kesicki, F. Walton, M.A., 2015. *Water Energy Nexus*. Paris: International energy agency.

¹¹ Ibid. pg. 14.

¹² Process in which biodegradable organic matter are broken down in absence of oxygen with biogas and digestate released as byproducts of the process.

¹³ CCM cluster, IOM 2021. *South Sudan: Malakal POC brief*, [online] Available at: <https://reliefweb.int/report/south-sudan/south-sudan-malakal-poc-brief-15-september-2021> [Accessed 16 Sept 2021]

¹⁴ Paniagua, H.L. et al., 2013. *Greenhouse gas emissions from stabilization ponds in subtropical climate*. *Environmental Technology*, 35(6), pp. 727-734.

Barriers to Energy Access in Malakal Protection of Civilians (PoC) Site

Energy access in Malakal PoC remains a challenge due to the complex nature of the operating environment. Energy in humanitarian facilities within the camp is largely supplied through infrastructure powered by diesel generators. Diesel is obtained through 'procurement and distribution model' which takes advantage of established humanitarian and development actors' logistics, fleets, and tax exemptions to bypass the following energy access barriers in Malakal:

Social barriers: i) safety risks on installed energy technology (e.g. a barbed wire barrier had to be erected around installed solar panels to prevent vandalism); ii) insecure river and road access that forces humanitarian actors to rely on expensive air shipment of diesel and any other basic energy products;¹⁵ iii) risk to individual safety and security with most private enterprises fearing to set up energy supply and delivery chains as Malakal is perceived as unsafe for business due to the protracted civil war; iv) community scepticism towards clean energy technologies such as anaerobic digestion, as there is a general fear about using faecal sludge as raw material for biogas production; v) lack of technical capacity in development of renewable energy technologies (e.g there was no local skilled technician during installation of a hybrid solar system in Malakal by IOM-WASH unit).¹⁶

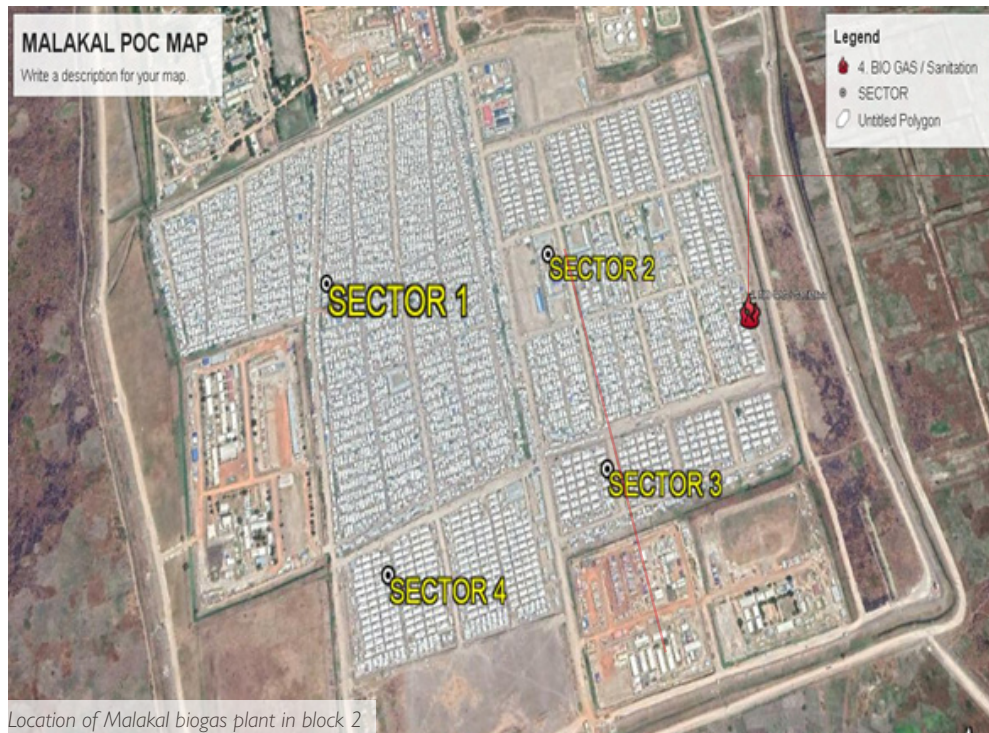
Structural barriers: Isolation of Malakal together with poor infrastructure (roads, electricity, and internet) which complicates supply of energy products and services.

