Blue Diversion AUTARKY

Sanitation off the grid

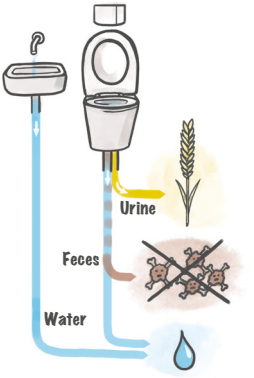
Guiding principles

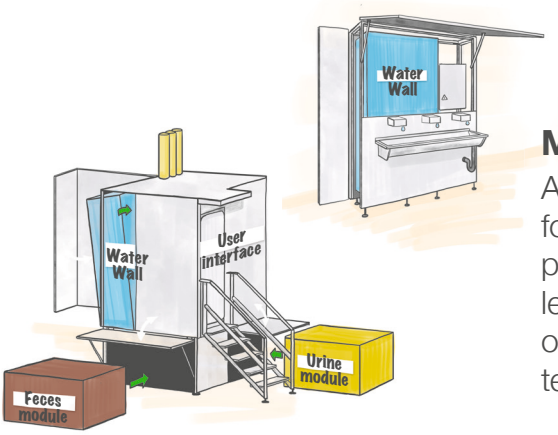
Safety & comfort

The Blue Diversion Autarky toilet offers the safety and comfort of a modern flush toilet without requiring piped water or sewerage.

Source separation

Pathogen inactivation, nutrient recovery and water recycling for flushing and hand washing are achieved by the separate treatment of feces, urine and water.





Modularization

A modular design allows for a wide range of applications. Single modules can be used alone or combined with other technologies.

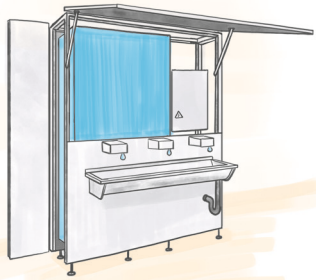
Realizations

Water treatment

- Closed-loop water recycling for flushing and hand washing
- Safe hygienic water
- Private and public applications

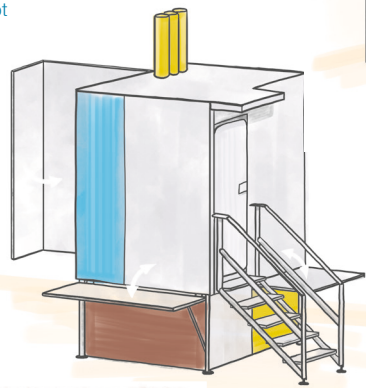
Hand washing station

- 300 usages per day
- No water or sewerage connection
- Low demand for electricity
- Field tests at an event location in Zurich and in an informal settlement in Durban



Autarky toilet

- 10 people household
- No water or sewerage connection
- Low demand for electricity
- Field tests on Eawag campus and in a peri-urban household in Durban
- Service concept



Urine treatment

- Nutrient recovery for fertilizer production
- Pathogen inactivation
- Volume reduction

Feces treatment

(in preparation)

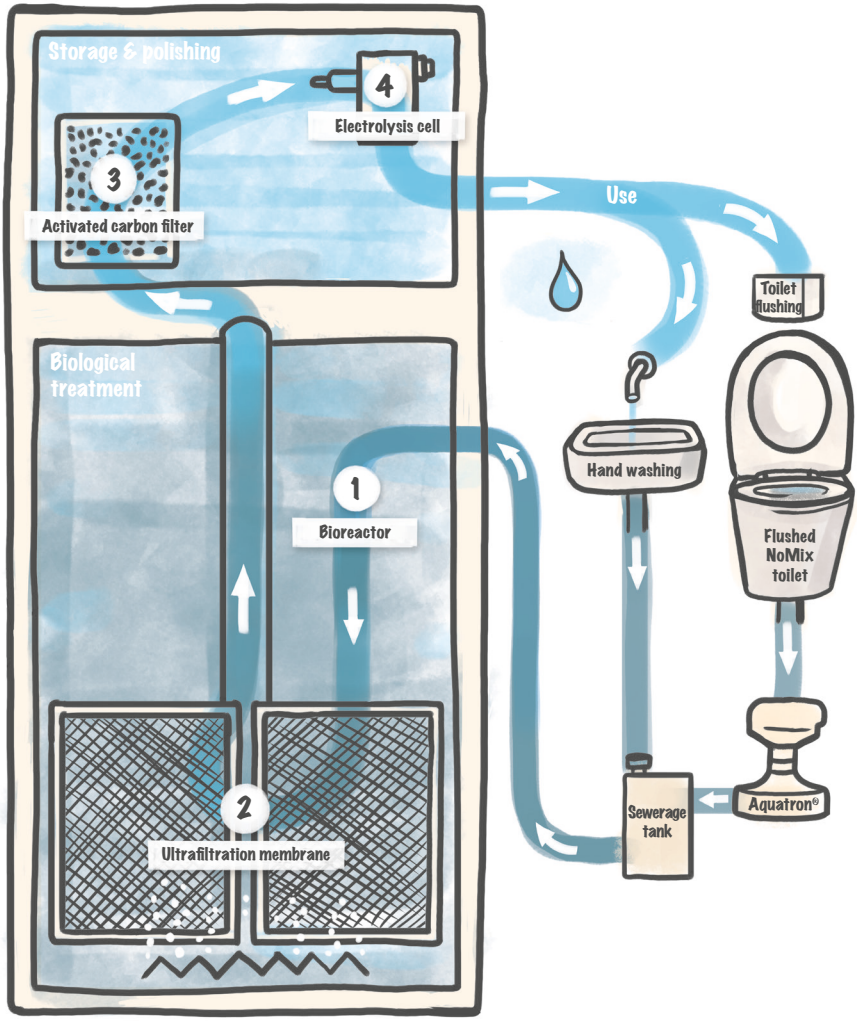
- Pathogen inactivation
- Feces converted to water, carbon dioxide and minerals
- Nutrient recovery

