

Composting is the microbiological degradation of organic matter to a humus-like stable product. Composting requires a specific carbon to nitrogen (C:N) ratio, moisture content, and oxygen flow to reach temperatures for optimal degradation and sanitization. Off-site composting, where waste is collected and transported to a dedicated facility, is often larger and more controlled compared to on-site setups. Controlled mixing, aeration and moisture levels, along with adequate retention of the heat generated in the compost matrix to transition from mesophilic conditions to thermophilic conditions (45-70 °C), ensure a well-managed compost process. Microorganisms that tolerate high temperatures, break down organic matter, reducing the volume of the waste. High temperatures kill pathogens. Off-site composting often occurs in aerated static piles, windrows (turned regularly), or in-vessel systems (containers with precise control). Additional waste feedstocks or bulking agents, such as food scraps, garden waste, animal manure, sawdust, straw, can be added to the fecal waste to improved feedstock characteristics. This is referred to as co-composting.

## INPUT STREAMS

- F Feces
- Ex Excreta
- BW Blackwater, sludge

## TARGET OUTPUT(S)

- △ Soil amendment, compost

## VALOO IMPACT PROJECT | KOMPOTOI

Uster, Switzerland | 2022

**Co-composting of excreta from public dry toilets**

During this pilot project, contents from dry toilets (i.e., urine, feces, toilet paper and sawdust) were composted together with green waste, soil, and mature compost. The dry toilet contents accounted for 13-16% of the total feedstock. The quality of the compost was analyzed for pathogens and pharmaceuticals. In collaboration with local authorities, this project contributed to a Swiss regulatory framework for the composting of fecal-based materials.

## SPECIFICATIONS

### INFRASTRUCTURE

Off-site composting at a dedicated facility generally requires access roads suitable for trucks transporting waste and compost. A weighbridge can be useful to weigh incoming and outgoing materials. To prevent leachate infiltration, an impermeable surface and drainage and collection mechanisms for leachate should be included in the site layout. Composting often requires enough space to prepare (shred/grind) the incoming material, compost, mature, and screen the compost. Plastic coverings are often used to provide insulation and maintain high temperatures. Access to water for moisture adjustments and access to power to operate blowers and machinery is needed.

### OPERATION & MAINTENANCE

To achieve thermophilic conditions, composting relies on precise process control including: feedstock management to maintain optimal carbon-nitrogen ratio and moisture levels, temperature management and control to achieve high temperatures for thermal sanitization, and aeration to ensure aerobic degradation, and reduce odors. Periodically measuring temperature and moisture content, as well as taking samples for lab analysis should be carried out by personnel. Equipment should be serviced and cleaned periodically, and drainage channels cleared.

### TARGET OUTPUTS

Under optimal conditions, off-site composting produces a pathogen free, stable, and mature, soil amendment rich in organics and nutrients. The nutrient content of compost varies depending on the feedstock (e.g., urine inclusion), and the composting process (e.g., addition of bulking agents, composting duration). Compost is typically characterized by a low nitrogen to phosphorus (N:P) ratio and as a slow-release fertilizer, meaning that the nutrients mineralize slowly for plant availability. Compost use in agriculture should comply with local regulations.

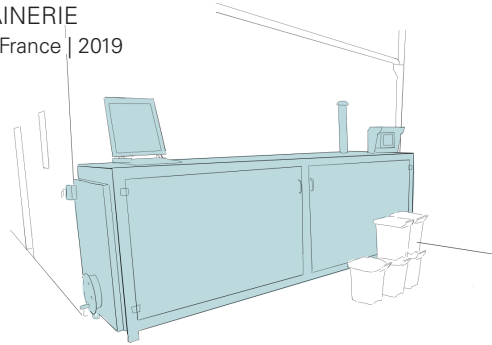
Compost, while rich in organic matter and nutrients requires sufficient stabilisation and sanitization before soil application to prevent human and environmental health risks.



## SELECTED CASE STUDIES

### LA FUMAINERIE

Bordeaux, France | 2019



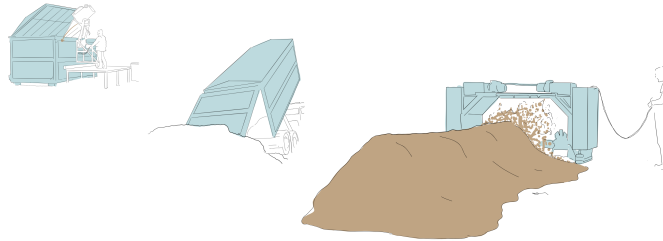
#### Chamber composting of collected feces in urban context

This non-profit organization works to promote dry sanitation and the management of human excreta. The organization collects jerry cans of urine and bins containing feces from urine-diverting dry toilets from 35 households (ca. 99 individuals) in Bordeaux. At a treatment facility, the feces are co-composted with green waste and food scraps in a closed chamber (~30 kg in the chamber) with mechanical aeration and mixing, and temperature control. After 8 weeks of composting and 6-8 weeks of maturation, the compost is reused for landscaping.



### KREISWERK BARNIM (ZIRKULIERBAR)

Eberswalde, Germany | 2019



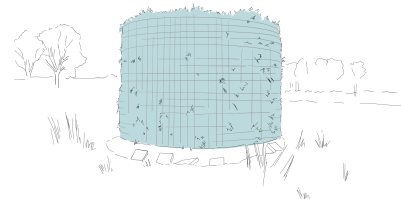
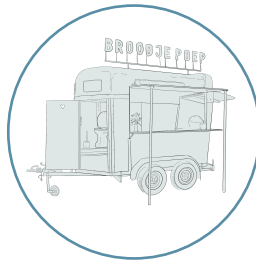
#### Windrow composting of human excreta from dry toilets

This is Germany's first recycling facility for the production of fertilizers from separately-collected feces and urine from dry toilets. After transport to the facility, the feces (and toilet paper) are first sanitized at 70 °C for 7 days in dedicated aerated "hygienization containers" to inactivate pathogens. The heat is generated by the microbial activity in the aerated container. Next, the sanitized organic matter is composted in windrows, together with other selected aggregates, and turned daily. Finally, the compost is sieved. The treatment facility can process about 200 m³ of solids at one time, and the composting process takes 6-8 weeks.



### BROODJE POEP

Groningen, Netherlands | 2015



#### "Biomeiler" composting for nutrient and heat recovery

The Broodje Poep food truck is a social design initiative that not only prepares sandwiches, but also has a dry toilet on the side. The collected excreta are transported to a treatment facility for composting in a biomeiler system. A biomeiler (~35 m³) includes an outer bufferzone of hay bales, filled with organic materials for aerobic composting, including: excreta, wood chips, sawdust, hay bales that have absorbed urine (collected from festivals), and urine. Water circulating through pipes embedded within the compost pile recover heat (~1 kW) generated in the pile. After two years, the compost is reused in agriculture to grow ingredients for the sandwiches.