Economic: i) Low purchasing power of IDPs and lack of financial/support services to small and micro enterprises interested in venturing into supply of energy equipment and services; ii) limited private sector engagement due to low profit incentives occasioned by low purchasing power of the population; iii) political instability and protracted nature of the conflict, which has led to infrastructure destruction.



WASH PILOT ANAEROBIC DIGESTER PROGRAM

In line with IOM's efforts to improve the sustainability of its emergency responses, IOM WASH adopted an integrated programming of sewage disposal by commissioning two pilot anaerobic digesters in Malakal PoC with a focus on achieving effective on site sanitation of faecal sludge and provision of cooking energy (biogas). Each one of the digesters have a volume capacity of approximately 9m³ and are fed with faecal sludge from 20 latrine stances (10 male and 10 female), as well as food waste from food waste manholes. System performance in one anaerobic digester was successfully optimized after an initial phase (Feb 2019-Aug 2019) of poor gas production. Optimization was conducted in one digester to save costs and resources in the event of infeasibility of technology. Optimization of system performance in the second anaerobic digester is almost complete with the digester earmarked for commissioning on 1st November 2021.



Circled area showing 20 shelters for cooking in block T2, of sector 2 in Malakal PoC. Each shelter has 4 households therefore, a total of 80 households use biogas for cooking on a 20-day rotational cooking plan.



¹⁵. Mozersky, D. Kammen, M.D., 2018. South Sudan's renewable energy potential, a building block for peace. Washington DC: United states institute of peace.

¹⁶. IOM-UN Migration. As the sun rises, the water flows: A green humanitarian response in South Sudan. [online]. Available at: <https://medium.com/@UNmigration/as-the-sun-rises-the-water-flows-a-green-humanitarian-response-in-south-sudan-2b629d2766dd> [Accessed 17 Sept 2021]

Timeline For The Optimization Of System Performance In Anaerobic Digesters (2019 – 2021)

1st Optimization phase: (September 2019-January 2020)

Finding

Food waste quality was found to be poor for anaerobic digestion (contained physical contaminants and indigestible large particles). Hydraulic retention time¹⁷ was found to be 7 days; this was below minimum 30 days recommended for effective digestion of organic waste.

Adaptive measures:

Faecal sludge feeding rate was reduced by reducing latrines connected to the digester from a total of 20 to 10 stances (through closure of 10 stances of male latrines). Use of food waste as a digester feedstock¹⁸ was halted.

Unchlorinated water (500 litres a week) was provided for cleaning latrines and dilution of sludge to reduce possible ammonia inhibition. Beneficiaries and sanitation team were trained on best practices in operation and maintenance of anaerobic bio-digesters through sensitization forums conducted by the research officer; latrine cleaners were sensitized on negative effect of soapy and chlorinated water on biogas production whereas, female beneficiaries that used toilets connected to the digester were sensitized on the need to use water during toilet visits.

Outcome:

Faecal sludge feeding rate reduced from 1.25 to 0.63m³/day effectively increasing hydraulic retention time from 7 to 14 days. Biogas pressure improved from 0.0001Kpa to 0.072Kpa as recorded by a digital manometer. Biogas production increased from 0.00048m³/day to 0.07m³/day as recorded by a gas flow meter.

2nd optimization phase (January 2020-Sept 2020)

Findings:

Hydraulic retention time of 14 days was still below recommended 30-40 days hence low gas production of 0.07m³/day witnessed after 1st optimization phase.

Optimization measures:

Pre-existing food waste manhole was converted to faecal sludge mixing tank to allow mixing of sludge to improve its homogeneity before being fed into digester; Mesh barrier was installed over outlet of mixing tank to prevent entry of physical contaminants into digester; A retractable wooden barrier was fixed over mesh to allow regulation of fecal sludge volume before it was fed into digester; Inlet pipe into digester was raised to a height of 0.21m from top of digester, from initial height of 0.21 from bottom of digester, to stop blockage of feeding pipes; 10 stances of latrines were raised to allow sludge to flow from them to mixing tank and into digester by gravity; A wall with a height of 0.48m was constructed at the base of the overflow chamber to raise the maximum sludge filling height, hence, increase usable gas volume; digester dome was plastered and rendered to seal cracks.

