Container-based Toilets with Solid Fuel Briquettes as a Reuse Product

Best Practice Guidelines for Refugee Camps

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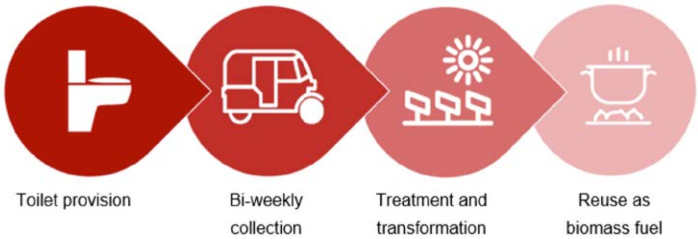
1. Introduction

Congestion and challenging ground conditions (rocky/hard pan soils, waterlogged soils, and flood prone areas) are frequently encountered problems that complicate efforts to achieve 100% sanitation coverage, and to do so affordably, in refugee camps. UNHCR, therefore, set out to identify practical and affordable solutions for such scenarios. To this end, funding was obtained from the Bill and Melinda Gates Foundation to identify potential solutions and test them by implementing them under operational research conditions. The project was implemented during October 2015 to September 2017 and the guidelines contained in this document are one of the principal outputs.

These guidelines were developed by Sanivation, a private sanitation company based in Kenya. The company has been in operation since 2014 and has growing operations in urbanizing communities in Kenya. Sanivation first piloted its sanitation system in Kakuma in 2014 in collaboration with the Norwegian Refugee Council (NRC). In 2014, the system demonstrated user satisfaction and was projected to be one of the most cost-effective approaches to refugee camp sanitation by Boston Consulting Group[1,2]. In 2016-2017 the system was implemented in an operational research environment to test its performance at a scale of around 1,000 people with a particular focus on difficult ground conditions[3] where pit latrines are not the ideal solution.

The system involves provision of container-based toilets, bi-weekly collection of faecal sludge, and treatment and transformation of faecal sludge into an income generating solid fuel product. The system goes beyond basic sanitation and ensures safely managed sanitation for households in accordance with Sustainable Development Goal (SDG) 6.2[4].

Figure 1 - Sanivation System Overview



Based on an analysis of the operational research in Kakuma, using conservative assumptions for revenues, the net costs[5] of the system at 250 households are estimated at US$54 per household per year and are reduced to US$29 at a scale of 500 households (Table 1). The economics improve as the system scales beyond 500 households.

Table 1 - Sanivation system cost

Total cost per household per year[i]	
250 HHs	$54
500 Households	$29

i If briquette production and sales start in year 1 total cost at 250 HHs = US$39 and at 500HHs = US$14

1 BCG (2015) Improving sanitation in refugee camps. See http://wash.unhcr.org/organisation/bcg/

2 Nyoka, Raymond, Andrew D. Foote, Emily Woods, Hana Lokey, Ciara E. O'Reilly, Fred Magumba, and others, 'Sanitation Practices and Perceptions in Kakuma Refugee Camp, Kenya: Comparing the Status Quo with a Novel Service-Based Approach', ed. by Jacobus P. van Wouwe, PLOS ONE, 12 (2017), e0180864 <http://dx.doi.org/10.1371/journal.pone.0180864>

3 In this case rocky soils and high water tables encountered in the area of implementation in 2 blocks of Kakuma I

4 SDG 6.2 definition: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

5 Total cost of fabricating and installing toilets, operating the regular faecal sludge collection service, treating the waste and producing and selling the briquettes, minus the revenues generated from briquette sales.

Key assumptions:

- 1 kg of faeces produced per HH/day
- Briquettes sold at 20 KES (0.2USD) per kg
- Briquette sales begin in second year of operation
- 1:3 ratio of faeces to carbonized biomass in briquettes

These costs account for start-up costs and local refugees managing the system themselves but do not include management expenses for the implementing partner. The net costs presented above also (conservatively) assume no briquettes are sold or produced during the first year of operations to account for ramp up in sales, staff training, and refugees learning to use the toilet properly. The presented cost may also vary for other locations depending on local conditions.

While the system has higher upfront costs than pit latrines, the container-based toilet to briquette approach has negative operating costs due to the revenue generated from reuse products. Therefore, the system becomes even more attractive at longer timelines (protracted refugee situations) and at larger scale (Table 2).

Table 2 - Capital costs, operating costs, and income at 500 households for 10-year lifecycle

	Total system costs over 10 years	Ongoing costs per household per year[ii]
Capital costs	US$210,000	0
Operational costs	US$985,000	US$197
Revenue from reuse products	US$1,050,000	US$210
Total	US$145,000[iii]	US$-13

ii Column presents costs to continue running the system after capital costs are covered.
iii Data presented in Table 1 is calculated by taking US$145,000/10 years/500 households

By leveraging faecal and biomass waste streams available in a camp environment[6], the system can contribute significant revenue.

Figure 2 - Seasonal flooding in Kakuma

In addition to saving UNHCR and implementing partners money in comparison to pit latrines, the container-based toilet to briquettes system has several key advantages and challenges (Table 3).

