CBSA
Container Based Sanitation Alliance

CALCULATING THE CLIMATE CHANGE MITIGATION POTENTIAL OF CONTAINER-BASED SANITATION SYSTEMS

Lauren Harroff Trondsen[1], Elena Bischak[2], Gavin McNicol[3], Matthew Reid[4], Rebecca Ryals[2], Kory Russel[5,6]

[1] Sanergy, [2] University of California, Merced, Life and Environmental Sciences, [3] University of Illinois at Chicago, Earth and Environmental Sciences, [4] Cornell University, Civil and Environmental Engineering, [5] Container Based Sanitation Alliance, [6] University of Oregon, Landscape Architecture and Environmental Studies

6 CLEAN WATER AND SANITATION
13 CLIMATE ACTION

OBJECTIVES

1. Integrate approaches to sustainable development goal (SDG) 6 (clean water and sanitation) and SDG 13 (climate action).
2. Develop a publicly available tool to determine greenhouse gas (GHG) impact of sanitation services.
3. Estimate climate impacts of container-based sanitation (CBS) systems specifically, coupled with a variety of waste treatment process and reuse products, like compost, biogas, briquettes, or animal feed.
4. Identify where in the sanitation value chain GHG emissions are most significant.

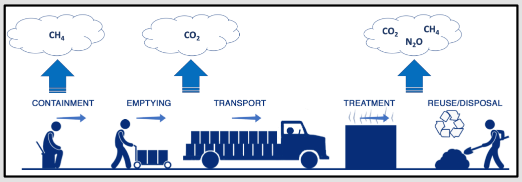
CONTACT

Lauren H. Trondsen
lauren.trondsen@saner.gy

Kory C. Russel
kory@cbsa.global

www.cbsa.global/climatepositive

BACKGROUND



- GHG emissions are associated with all stages of the sanitation value chain and contribute to 2-6% of global methane (CH_4) emissions and 1-3% of global nitrous oxide (N_2O) emissions.[1-3]
- Container-based sanitation (CBS) are systems where toilets collect human excreta in sealable, removable cartridges that are transported to treatment facilities when full.
- Replacement of anaerobic processes with aerobic processes and production of resource recovery products has potential to mitigate GHG emissions.

METHODS

- Excel-based calculator compares GHG emissions from a sanitation project to the baseline scenario.

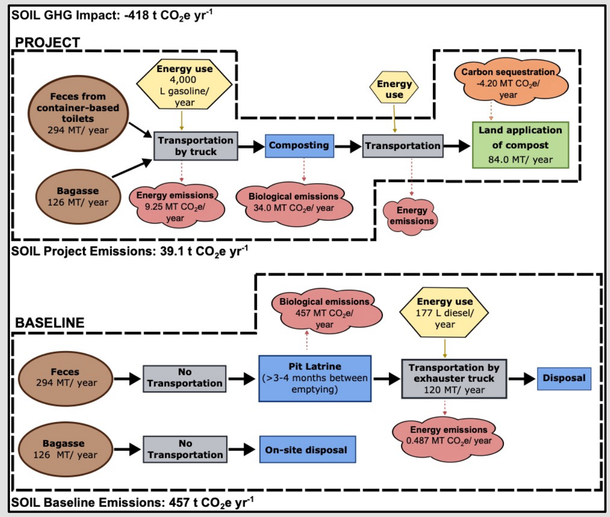
GHG Impact = Project Emissions - Baseline Emissions

- Emissions calculated based on IPCC GHG Inventory Approach, Clean Development Mechanism (CDM) approved methods, and scientific literature
- Examined four case studies:

Table 1. Description of operations for each case study

Sanergy	Nairobi, Kenya: 60,000 t waste yr^{-1} (10% feces from CBS toilets, 70% food waste, 20% sawdust); produces insect-based animal feed and compost
SOIL	Port-au-Prince and Cap-Haitien, Haiti: 420 t waste yr^{-1} (70% feces from CBS toilets, 30% bagasse); produces compost
Loowatt	Antannarivo, Madagascar: 58.3 420 t waste yr^{-1} (98% mixed feces and urine from CBS toilets, 2% food waste); produces biogas, liquid fertilizer, and compost
Sanivation	Naivasha, Kenya: 60,000 t waste yr^{-1} (80% fecal sludge from pit latrines/septic tanks, 20% sawdust); produces briquettes

Figure 1. Example process flow diagram for SOIL showing boundaries for project and baseline emissions.



