reinvented | 新世代
toilet | 厕所
expo | 博览会

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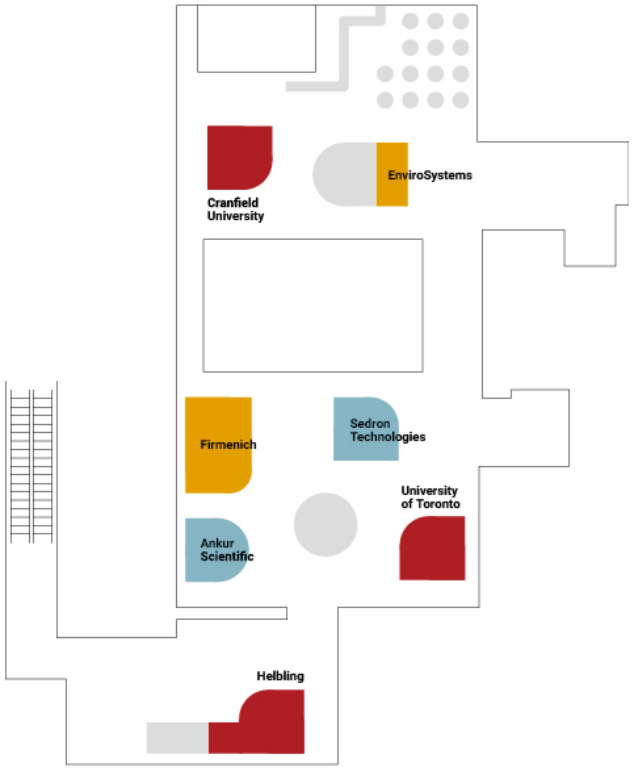
Guardian Art Center
6-8 Nov 2018

EXHIBITION MAP

Floor 1

Floor 2



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Reinvented Toilet Exhibitors

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Additional Technologies (not exhibiting at the Reinvented Toilet Expo)

LEGEND

Reinvented Toilet Exhibitors

Reinvented Toilets are a new generation of toilets that treat waste and kill pathogens without the need for connections to sewers, treatment plants, water supply, or continuous electricity. These new toilets use a variety of innovative technologies to break down human waste and destroy germs, leaving behind clean water and solids that won't harm people or the environment. The toilets can be used either for individual households or multiple stall facilities that can serve local communities, schools, apartment buildings, and commercial enterprises.

Product is Appropriate For:

The presence of these icons indicates that the technology can be used for the listed applications. Some solutions, for example, only work in certain configurations such as a squat plate, while other solutions are more adaptable.

Omni-Processor Exhibitors

Omni-Processors are self-powered treatment plants that can process human waste such as sludge and biosolids, kill dangerous pathogens and convert the resulting materials into products with commercial value-like clean water, electricity, and fertilizer. Omni-processors can be used to augment existing sanitation services within a city, as part of a fecal sludge treatment plant or complementing a waste-water treatment plant.

Product is Appropriate For:

The presence of these icons indicates the type of inputs that can be processed by the solution in the current design.

Key terms:

- **KLD** - *Capacity is defined in KLD (kiloliters per day)*
  Wet sludge - *input sludge to FSTP (0.5%-5% total solids)*
  Dewatered sludge - *sludge processed to increase solids content (20%-45% total solids)*
- **FSTP** - *Fecal Sludge Treatment Plant*
- **WWTP** - *waste water treatment plant*
- **MSW** - *Municipal solid waste*

Enabling Technologies and Sector Partners

Enabling technologies include components or complementary technologies that enable products or systems to work more efficiently and effectively in our target markets. Examples include interfaces, malodor technologies, liquid treatment, among others.

Additional information

Status of the IP: The presence of the lightbulb and the text underneath the lightbulb gives an indication of whether there is intellectual property (IP) such as a patent associated with this product, and whether it is IP Filed, Patent or Patent Pending, or if the company is a Licensee.

Status of the Product: The presence of the start indicates that the product is available for purchase. This means that the product is launched and is available for purchase orders. Geography, markets, quantities available, and lead times may vary.

RECYCLING TOILET | CLEAR

Biological Reinvented Toilet

The Clear toilet uses a full-water cycling process for treatment of the sewage. A rain water collecting system can also replenish the water to the processor for self-renewal.Blackwater from the toilet is pumped up to the sewage processor for treatment and then recycled to the storage tank for flushing. An advanced unique "Biofilm-MBR" treatment process is employed as the core technology for treatment, producing a stable and clean effluent that is further disinfected to ensure safety of the effluent for reuse.