6 Assuming that enough biomass waste streams are available.

Table 3 - System key advantages and potential challenges

Advantages	Challenges
Saves space: Toilets never fill nor leave sludge in the ground, avoiding decommissioning old toilets and having to dig new ones.	**Logistics:** Toilets require servicing twice a week by trained staff. Staff needs to be trained on health and safety protocols.
Copes with challenging environment conditions: Toilets sit above ground and are therefore viable for rocky/ unstable soils and areas with high water tables/prone to flooding.	**Up front cost:** Initial investment required is usually higher than pit latrines.
High levels of satisfaction and access: Seated toilets shared by a single family are more comfortable and accessible for all users (see article on footnote 2). They are also more appropriate for the elderly and less able bodied.	**Lead time:** Time required for initial system deployment, including waste processing plant, is higher than traditional solutions.
Improves health: All faecal waste is removed and treated, eliminating the risk of contamination of the local environment. This is particularly relevant in environments where pit latrines can't be decommissioned and replaced easily and safely.	**Behavior change:** Additional user training required to ensure correct toilet use.
Supports livelihoods and autonomy: Local staff and refugees are trained and derive incentive employment from the system.	**Variable costs:** While the system has variable cost savings based on sales of reuse product, without any reuse product sales the operational costs remain under $40/ household/year.[4]
Reduces environmental harm and improves access to sustainable fuel: Helps meet the demand for cooking fuel and reduce deforestation[5].	
Increases speed of toilet deployment: Faster to deploy a toilet unit than digging a pit latrine.	

iv Annual operational costs of toilet provision, toilet servicing and waste disposal are 36 USD per HH at scale of 500HHs. Annual operational and capital costs of toilet provision, toilet servicing, and waste disposal are 67 USD per HH at scale of 500 HHs. For a breakdown on costs by system component see Annex 1

v According to *Baconguis, S. (2003) 'Abandoned biomass utilization for household energy as a CDM mechanism for carbon dioxide emission mitigation in the Philippines.' 2003 International Conference on Tropical Forests and Climate Change, Manila (Philippines), 21-22 Oct 2003*, each tonne of briquettes produced saves around 88 trees , hence the 584 tonnes from 500 households could save around 50,000 trees

2. Technical specification

During system implementation, users are provided with a locally fabricated container-based seated toilet. The container-based toilet has a urine diversion mechanism whereby urine is infiltrated into the ground while faeces is contained in a lined[7] container inside the toilet. The faecal sludge is collected and transported to a central processing site twice a week, where it is treated using a solar thermal treatment process. Once free of pathogens, the treated faeces are combined with a high carbon co-waste product, such as charcoal dust, to make solid fuel briquettes. The briquettes are a replacement for traditional charcoal.

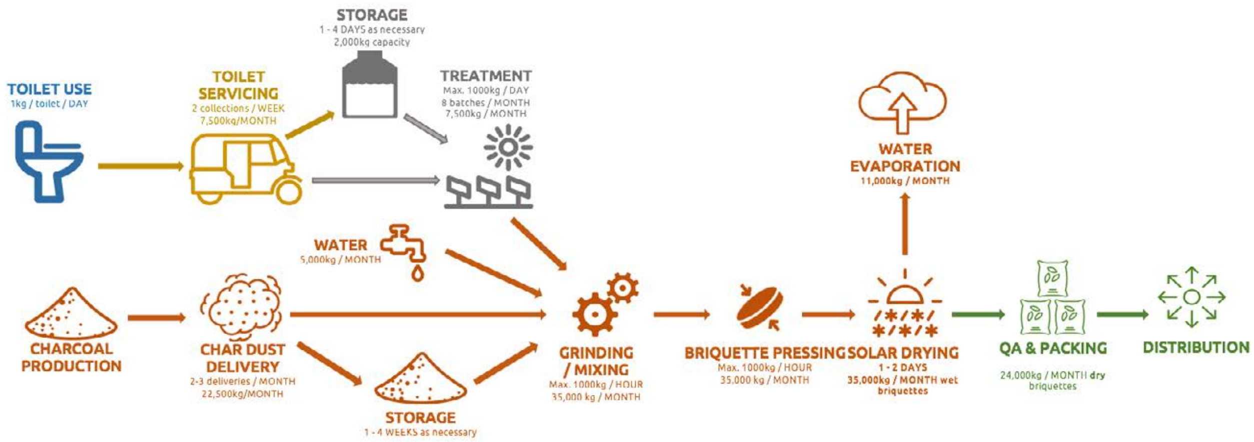
At a scale of 250 HHs, the deployed system can treat approximately 7.5 tons of faeces and can produce approximately 24 tons of briquettes each month, as noted in Table 4.

Table 4 - Inputs and outputs for Sanivation's sanitation system

	Inputs			Outputs - Briquettes	
	Faeces from 250 HH	Co-waste stream	Water	WET	DRY
Tons/MTH	7.5	22.5	4.5	34.5	24

Specifications for key components are given in the following section.