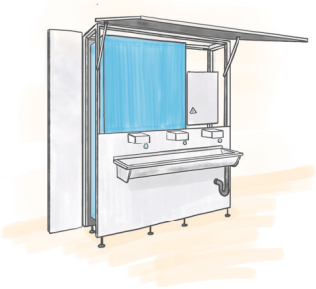
User interface

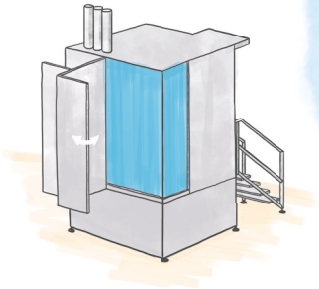
- Flushed urine-diverting toilet (NoMix)
- Waterless urinal
- Hand washing basin and soap
- Appealing design by EOOS

Autarky water module

The "Water Wall" recycles water for hand washing and toilet flushing. A multi-barrier approach with four treatment stages ensures that the recycled water is safe for reuse.







Properties of the current module:

Capacity:	>250 L/day *
Energy use:	1 kWh/day
Footprint:	0.4 m²
Volume:	0.9 m³
Additives:	Nutrient-supplemented biodegradable soap
Service:	Water refill once per week

* 300 usages for a stand-alone hand washing station
10 full-time users for the Blue Diversion Autarky toilet

User interface
Provides water for hand washing and toilet flushing

1 **Bioreactor**
Degrades organic matter and ammonia

2 **Ultrafiltration membrane**
Filters microorganisms including pathogens

3 **Activated carbon filter**
Removes traces of organic matter, color and smell

4 **Electrolysis**
Removes traces of organic matter and produces the disinfectant chlorine for safe water storage