Outcome:

Hydraulic retention time increased from 14 days to an average of 43 days, which increased gas production rate to between 3.0m³ biogas/day -4.0m³ biogas/day as measured by a gas flow meter. Production was monitored for 106 days (between 16/5/2020 and 27/9/2020) to verify production capacity. Biogas pressure increased to 3.62Kpa from 0.072Kpa recorded after the first optimization phase. Laboratory tests conducted in Malakal confirmed chemical oxygen demand (COD)¹⁹ of faecal sludge in the digester reduced by 85% - 98%. COD removal in efficiently operated anaerobic systems should be above 80% hence, COD reduction efficiency achieved in existing digester confirmed feasibility of anaerobic technology in displacement contexts.²⁰ Due to increased/optimized gas production, a central kitchen was constructed for utilization of gas for cooking and a gas pipe network laid below ground for delivery of gas from digester to the kitchen.

3rd optimization phase (Sept 2020-Sept 2021)

Activities undertaken.

Collated process data and monitored system performance of functional digester to institute adaptive programming in case of process disturbance and drafted standard operating procedures (SOPs) to guide on implementation of adaptive measures. Monitored utilization of biogas and collected data on number of users and frequency of utilization. Evaluated feasibility of produced biogas to power lamps for illumination of female latrines. Research officer developed capacity of Malakal WASH staff in anaerobic digester design, operation, and maintenance through a four- day workshop.

The following activities were undertaken in optimization of the second digester: Pre-existing food waste manhole was converted to faecal sludge mixing tank to allow mixing of sludge to improve its homogeneity before being fed into digester; Mesh barrier was installed over outlet of mixing tank to prevent entry of physical contaminants into digester; A retractable wooden barrier was fixed over mesh to allow regulation of fecal sludge volume before it was fed into digester; digester dome was plastered and rendered to seal cracks; Inlet pipe into digester was raised to a height of 0.21m from top of digester, from initial height of 0.21 from bottom of digester, to stop blockage of feeding pipes; 20 stances of latrines were constructed and connected to the biogas digester ; A wall with a height of 0.40m was constructed at the base of the overflow chamber to raise the maximum sludge filling height, hence, increase usable gas volume.

Outcome

Availability of standard operational procedures that guide on maintenance and operation of the functional biogas plant hence, ensuring its sustainability. Availability of local capacity in anaerobic digester design, operation and maintenance that guarantee sustainability of installed plants and design and implementation of additional units. Availability of a data log with daily values of process parameters useful in gauging digester health/system performance. Illumination of female latrines at night using a biogas lamp hence improving individual safety and security.

The second anaerobic digester is still non-functional due to percolation of water from the ground into the digester's hydraulic chamber²¹ due to a high-water table and unnoticeable cracks on the digester wall. To avoid redundancy of supply and application components connected to the digester (Kitchen and 20 latrine stances), IOM is in the process of installing an alternative flexible plastic (PVC) digester for anaerobic digestion of faecal sludge and production of biogas.



Female beneficiary cooking with Biogas in Malakal © Geophrey OYUGI / IOM 2020

¹⁷. Hydraulic retention is the average time taken by biodegradable solids in an anaerobic digester.

¹⁸. Feedstock is organic matter available on a renewable basis for anaerobic digestion.

¹⁹. Chemical oxygen demand represents amount of oxygen required to oxidize a substance to carbon dioxide and water. It is used to determine bulk organic content of wastewater.

²⁰. Chukwuemeka, J.A., 2019. Anaerobic waste-water treatment and biogas plants, a practical handbook. London: Taylor & Francis.p18

²¹. Hydraulic chamber is the section of the digester where faecal sludge is stored

RESULTS

Health and sanitation

The anaerobic bio-digester continuously treats an average of 214 litres of faecal sludge containing 5.4kgs of dry feces per day. This volume of faecal sludge is produced from 10 latrine stances served by 177 female IDPs every day. The digester effectively treated 78, 110 litres of faecal sludge between May 2020-May 2021. Successful production and use of biogas alleviated risk of respiratory complications faced by IDPs due to use of firewood for cooking.