Figure 3 - System flow chart



7 Plastic bags are currently used as liners

Toilet Use and Servicing

The toilet[8]

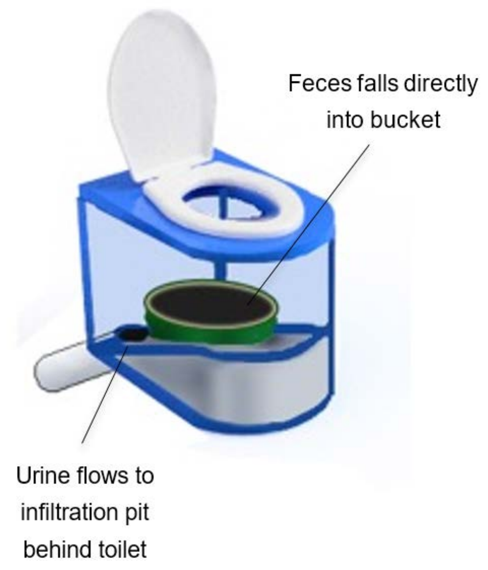
The toilet is a seated container-based, urine-diversion toilet for household use. Faeces is collected in a lined container, while urine is transported via a short connecting drainage pipe into an infiltration pit. Toilet bases and urine diverters can be made using ferro-cement by semi-skilled refugee and/or host community staff. Containers and toilet seats are ubiquitous enough to be procured from local markets and the toilet can be easily assembled on-site at the household. The entire construction, assembly, and installation process takes approximately 3 days and trained staff should be able to produce 4 toilets per person per day. For emergency settings, other materials like fiber-glass and plastic could be considered to increase portability and speed of deployment.[9].

Figure 4 - A mother and child with their toilet in Kakuma

8 A detailed toilet design can be provided upon request.

9 In the event the toilet is to be shared with more than one family, a squatting toilet option should also be considered.

Figure 5 - Toilet diagram



Type:	Container-based – seated
Materials:	**Base** - ferro-cement
	Urine Diverter - ferro-cement
	Top – Wood
	Seat – Plastic
	Waste Container – 20L Container with plastic bag lining
Footprint:	40 cm wide x 60 cm long x 40 cm tall (not including lid)
Production Time:	3 days
Weight:	~60 kg
Life span:	5+ years.

Toilet Servicing

Collection service operators (refugee and host community labour) remove the filled plastic bags from waste containers twice a week. This prevents smells in the toilets, and allows the service operators to closely monitor toilet performance and improve user satisfaction. During every household visit, the operator replaces the toilet container and deposits the plastic bag from inside the used container into a sealable metallic barrel that can be locally procured. The barrel consolidates waste and is then transported between households using a dolly cart or other appropriate means (dependent on the state and width of the local paths). Once the metallic barrel reaches its full capacity, it is loaded and secured on a tuk-tuk and transported to the waste treatment site. The tuk-tuk was chosen due to its low operational and maintenance costs, speed to move between collection points and the treatment site, its weight-bearing capacity, and its adaptability and maneuverability in different conditions, especially narrow roads and rough terrain. Alternative options such as handcarts and pick-up trucks could also be used depending on road conditions and distances to be covered.

Collection service operators

Figure 6 – A Sanitation Collection Service Operator

Operators required:	~1 per 50 HHs
Frequency of collection:	Twice a week per HH
Training required:	1 week
Supervisors required:	1 per 20 operators