User interface
Provides recycled water for hand washing and toilet flushing

Previous water wall version during field testing in Zurich

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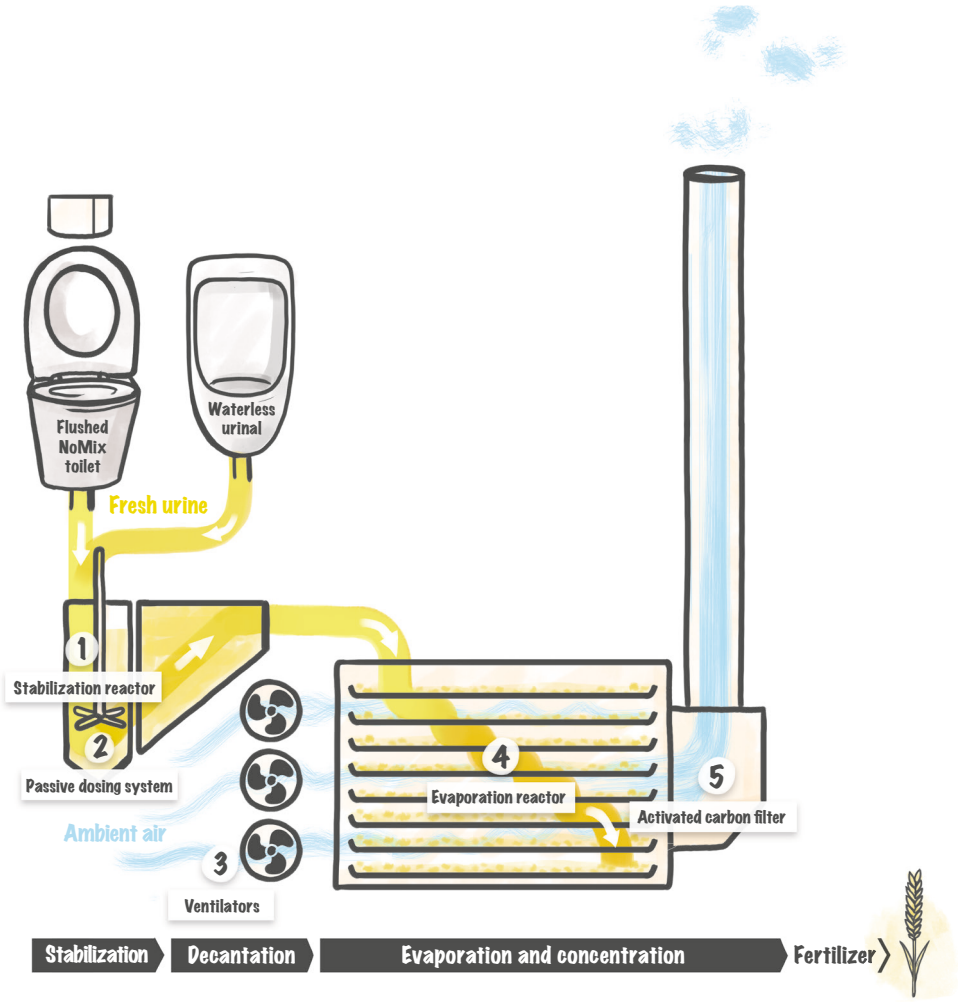
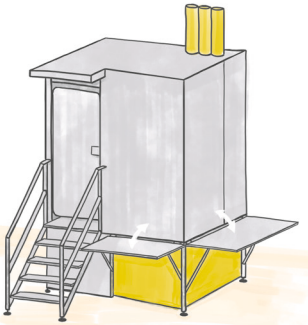
Autarky urine module

The urine module recovers nutrients in a solid form. Chemical stabilization of fresh urine inactivates pathogens and prevents the loss of nitrogen.





Properties of the current module:

Capacity:	13 L urine/day *
Energy use:	1.3 kWh/day
Footprint:	1.3 m^2
Volume:	1.1 m^3
Additives:	1,8 kg hydrated lime per month
Service:	Fertilizer harvest and hydrated lime refill once per month

* 10 full-time users for the Blue Diversion Autarky toilet

Urine treatment module during field test in Zurich

1. **Stabilization reactor**
   Inactivates pathogens and prevents nitrogen loss
2. **Passive dosing system**
   Provides sparsely soluble lime ($Ca(OH)_2$)
3. **Ventilators**
   Enhance evaporation
4. **Evaporation reactor**
   Removes water and concentrates nutrients on removable trays
5. **Activated carbon filter**
   Removes unpleasant odor from off-gas

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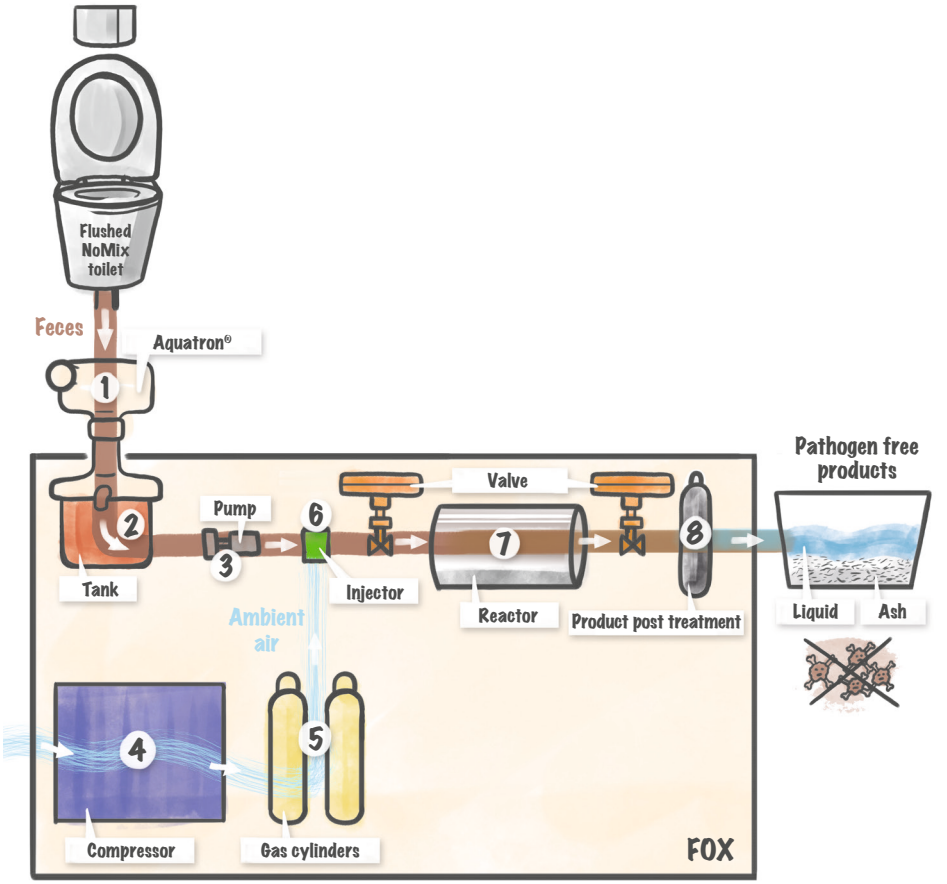
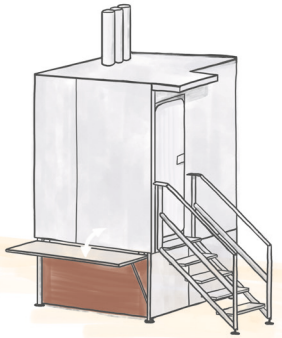
Autarky feces module