Energy access

Average biogas production rate in the single digester is 4m³biogas/ day which corresponds to an average biogas yield of 0.74m³ of biogas/kg dry feces fed into the digester. Methane percentage in produced biogas was found to be 67% hence, making the biogas feasible for cooking and lighting application. Produced biogas is continuously utilized for cooking by female IDPs. Biogas produced per day from the single digester provides cooking energy for about 4 households per day in PoC. Each household has an average of 5 people; hence, the bio-digester serves around 20 people per day. Produced biogas satisfies cooking demand of 400 internally displaced persons every 20 days on a rotational cooking plan

Environmental protection

It was estimated that the use of biogas for cooking from the digester saved 9.4 - 11.4 tonnes of firewood per year and abated greenhouse gas (GHG) emissions by 11.07 tonnes CO₂eq -13.32 tonnes CO₂eq in the recording year (May 2020-May 2021).



IDPs employed as biogas operators mixing faecal sludge in a mixing tank before it is fed into a digester © Geophrey OYUGI / IOM 2020

Job creation

Additionally, optimized biogas plant enhanced livelihoods through job creation. The biogas plant created employment across the energy value chain in construction, operation, and maintenance. In total, IOM engaged 25 IDPs to perform a number of tasks: 1 IDP was employed as a biogas operator to monitor the system performance and ensure smooth operations at the biogas site; 1 IDP was employed as an assistant to the biogas operator; 15 female IDPs were employed to clean toilets on a rotational basis throughout the year. Additionally, indirect employment was created during construction, with 8 IDPs employed to partake in toilet and digester construction. IOM is currently working on a plan to develop and strengthen a market system that would make energy production from biogas a profitable enterprise in Malakal PoC.

Women empowerment and equality:

Use of biogas from a single digester saved each woman a combined total of 4.4 hours a day in forgone firewood collection and reduced cooking time. Assuming time saved was sold as casual labor in IOM, a single woman would earn about 2 USD per day. Since four women are served by a single digester per day, total work hour saved per day was 17.6 hours. Work hour savings from use of biogas produced in a single digester increase earning potential of women by 4,015 USD per year. Time saved and increased earning potential will enable women to engage in productive enterprise hence increase their status in POC and promote equality.



Biogas lamp illuminating a block of 10 stances of latrines © Geophrey OYUGI / IOM 2020

Protection

Biogas lamp installed in a block of 10 latrine stances improved individual security and safety of users (female beneficiaries) during the night. The latrines are used by around 177 female beneficiaries per day. Estimates show use of biogas saved 9.4 - 11.4 tons of firewood per year. Reduced use of wood fuel reduced frequency of firewood collection by women, hence alleviated the risk of gender-based violence in forests during firewood collection.

SCALE UP AND DIFFUSION OF TECHNOLOGY

The pilot biogas project has received considerable interest, being featured in the 2020 Greening the Blue Report, which provides a snapshot of the UN System's environmental impacts throughout 2019 and the activities underway to reduce them. Additionally, it has been featured in ECHO DG Compendium of Good Practices related to environmental sustainability in humanitarian action. Borrowing on the success of the pilot project and proof of concept, IOM South Sudan is now seeking opportunities to sustainably scale up this technology and replicate it across the sector to increase its benefit to the environment and IDPs. Since the primary purpose of anaerobic digestion in this context was treatment of faecal sludge with biogas produced as a derivative of the process, capacity for expansion of technology was based on demand for effective on-site sanitation. Only 1 toilet block of 10 stances of latrines is currently connected to a functioning digester against existing 135 toilet blocks in Malakal PoC; this presents a huge potential for expansion of technology.

Cow dung is a very rich feedstock for anaerobic digestion with higher biogas potential than fecal sludge. Case in point biogas currently produced by 177 female IDPs could be produced by about 4 cows each weighing 450kgs. Most South Sudanese citizens own herds of cattle as a symbol of wealth. IOM seeks to capitalise on the huge energy potential of cow dung by evaluating feasibility of expansion of technology to the larger Malakal community, beyond the PoC. In line with this, IOM is currently conducting anaerobic digestion of cattle slurry at laboratory scale. Process parameters and indicators from the laboratory experiment will be used to model, size and design cattle slurry fed digesters in Malakal.²²

²² Feedstock is organic matter available on a renewable basis for anaerobic digestion.