Key features:

- Current design has four stalls and three urinals and can serve up to 1000 users/day
- Ability to operate in remote, or water-scarce conditions where there is not existing sanitation solutions such as sewers
- Wifi and media player features available

Website

Wechat interface

Status of development

TRL

CONCEPT → EARLY PROTOTYPE → PRODUCT AVAILABLE

- Clear prototype development and testing complete in China
- Over 100 units have been sold and are in operation at sites across China, shown at left.

Use Cases

- **Multi-unit:** Design of system is most readily applicable to tourism sites, school, or public/ community applications
- **Household:** Technology could be potentially scaled down to serve as a single household unit. up to 10 users per day

Product is Appropriate For:

Squat | Pedestal | Wipe | Wash

1000	$.03	10
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

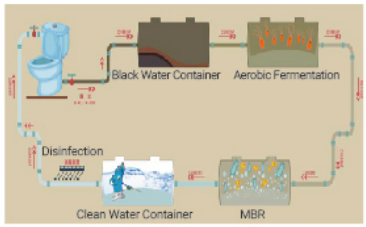
Frontend

Compatible with multiple front ends, currently designed as a multi-seat unit.The wastewater is grounded and lifted to the treatment unit.

Processing

Initially treated with physical precipitation. A special aerobic media is placed in the aerobic reactor and proprietary bacteria, specifically developed for treating wastewater, is attached on the media as a biofilm. This biofilm can effectively biodegrade more than 50% of the organic pollutants and reduce its concentration.

The wastewater is then treated by a MBR (membrane biological reactor) to separate pollutants in large size, which can be refluxed in the biodegrade process, producing clean water. Finally, the produced clean water is further disinfected via UV to kill all bacteria in the water.



Power System

The system requires external power either from grid electricity, or from solar panels. Estimated requirement is 5.65 kWh/day.

Inputs

Does the system require an external source of electricity?
Yes. Currently either grid or solar panels

Does the system require the use of water?
Yes. Rainwater collection is required for startup only. Flush water is recycled.

Does the system require any other "consumable" inputs?
No

Outputs

How much energy will be recovered?
None. Energy is used in process

How much water will be recovered?
Water is recycled to be self-sustaining

How much fertilizer or other by products will be produced?
None

Treatment

Treats Solids and liquids
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? Yes
Does the system require any off-site or additional processing?
Yes. Solids is required to clear every year.

Business considerations

Estimated daily operating cost
$0.03/user/day
Estimated Capex $50,000 (TT-1 model)
Size L 6.06m **x W** 5.96m **x H** 5.04m
Maintenance requirements
Membranes to be monitored and replaced as needed every two years. Solids may need to be emptied every year.
Life expectancy 10 years

For More Information

Clear (Suzhou) Environmental Technology Co., Ltd
"Tim" Cao (tim@clearet.com)
China

CLEAR

Seeking: Communities or community sites interested in purchasing and deploying units

- Product is available for sale in China

Available for Purchase

OYSTRA | CRANE ENGINEERING

Mobile Septage Treatment System

The Oystra Mobile Septage Treatment System (MSTS) is a new sanitation system that processes human fecal sludge into non-potable water for agricultural or industrial use or safe discharge. Oystra is a truck-mounted dewatering system for use in areas like dense urban settlements where poor sanitation poses the greatest risks to human health. The latest generation prototype will be more cost effective, transportable, and easier to maneuver in crowded informal settlements than traditional septage collection methods.

Key features:

- Makes septic tank emptying and treatment safer and less expensive
- Pre-processes the septage from pit latrines or septic tanks to discharge clean, safe water
- Results in reduced solids volume to transport to treatment, therefore reducing transport cost

Status of development

TRL 4

CONCEPT | **PROTOTYPE** | PRODUCT LAUNCHED

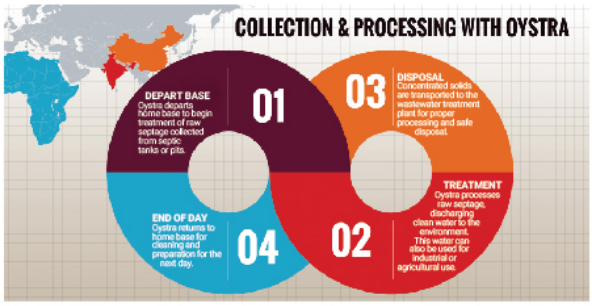
- In 2016, Crane built the initial Oystra Mobile Septage Treatment System (MSTS) prototype and tested locally in 2017
- The second generation prototype is complete and began field testing in October 2018

Use Cases

- **Pit and tank emptiers:** Designed to be used by pit/tank emptiers who collect and transport septage from containment sites to treatment facilities

3L/S	TBD	20
Capacity	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?