The Fecal Oxidation Unit "FOX" processes wet feces under supercritical conditions. Pathogens are removed, organic compounds are oxidized and mineralized. Additionally phosphorus is recovered as a solid.



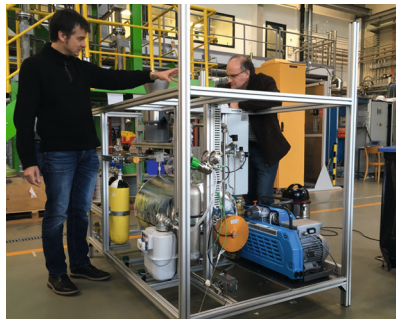


Properties of the current module:

Capacity:	2 kg feces/day *
Energy use:	14 kWh/day
Footprint:	1.4 m^2
Volume:	1.3 m^3
Additives:	No additives needed
Service:	Maintenance on demand

* 10 full-time users for the Blue Diversion Autarky toilet

1. **Aquatron®**
   Separates solids and liquids
2. **Tank**
   Stores solids
3. **Macerating pump**
   Homogenizes and transports feces
4. **Compressor**
   Pressurizes ambient air
5. **Gas cylinder**
   Stores pressurized air
6. **Injector**
   Stores homogenized solids immediately
7. **Reactor**
   Supercritical water oxidation of feces
8. **Product post-treatment**
   Separates water, minerals and off-gas under high pressure and high temperature



Build-up of lab-scale prototype at PSI

18 applications for the Autarky systems

The aim of the Blue Diversion Autarky project is to develop a sanitation system for poor neighborhoods. However, the Autarky toilet and the Autarky modules can be applied in many situations.

Densely populated areas without sewer connection

- Private homes
- Ablutions blocks
- Schools
- Hospitals
- Refugee camps
- Public toilets in parks and in squares
- Festivals

Transportation

- Trains
- Ships and boats
- Airplanes
- Mobile homes

Remote areas

- Mountain cabins
- Vacation homes
- National parks
- Beach resorts
- Camping sites
- Community gardens
- Construction sites

Team

Participants of kick-off meeting for the current Blue Diversion Autarky project (2017)

The Blue Diversion Autarky team consists of researchers and experts from the Swiss Federal Institute of Aquatic Science (Eawag), the Paul Scherrer Institue (PSI), the University of Applied Sciences and Arts Northwestern Switzerland (FHNW) and from EOOS. The project is supported by an advisory board of six international commercial partners.

Funding is provided by the Bill and Melinda Gates Foundation (BMGF).

Project lead and urine treatment: Prof. Dr. Kai M. Udert
Water treatment: Prof. Dr. Eberhard Morgenroth
Feces treatment: Prof. Dr. Frederic Vogel
Project coordination and commercialization: Dr. Juri Lienert

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11/2018

The Blue Diversion Autarky toilet is a sanitation system which provides hygiene and comfort without relying on water and wastewater infrastructure. Water, urine and feces are collected separately and treated on site in specific modules. The Blue Diversion Autarky toilet recycles water for hand washing and flushing, recovers nutrients for fertilizer production and inactivates pathogens reliably. The treatment modules can be replaced, integrated in other sanitation systems or used as stand-alone units. One example is the hand washing station, which was also developed by the Blue Diversion Autarky team.

www.autarky.ch

Funded by

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