Barrels and dolly cart

Figure 7 - A Collection Service Operator with barrels and dolly cart

Barrels

Materials:	Steel
Capacity:	~50 Liters
Lifespan:	5 years

Dolly cart

Materials:	Steel
Capacity:	2 barrels
Lifespan:	5 years

Tuk-tuk

Figure 8 - Tuk Tuk back and front views

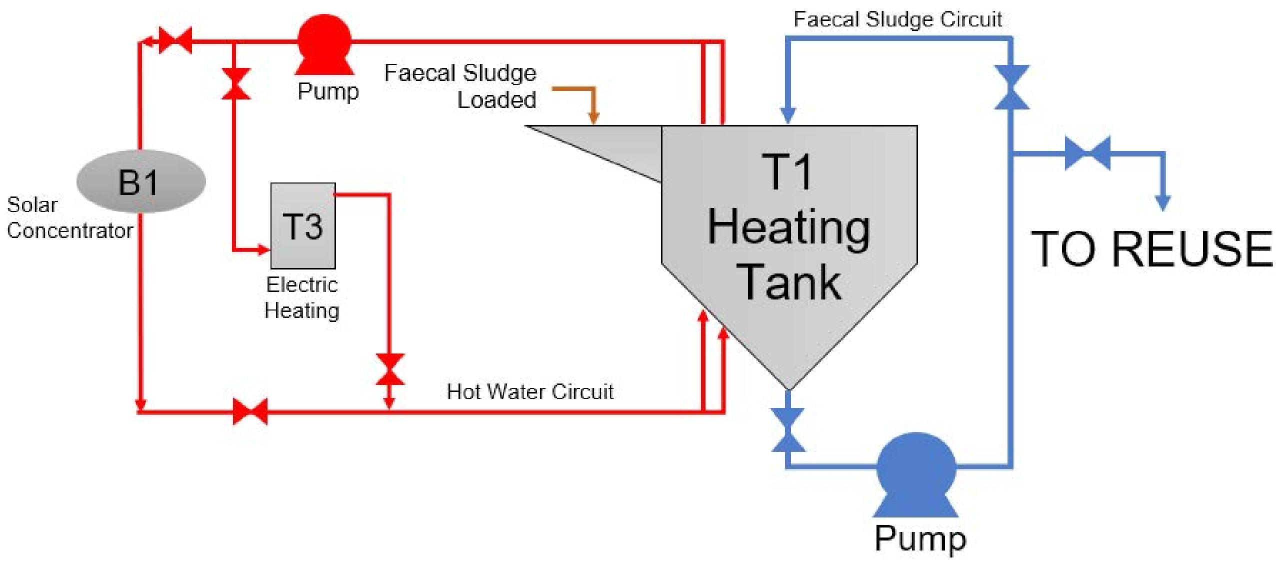
Number required:	1 per 500 HHs
Engine capacity:	395cc
Load capacity (weight):	500kg
Load capacity (barrels):	12
Fuel tank capacity:	10 liters

Treatment and Reuse

Solar thermal treatment system

Heating faeces to temperatures above 65°C for a minimum of 3 hours is one of the most efficient means to render faecal sludge safe for reuse[10]. Various heat sources can be used, but solar or electrical heating are recommended where feasible. The system that Sanivation uses in Kakuma heats a heating fluid that is continuously pumped through a closed circuit of pipes running through an insulated jacket. The insulated jacket surrounds a tank into which faecal sludge is loaded. The heating system is semi-automated with temperature sensors measuring the fluid and sludge temperatures and a controller activating a circulation pump accordingly. Safety mechanisms, including pressure relief valves and temperature alarms, are incorporated into the design to maximize operator safety and to minimize the potential for user error. Pathogen inactivation tests for *Escherichia coli*, a faecal indicator bacterium, should be carried out during the initial treatment batches and annually thereafter. For ongoing waste treatment, temperature monitoring with a minimum of two temperature probes is the recommended safety mechanism to ensure all faeces leaving the tank are safely treated and can be reused. Temperature probes must be calibrated at least once a year. The system can be built offsite and assembled in a standard shipping container for ease of transportation and rapid deployment.

Figure 9 - Simplified Process Flow Diagram of the treatment system



10 Foote, A. M., Woods, E., Fredes, F., & Leon, J. S. (2017). Rendering faecal waste safe for reuse via a cost-effective solar concentrator. Journal of Water Sanitation and Hygiene for Development. https://doi.org/10.2166/washdev.2017.112

Figure 10 - Treatment tank

Manufacturing:	Local (in an industrial city)
Treatment time:	65°C heat for >3 hours
Treatment capacity:	2,000 tons/day
Equipment footprint:	25 m^2
Operations footprint:	1 acre for all operations, including briquette drying and faecal sludge storage (drying beds)
Operation:	Semi-automated (pumping activated by logic controller)
Life span:	10 years
Energy usage:	9kW

Briquette Production

Following full treatment rendering faeces safe for reuse, the high energy content of faeces can be utilized as a biomass fuel like charcoal and wood. In the resulting solid fuel briquettes, faeces act as a binder for other biomass waste streams such as charcoal dust, agricultural residues, and carbonized prosopis (a woody invasive weed in East Africa). The reuse process starts with treated faeces being pumped directly into a grinding wheel mixer, where it is mixed with crushed high-carbon co-waste. Briquettes have been produced successfully with a range of 10-30% wet faecal sludge by mass. Water is added as required to produce the required consistency for mixing and pressing. When it reaches the required consistency, it is transferred to a roller press, which presses the mixture into briquettes. Pressed briquettes are spread onto drying racks and dried in the sun for 3 days. Before the briquettes are packed ready for sale, they should pass through a quality control process involving measuring the burn time, water boiling time, and resistance to breaking when dropped from a height of 1 meter.