IOM'S ENERGY RESPONSIVE WASH SERVICE DELIVERY

Main programmatic components include:

Component	Approach & Activities	Cross-cutting themes
<p>Conduct advocacy on the use of anaerobic digestion technology</p>	<p>Improving access to biogas energy in WASH involved eradicating skepticism towards the use of biogas produced from faecal sludge. IOM WASH achieved this by:</p> <ul style="list-style-type: none"> Conducting a baseline biogas intention survey to measure the acceptance and needs of the population with regards to anaerobic digestion technology and cooking energy demand. Conducting focus-group discussions with the main users (women) to assess possible community norms and practices that would prevent them from using biogas in cooking. Conducting sensitization forums for female beneficiaries with biogas researcher on anaerobic technology and, highlighting beneficiaries' integral role on success of the circular economy created by anaerobic digestion of faecal sludge.²³ Educating IDPs on necessary behavioral changes on toilet usage to guarantee success of biogas project 	<p>Integrated WASH Programming</p> <ul style="list-style-type: none"> Community inputs taken into consideration during project design and implementation, addressing existing social and structural barriers Development of WASH and Energy infrastructure technical designs that address sanitation and energy barriers <p>Accountability</p> <ul style="list-style-type: none"> Participation & representation of the most vulnerable (women, girls,) <p>Gender mainstreaming</p> <ul style="list-style-type: none"> Creation of female community leaders for operation, maintenance, and regulation of biogas use. <p>Livelihood development</p> <ul style="list-style-type: none"> Improvement of IDPs livelihood through employment and capacity building across the entire value chain of digester construction, operation, and maintenance
<p>Building human resource capacity of (beneficiaries and support staff)</p>	<p>Improving access to biogas energy in WASH involved building local capacity in design, operation, and maintenance of anaerobic digesters to ensure sustainability of the project. IOM WASH achieved this by:</p> <ul style="list-style-type: none"> Adopting cash-for-work program that ensured locals in the community were employed in digester construction. Providing technical training of design operation and maintenance of anaerobic digesters to WASH staff. Providing practical capacity building support to IDPs employed as casual workers on operation and maintenance of biogas plants. Employing a biogas operator from trained casual workers to monitor operations at biogas site. Providing practical capacity building support to female beneficiaries on biogas usage, operations, and maintenance 	<p>Gender mainstreaming</p> <ul style="list-style-type: none"> Creation of female community leaders for operation, maintenance, and regulation of biogas use. <p>Livelihood development</p> <ul style="list-style-type: none"> Improvement of IDPs livelihood through employment and capacity building across the entire value chain of digester construction, operation, and maintenance
<p>Process monitoring through Data collection through standardized monitoring and evaluation procedures.</p>	<p>Improving access to biogas energy in WASH involved monitoring installed anaerobic digesters to ensure optimum system performance. IOM WASH achieved this by:</p> <ul style="list-style-type: none"> Developing standard operating procedures (SOP) for digester feeding. Developing standard operating procedures for inspection of biogas plant and site to inform of required maintenance or replacement of equipment. Developing standardized indicators for evaluation of system performance, and a monitoring framework build on periodic recording and collection of process data. Developing standard operating procedures to inform adaptive programming in cases of process disturbance in digesters 	<p>Livelihood development</p> <ul style="list-style-type: none"> Improvement of IDPs livelihood through employment and capacity building across the entire value chain of digester construction, operation, and maintenance

Publications:

ECHO DG, 2021. Compendium of good practices for a greener humanitarian response. [online]. Available at: <https://www.urd.org/en/project/compendium-of-environmentally-friendly-practices>

UNEP, 2020. Greening The Blue Report 2020 [online].

Available at: <https://wedocs.unep.org/bitstream/handle/20.500.11822/34468/GBR20.pdf?sequence=3&isAllowed=y>

Media Products:

→ Project video showcasing IOM's approach to improve energy access in WASH programming: [Delivering clean energy in humanitarian settings video \(2020\)](#).

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²³ Model of production which seeks to reduce waste to a minimum by reusing and recycling existing materials and products as much as possible.