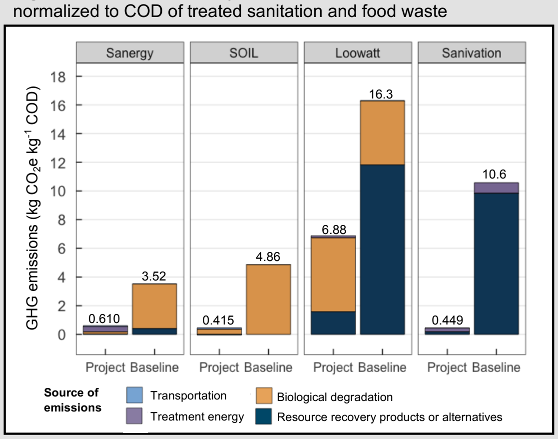
**Process flow diagrams for other case studies are available in the supplemental files.*

RESULTS AND KEY FINDINGS

Table 2. Calculated GHG impact (project emissions – baseline emissions) for each case study

Case study	GHG Impact		
	Annual (t CO_2e yr^{-1})	Per capita (kg CO_2e cap^{-1} yr^{-1})	COD-basis (kg CO_2e kg^{-1} COD)
Sanergy	-19,300	-129	-2.95
SOIL	-418	-66.2	-4.44
Loowatt	-20.1	-33.5	-9.45
Sanivation	-24,300	-243	-10.1

Figure 2. Breakdown of project and baseline GHG emissions normalized to COD of treated sanitation and food waste



- On an annual basis, the four case studies mitigated between **20.1 and 24,300 t CO_2e yr^{-1}, equivalent to removing between 4 and 5,300 passenger cars from the road.**[4]
- Transportation emissions had minimal impact on overall emissions, both for project and baseline scenarios *(Fig. 2, light blue bars)*.
- Production of energy from resource recovery in the form of briquettes and biogas provided greatest GHG mitigation potential *(Fig. 2, dark blue bars in baseline emissions for Loowatt and Sanivation)*.
- Biogas production also had high potential to *produce* methane due to leakage *(Fig. 2, orange and dark blue bars in project emissions for Loowatt)*, but it was offset by baseline emissions from fossil fuels *(Fig. 2, dark blue bars in baseline emissions for Loowatt)*.
- Replacement of anaerobic waste containment and treatment process with aerobic processes also offered large GHG mitigation *(Fig. 2., orange bars in baseline emissions for Sanergy, SOIL, and Loowatt)*. This was true for both sanitation waste and food waste but was most pronounced for sanitation waste that was diverted from pit latrines.
- Sensitivity and uncertainty analyses found that our calculations were conservative. Under most scenarios tested in the sensitivity analysis, the resulting mitigation potential of was higher than reported in the default values.
- Providing citywide inclusive sanitation requires a diverse portfolio of sanitation technologies and systems, but **if CBS were scaled to even 10% of the 1 billion people currently living in informal settlements, our results show that it would mitigate between 0.335 and 1.29 Tg CO_2e yr^{-1}.**

Sanitation systems that replace anaerobic containment and disposal with aerobic treatment and resource recovery provide a clear opportunity to simultaneously address climate- and sanitation-related SDGs. This GHG Calculator provides stakeholders with a tool to inform data-driven decision-making around sanitation development scenarios.

ACKNOWLEDGEMENTS

Thank you to the Water Supply and Sanitation Collaborative Council (WSSCC), Roshni Dave, Sanergy, SOIL, Loowatt, and Sanivation.

SANERGY Sanivation SOIL Loowatt Flush with Happiness

References: 1. Saunois et al., 2016, 2. Syakila and Kroeze, 2011. 3. Tian et al., 2019. 4. EPA, 2018 GHG emissions from a typical passenger vehicle