Figure 11 - Simplified process flow diagram of briquetting system

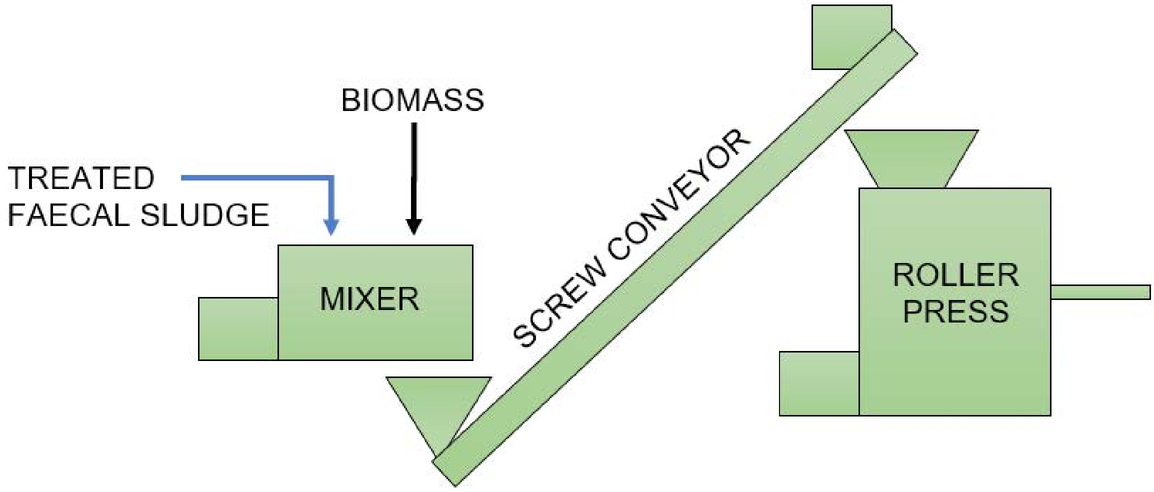


Figure 12 - Treatment and reuse system comprising treatment tank, mixer, conveyor and roller press

Mixer

Figure 13 - Mixer

Manufacturing:	Imported
Life span:	10 years
Machinery Footprint:	2.5m^2
Production capacity:	1 ton per hour
Energy usage:	5.5 KW
Operation:	6 hours per production day

Barrels and dolly cart

Figure 14 - Roller Press

Manufacturing:	Imported
Life span:	10 years
Machinery Footprint:	2.5 m^2
Production capacity:	1 ton per hour
Energy usage:	7.5 KW
Operation:	6 hours per production day

Drying racks

Figure 15 - Drying racks

Materials:	local wood and metal mesh
Briquette drying time:	2-3 days
Footprint:	1m x 15m
Height:	0.5m
Mesh Aperture:	2mm

Charcoal briquettes

By carefully controlling the production process, it is possible to produce a briquette with a calorific value higher than wood and with less smoke emissions than traditional charcoal, as presented in Table 5. Briquettes are tested for strength, burning time, calorific value, and CO emissions. The price point for the briquettes should be determined through a local market assessment. Where charcoal or other carbonized solid fuels are sold, the initial price for solid fuel briquettes containing human waste should be similar to these fuels. In Kakuma, briquettes are sold at US$0.20 per kg, which is the same price as traditional charcoal.

Figure 15 - Drying racks

Calorific value: 22 MJ/Kg

Burning time: 4.5 hours

Emissions (CO ppm): 82 ppm

Price of sale: 20 KES (~$0.2 USD) per Kg

Table 4 - Inputs and outputs for Sanivation's sanitation system

	Charcoal	Wood	Sanivation briquettes
Calorific value	29 MJ/kg	15 MJ/kg	22 MJ/kg
Burning time	3 Hours	1 Hour	4.5 Hours
Emissions (CO ppm)	118 ppm	NA	82 ppm
Emissions (PM2.5 ppm)	213 ppm	NA	196 ppm

All fuels were tested according to the water boil test (WBT) testing protocols[11] using a Kenya Ceramic Jiko[12] (KCJ). Tests were carried out independently by the University of Nairobi, and the Kenya Industrial Research and Development Institute (KIRDI).

11 For EBT testing protocols see http://cleancookstoves.org/technology-and-fuels/testing/protocols.html

12 Traditional Kenyan cook stove

Health and Safety

As a sanitation intervention, health and safety protocols must be enforced to ensure the health of staff, customers and the general public during the course of collection and processing of human waste. The minimum required protocols are presented in Tables 6 and 7[13]:

Table 6 – Operational protocols

Protocol	Details
General Safety Protocols	General daily activities including heavy lifting, driving vehicles, handling untreated faeces, and operating machinery
Latrine Emptying and Transfer Safety Protocol	How to service a toilet safely (set up, toilet emptying, and human waste transfer)
Human Waste Processing (Red Zone) Safety Protocol	Staff induction to Biohazard Zone, waste transfer to treatment tank, cleaning and disinfecting tools, and Personal Protection Equipment (PPE)
Fuel Production Safety Protocol	Handling and lifting of biomass, operating machinery, briquette production, and equipment cleaning
Emergency Spillage Protocols	How to manage spillage of hazardous materials

Table 7 – Planning documents

Protocol	Details
Medical Protection Plans	Staff training, medical immunization, and health checks
Health and Safety Monitoring Plan	Spot checks, incident reporting, and investigations

13 Additional information on safety procedures can be found in https://www.cdc.gov/niosh/docs/2002-149/pdfs/2002-149.pdf

3. Monitoring

Key system components require regular monitoring by local staff to prevent and avoid malfunctions, as well as ensure that users are satisfied with the service they are receiving. All monitoring tools are simple enough to use that staff can master their use within a month. Tables 8-10 present the key components monitored throughout the sanitation chain.