Inputs

Does the system require an external source of electricity?
Yes. Currently powered by truck-mounted diesel generator (<60kW steady state)

Does the system require the use of water?
No

Does the system require any other "consumable" inputs?
Diesel fuel

Outputs

How much energy will be recovered?
None. Energy is used in process

How much water will be recovered?
50-80% of intake volume discharged as safe industrial or agricultural water

How much fertilizer or other by products will be produced?
None

Treatment

Liquid Separated, treated, then discharged
Solids Not treated
Pathogen treatment success? Confirmed total pathogen removal from liquid effluent
Are chemical processes used? No
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? Yes. Concentrated septage to be transported to treatment facility

Business considerations

Estimated daily operating cost
(not available)
Estimated Capex
(not available)
Size H 3.2m **x W** 2.2m **x L** 4.5m (processor)
H 2.8m **x W** 2.4m **x L** 9.4m (with truck)
Maintenance requirements
Filters to be replaced every 6-12 months, daily cleaning after shift
Life expectancy 20 years

For More Information

Crane Engineering
Mark Hassman (M.Hassman@craneengineering.net)
https://blog.craneengineering.net/news/
707 Ford Street | Kimberly, WI 54136 **USA**

Seeking: Pilot partners for testing of prototypes in real-world conditions

- Patent applications filed for integrated system
  Team field testing second-generation prototype in October
- 2018 with plans for 2019 tests in Africa

Patent-pending

NANOMEMBRANE TOILET | CRANFIELD UNIVERSITY

Dry combustion Reinvented Toilet

Fully self-contained household toilet system. Frontend resembles a Western-style pedestal toilet with a novel waterless swiping flush mechanism, and all waste processing components are housed within the pedestal. In the backend, solids and liquids are settled.The solids are extracted by a specifically designed screw, then dried and combusted, while liquids are preheated and purified with a hydrophobic membrane.

Key features:

- Single household system: up to 10 users/day
- System design is completely self-contained, no water or power connections are required
- Unique waterless flush system minimizes water requirements
- Heat from the combustion process is used to drive water through the membrane
- System produces clean water each day for household use
- Ash requires occasional disposal

Status of development

TRL 4

CONCEPT | **EARLY PROTOTYPE** | PRODUCT ANNOUNCED

- Optimized subcomponent performance
- Frontend and backend component prototypes developed in Cranfield, UK
- Frontend tested in households in Durban, South Africa. Full system to be tested in 2019

Use Cases

- **Household:** Designed as a self-contained, household unit up to 10 users per day
- **Multi-unit:** Core processing technology could be scaled for school, or public/community application

Product is Appropriate For:

Pedestal | Wipe

10	TBD	10
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

1.Frontend

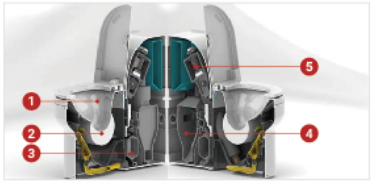
User encounters a pedestal toilet with a unique waterless flush system. A rotating odor barrier and scraper mechanism manages odor and enables dry flushing.

2.Urine/Feces Separation

Solids and liquids are separated by gravity sedimentation. Liquids flow over a weir to liquids processing, while the solids are extracted using a screw.

3. Liquid Processing

A hydrophobic membrane separates clean water from the contaminated urine. The clean water is then sent to a storage tank for later use.



5. Power System

The lifting of the toilet seat powers the bowl. Excess heat from the combustor is used as the driving force for water separation. There are opportunities for electrical energy generation under development from thermal and electrical gradients, to offset residual power requirements.

4. Solids Processing

Solids are dried, pelletized and combusted resulting in ash. The combustor being developed is a micro-combustor that can be fed at <1 g/min of dried fecal waste.

Inputs

Does the system require an external source of electricity?
No. Energy is generated mechanically and potentially through thermal and electrical gradients.