Table 8 – Toilet Monitoring

What	Why	When	How	Who
Toilet smell, cleanness, hardware status, and quantity of faeces collected	Ensure correct usage	Every toilet servicing round (twice weekly)	Toilet servicing form – See Annex 1 (Mobile app)	Refugee staff: Toilet service representative (TSRs)
Toilet user satisfaction	Ensure users are satisfied	Biweekly: Initial 3 months	Toilet user satisfaction survey - See Annex 2 (Mobile app)	Refugee staff: Quality control officer

Table 9 - Waste Treatment Monitoring

What	Why	When	How	Who
Faeces treatment temperature	Ensure pathogen inactivation	Every treatment batch (at least once a week)	Thermocouple connected to data logger via USB	Refugee staff: Waste treatment officer
Treatment tank pressure levels	Avoid leakages and system malfunction	Every treatment batch (at least once a week)	Pressure gauge on piping system	Refugee staff: Waste treatment officer

Table 10 - Waste Reuse Monitoring

What	Why	When	How	Who
Ratios of faeces and char-dust in briquettes	Ensure input materials are used efficiently	Every production batch (Daily)	Inputs weighed as they are added to the mixer	Refugee staff: Waste reuse officer
Burn time, water boil test, breakage test	Ensure briquette quality	Every production batch (Daily)	Briquette quality control form - See Annex 3	Refugee staff: Waste reuse officer

4. Mobilization / promotion

Promotion of toilet and correct toilet use

Toilet users should be engaged from the outset, to ensure long-term uptake and continuity. In addition to focus group discussions and key informant interviews, toilet demonstrations for the entire selected blocks should be carried out, giving users the opportunity to request a container-based toilet. Potential selling points and challenges are given in Table 11.

Table 11 - Key selling points and potential challenges

Key selling points	Potential challenges
No pit digging: Refugees are not required to dig a pit to get their toilet commissioned. The implementing organization is responsible for the entire installation process.	**Sitting:** Some users prefer to squat. *Solution:* Target users who are willing to sit, while developing an option suitable for squatters[vi].
No waste overflowing when it rains: The toilet container is constructed above ground, preventing overflowing during rains.	**Faeces visibility:** Faeces is visible in toilet container. *Solution:* Use provided charcoal dust to cover faeces.
Waste is removed from toilets weekly: There is no need to decommission toilets and require more space for new pit latrine following filling of a pit.	**Odor:** Smell of toilets where no charcoal dust is used. *Solution:* Work with the quality control team to make sure the user understands the correlation between charcoal dust usage and decreased smell.
Sitting toilet: The toilet is more comfortable to use and particularly helpful for elderly and disabled.	

vi Over 80% of the population interviewed in Kakuma preferred to sit when sharing the toilet within their HH.

Following toilet installation, three key strategies are recommended to promote appropriate use of the implemented toilet.

1. Individual household training (see Annex 4)
2. Displaying toilet training flyers in each toilet (see Annex 5)
3. Conducting weekly monitoring of toilets

During toilet installation, the household should receive training from a trained facilitator on how to use toilet. A laminated flyer with instructions for how to use the toilet should be displayed in each toilet. Additionally, monitoring staff should visit each household once a week to check proper toilet use and provide additional training if required.

Promoting charcoal briquettes

Three primary promotion techniques are recommended for the sales and marketing of charcoal briquettes:

1. Product demonstrations to local leaders
2. Free product samples
3. Door-to-door selling by trained sales reps

Sales staff can hold product demonstrations with community leaders to show that the charcoal briquettes are safe, burn longer, and produce less smoke than wood and traditional charcoal. The implementer should then engage with communities, or ask the leaders to do so, to explain to them that the product is safe. Small product samples of 1 kg can be distributed by sales representatives as a free product sample to selected households. The selection of households should be aimed to target the different ethnic groups and cultures identified through a market assessment assessing product acceptability and market size. Sales representatives should gather initial user feedback, establish a relationship with the customer and directly sell the charcoal briquettes. Once awareness and popularity of the product are established, a network of retailers and distributors can be developed through which it can be sold. Potential selling points and challenges are given in Table 12.

Table 12 - Key selling points and potential challenges for briquette sales

Key selling points	Potential challenges
Burning time: Charcoal briquettes burn approximately 1.5 times longer than traditional charcoal.	**Local perception:** Products made from faeces may be rejected based on religion or culture. *Solution:* Work closely with community leaders and population to demonstrate product is safe and clean.
Less smoke: The briquettes produce less smoke than wood and charcoal.	**Local producers:** Product may compete with traditional charcoal and affect the livelihood of the local population. *Solution:* Ensure product demand is higher than product supply and employ charcoal producers as sales representatives.
Cost: The briquettes are sold at the same price as traditional charcoal but because they burn longer they save users money.	

5. Guide for Implementation

A mobilization period of several months will be required for this sanitation solution to ensure that all necessary partners understand the approach and their role within it. Setting up and refining the system will take a minimum of 12 months, allowing sufficient time to run through the 6 stages presented in the Table 13. For an implementing partner to engage a service provider like Sanivation, or for the implementing partner to conduct the process independently, the implementing partner should do the following steps.

Table 13 - Implementation Guide for work with Service Provider

Implementing Partner Implementation Guide to work with service provider	
Stage 1 : 1 month **Pre-implementation**	▪ Understand current costs of sanitation per household ▪ Develop objectives for system, decide on target population, and know the amount of funding available ▪ Solicit service provider
Stage 2-4 : 5 months **Stakeholder consultation and system refinement**	▪ Decide on communication plans and which stakeholders need to be involved in decision making process ▪ Dedicate and empower a contact representative to work and consult with service provider
Stage 5: 5 months **Expansion**	▪ Review service level performance ▪ Finalize plans for project integration to implementing partners' main activities and secure any necessary funds
Stage 6: 1 month **Evaluation**	▪ Communicate results and next step plans with upper level management

If an implementing partner wants to engage the work on their own or advise a private service provider, they should follow the following steps.

Table 14 - Implementation guide for engaging on work on their own or advising private service provider

Local Implementation Guide	
Stage 1 : 1 month **Pre-implementation**	▪ Respond to solicitation ▪ Create project and management plan
Stage 2-4 : 7 months **Stakeholder consultation**	▪ Agree on project plan with local stakeholders, particularly community leaders ▪ Hold focus group discussions and key informant interviews ▪ Conduct skills and materials assessment ▪ Evaluate bio-waste supply chains and markets for reuse products ▪ Apply for all regulatory approvals required ▪ Secure access to water, power, land and any infrastructure needs etc.
Stage 3 : 2 months **Rapid Prototyping**	▪ Prototype key technologies and reuse products; verify they meet the needs, preferences and challenges of the target population ▪ Develop detailed procurement and capacity development plans ▪ Recruit and train local staff ▪ Conduct risk analysis and put in place mitigation measures and test monitoring tools ▪ Meet with local stakeholders
Stage 4 : 2 months **System roll out**	▪ Procure all necessary equipment and install toilet, treatment, and reuse technologies ▪ Begin operations and implement monitoring and quality control systems ▪ Update risk register ▪ Decide on pricing and sales strategy for reuse products ▪ Meet with local stakeholders
Stage 5 : 5 months **Expansion**	▪ Further toilet deployment and capacity building of operation staff ▪ Implement sales approach for reuse products ▪ Meet with local stakeholders
Stage 6 : 1 month **Evaluation**	▪ Comprehensive evaluation of the system, its operations, and its impact ▪ Refine and document final systems and processes ready for handover and/or expansion ▪ Reporting of key findings, lessons learnt, and recommended steps for project continuation and/or potential hand over

6. Annexes

Annex 1: Financial Breakdown for Kakuma

Table 15 - Capital and operational cost breakdown per system component at 250HHs

		10 years (US$/HH)	Average per year (US$/HH)
Toilets	Operational costs[vii]	US$80	US$8
	Capital costs[viii]	US$280[ix]	US$28
	Total costs	**US$360**	**US$36**
Servicing	Operational costs[x]	US$341	US$34
	Capital costs[xi]	US$29	US$3
	Total costs	**US$371**	**US$37**
Waste treatment & briquette production	Operational costs[xii]	US$1,699	US$170
	Capital costs	US$214	US$21
	Total costs	**US$1,913**	**US$191**
Revenue	Briquette sales	US$2,102	US$210

vii Key costs: toilet maintenance materials and labour
viii Key costs: toilet infrastructure and replacement after 5 years
ix Assumes toilet replaced 5 years and costs US$140
x Key costs: servicing labour, fuel, plastic bags, and personal protection equipment
xi Key costs: barrels, tuk-tuk, and dolly cart
xii Key costs: treatment and reuse labour, fuel for generator, carbonized biomass, and personal protection equipment

Table 16 - Capital and operational cost breakdown per system component at 500HHs

		10 years (US$/HH)	Average per year (US$/HH)
Toilets	Operational ($/HH/year)	US$80	US$8
	Capital ($/HH/year)	US$280	US$28
	Total	**US$360**	**US$36**
Servicing	Operational ($/HH/year)	US$282	US$28
	Capital ($/HH/year)	US$31	US$3
	Total	**US$313**	**US$31**
Waste treatment & briquette production	Operational ($/HH/year)	US$1,607	US$161
	Capital ($/HH/year)[xiii]	US$111	US$11
	Total ($/HH/year)	**US$1,717**	**US$172**
Revenue	Value generated $/HH/year	US$2,102	US$210