Does the system require the use of water?
No

Does the system require any other "consumable" inputs? No

Outputs

How much energy will be recovered?
None. Recovered energy is used in process

How much water will be recovered?
>10 litres/day usable

How much fertilizer or other by products will be produced?
10g ash/user/day

Treatment

Solids treatment Combustion
Liquids treatment Membranes
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? No
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
(not available)
Estimated Capex (not available)
Size L 1.25m **x W** 0.75m **x H** 1.0m
Maintenance requirements
Water/ash to be emptied daily (by user),
Ash to be emptied weekly, and membranes to be cleaned four times a year
Life expectancy 10 years

For More Information

Dr. Alison Parker (a.parker@cranfield.ac.uk)
http://www.nanomembranetoilet.org/
Cranfield University, **United Kingdom**

Seeking: Commercialization partners for product development, manufacturing, and launch

- Technology is available for licensing for further product development, manufacturing, and launch
- Two patents published, one further patent filed.

Patent pending

THE EMPOWER SANITATION PLATFORM | DUKE CENTER FOR WASH-AID

Dry combustion Reinvented Toilet

Community toilet with both liquid recycling and solids processing. The toilet is compatible with pedestal and squat plate styles. Onsite processing includes electrochemical disinfection and recycling of liquids, and drying and sterilization of solids with optional combustion. User amenities may include body wash and hand wash stations and menstrual pad dispenser and disposal options.

Key features:

- User options developed through four year in-field household and community design studies
- Liquids processed via active filtration and electrochemical disinfection, meeting ISO discharge standards
- Independent solid and liquid processing modules can be paired with other technologies to create a suite of sanitation products
- Examples of new products include The Reclaimer, a liquid recycling unit, and a stand-alone menstrual waste management unit

Status of development

TRL

CONCEPT | **ADVANCED PROTOTYPE** | PRODUCT ANNOUNCED

- Third generation (TRL 7) prototype in active testing in Coimbatore, India and Durban, South Africa; Coimbatore testing focuses on women and girls.
- Both liquid recycling and menstrual pad processing products will be tested first in India in January 2019.

Use Cases

- **Household and Community:** Designed for 10 to 50 users per day. The processing system can be adapted to service multiple seats in a community block.

Product is Appropriate For:

Squat | Pedestal | Wipe | Wash

10 to 50	TBD	10
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

Frontend

Compatible with both pedestal and squat plate interfaces.

Urine/Feces Separation

Mesh belts used for initial separation. Baffle tanks in liquid processing stream allow for additional settling of solids.

Liquid Processing

(blue) Hybrid processing includes activated carbon filtration with electrochemical disinfection. A post baffle filter is used for Helminth egg removal. The disinfected liquid is recycled for flush water.

Liquids processing | Solids processing

Power System

Currently powered by grid power. Optional solar panels (500 W) for supplemental and off-grid energy.

Solids Processing

(red) After initial separation, solids are dried @ 90ºC. Combustion option may increase solids processing capacity across multiple units.

Inputs

Does the system require an external source of electricity?
Yes. Requires 5-7kWh/day, currently provided through grid power (deep-cycle batteries) or 500 W photovoltaic panels.

Does the system require the use of water?
Wash and/or flush water 30L initial charge, otherwise recycled water is used in system.

Does the system require any other "consumable" inputs? No

Outputs

How much energy will be recovered?
None. Energy is used in process.

How much water will be recovered?
10-30 L/day-excess water will be discharged after disinfection, remainder is used for flush water.

How much fertilizer or other by products will be produced?
Sterilized dried solids may be collected or incinerated onsite.

Treatment

Liquids Electrochemical and activated carbon
Solids Thermal
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
(not available)
Estimated Capex (not available)
Size L 1.5m **x W** 2.0m **x H** 1.25m
Maintenance requirements
Ash/dried solids emptied weekly (by user)
Life expectancy 10 years
Other features Menstrual pad disposal

For More Information

Duke University Center for WaSH-AID
Dr. Brian Stoner (stoner@duke.edu)
http://washaid.pratt.duke.edu/
Durham, NC **USA**

Duke | PRATT SCHOOL of ENGINEERING | Center for WaSH-AID

Seeking: Commercialization partners for product development, manufacturing, and launch

- Provisional patents pending for liquid and solid modules

Patent pending

BLUE DIVERSION AUTARKY | EAWAG

Reinvented Toilet

EAWAG exhibits two products: the **Blue Diversion Autarky toilet**, which separates and treats urine, solids and flushing water on site. Urine is chemically stabilized and concentrated. Solids are processed with supercritical water oxidation. The water treatment module combines a biological membrane reactor, activated carbon and electrolysis to provide save recycled water. The water treatment is available as a stand-alone handwashing station called **Water Wall**. Urine and solids treatment can also be provided as separate units.