xiii Key costs: treatment tank, mixer, roller press, and drying beds

Annex 2: Toilet servicing form

Paper form

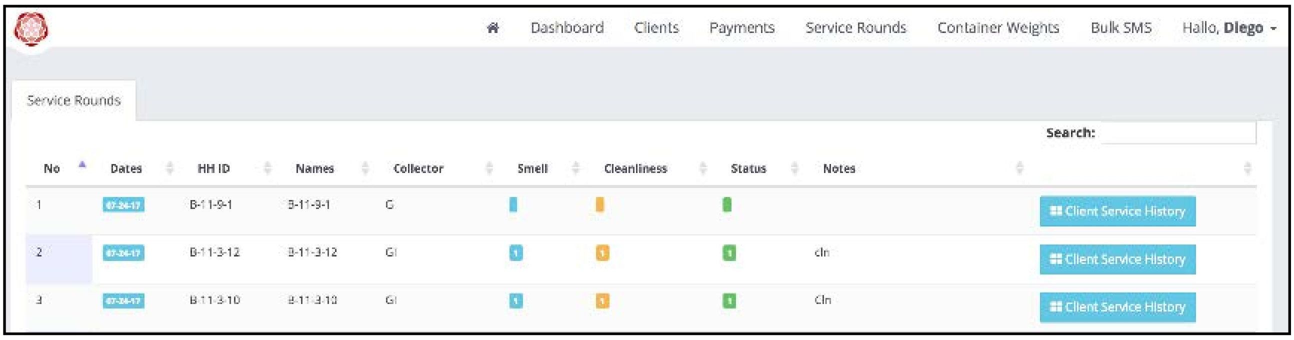
Table 17 - Toilet servicing form

Household ID	Smell (1-3)	Cleanliness (1-3)	Toilet Status (1-2)	Notes/Clients Comments
Household 1				
Household 2				
...				

Smell	Cleanliness	Toilet Status
1. No Smell	1. Very Clean	1. OK
2. Average	2. Average	2. Repair
3.Really bad smell	3.Very dirty	

Online dashboard

Figure 17 - Online dashboard



Annex 3: Toilet user satisfaction survey

Table 18 – Toilet user satisfaction survey

1. For you and your family, how do you like the toilet and structure?	☐ Like ☐ Indifferent ☐ Dislike
2. For you and your family, how do you like the way the wasted is collected?	☐ Like ☐ Indifferent ☐ Dislike
3. How do you feel about your new toilet compared to the pit latrine?	☐ The pit is better ☐ The Sanivation toilet is better ☐ They are the same
3b. Why?	(open-ended)
4. Is there anything we should fix about the toilet?	☐ Flies ☐ Cockroaches ☐ Smell ☐ Fills quick ☐ Other
5. Is there anyone in the family who is not using the toilet?	☐ Yes ☐ No
5b. Why aren't they using?	(open-ended)
6. Do you have any comments?	(open-ended)

Annex 4: Charcoal briquette quality control form

Table 19 - charcoal briquette quality control form

Sack Number							
Date							
Date sack was made							
# of Days on Drying Rack							
Batch Recipe							
Smell & Boiling Test							
Mass of Briquette (kg)							
Smell Rank (1-3)							
Time water placed on							
Time water boiled							
Total time (min) to boil							
Drop Test							
Number of Briquettes Dropped	5	5	5	5	5	5	5
Whole Briquettes after Drop 1							
Whole Briquettes after Drop 2							
Whole Briquettes after Drop 3							
Passed: Y/N							
Shake Check							
Number of Briquettes Checked	20	20	20	20	20	20	20
Number of Briquettes broken							
Passed: Y/N							

Annex 5: Household training script

Sanivation
Sanitation as a Service

Toilet Training

Intro:

1. Hi! I'm going to explain to you how to use your Sanivation toilet. I know you were taught before, but I want to go over it again just to be sure.

2. Are all of your family members present? Can you please assemble them. *(wait for whole family to arrive)*

3. Is it ok if we enter your toilet? *(Open the door)*

Using the toilet

1. *(Looking at toilet)* This is your Sanivatiot toilet. It is for all people, young and old, mothers and fathers. It is more comfortable and safer than anything else. We work in many cities and all people use it. It is for everyone, not just old or disabled.

2. To use the toilet, sit on the seat and slide all the way back. You can't squat on this. *(Demonstrate sitting)*

3. You'll see the urine goes around and out the back and the poo goes into the bag.

4. When you poop, put all the papers into the separate bag. Then put 1 scoop of charcoal powder in the bucket. If you use the charcoal powder, the smell will be little and there won't be any bugs.
(Demonstrate putting charcoal in the bucket, and paper in the bag)

5. Don't put anything except for poopoo into the bucket, or it will be dirty and smelly.

6. When you are finished, wash your hands with soap.

Demonstration

1. Please keep the toilet clean and use it like we showed you, because it will be nicer for you and your family. And if it is clean, the collector will have a better job.

2. Do you have any questions about using this toilet?

3. Ok. Can I please have a volunteer to demonstrate using the toilet. *(give paper).* Thank you, can you please demonstrate.

4. If poop gets into the cement, use a stick or a polythene to push it into the bucket. Then wash the cement with water.

5. Now remember: sit, use charcoal powder, and put rubbish in the bag.

Annex 6: Toilet training flyer

Sanivation

UNHCR
The UN Refugee Agency

Container-based Toilets with Solid Fuel Briquettes as a Reuse Product
Best Practice Guidelines for Refugee Camps