Rendering of the Blue Diversion Autarky toilet shown at RTE. © Eawag/ EOOS

Key features:

- Source separation allows for water recycling, nutrient recovery and optimal disinfection
- Modular design: all treatment units can be operated alone or integrated in other systems
- Superstructure allows integration of other treatment units.
- Attractive frontend developed with partner EOOS offers hygiene and comfort of modern water flushed toilets

Status of development

TRL 4 5

CONCEPT | EARLY PROTOTYPE | PRODUCT ANNOUNCED

- Water Wall has TRL 6. Field tests in East Africa and Zurich
- Urine module and user interface TRL 4. Field tests ongoing
- Exhibited toilet unit TRL 4, does not include feces module.
- Feces module TRL 3. Field tests in the beginning of 2019.

Use Cases

- **Household or single stall:** Current Blue Diversion Autarky Toilet is designed for 10 users per day
- **School:** Current Water Wall can be used as a hand washing station with three faucets

Product is Appropriate For:

Pedestal | Wipe | Wash

10+	TBD	TBD
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work? (Blue Diversion Autarky Toilet)

© Eawag/EOOS

1.Frontend

Water-flushed urine-diverting pedestal, waterless urinal and hand washbasin. Water is recycled.

2.Urine/Feces Separation

Source-separating unit designed by EOOS. Urine is separated in a urine-diverting pedestal (NoMix toilet). Solids are separated in an Aquatron.

3.Liquid Processing

Urine processing (3): Urine is chemically stabilized then undergoes passive evaporation, resulting in a solid product that can be harvested as fertilizer. Water processing (4): Three units are used for treating the used flushing water and handwashing water: membrane bioreactor with ultrafiltration, activated carbon filter and electrolysis to produce residual chlorine

5.Solids Processing

Feces, toilet paper and some flushing water are fed into a small-scale, batch-processing supercritical water oxidation reactor developed by the University of Applied Sciences and Arts, Northwestern Switzerland (FHNW).

6.Power System

Water wall and urine processing can be operated using solar power. SCWO reactor is still too early in development to assess energy requirements.

Inputs

Does the system require an external source of electricity?
All units require power supply.

Does the system require the use of water?
Water is internally recycled. Some water will have to be refilled.

Does the system require any other "consumable" inputs?
Calcium hydroxide for urine stabilization.

Outputs

How much energy will be recovered?
None. Energy is used in process.

How much water will be recovered?
<10 litres/day produced. Designed to be recycled, none is intended for discharge

How much fertilizer or other by products will be produced?
Nutrient recovery: >70% nitrogen, >80% phosphorus, >70% potassium and others

Treatment

Solids Yes, supercritical wet oxidation
Liquids Yes, urine (chemical stabilization and evaporation); wash water (membrane bioreactor, ultrafiltration, activated carbon, electrolysis)
Pathogen treatment success? Autarky system will have total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost (not available)
Estimated Capex (not available)
Size Blue Diversion Autarky Toilet:
L 2.2m **x W** 1.9m **x H** 3.4m (without stairs)
Water Wall: **L** 1.9m **x W** 0.9m **x H** 2.3m
Maintenance requirements
Water refill, fertilizer harvest from urine and feces treatment, supply of chemical reagent
Life expectancy 10 years

For More Information

Dr. Juri Lienert (juri.lienert@eawag.ch)
www.bluediversiontoilet.com/
www.autarky.ch
Eawag, **Switzerland**

Blue Diversion AUTARKY Sanitation off the grid | eawag aquatic research

Seeking: Commercialization partners for product development, manufacturing, and launch

- Actively looking for and engaging partners for manufacturing and/or commercialization of the Water Wall component and for Autarky system.
- Patent protection on the frontend of the device is being pursued by EOOS.
- IP filed for hand-washing soap.

IP filed

ECO-SAN TOILET | ECO-SAN

Electrochemical Reinvented Toilet

Eco-San is one of the leading developers of the CalTech technology, focusing on school and public toilets, and containerized toilet units. The backend processing technology capitalizes on anaerobic digestion of solids and an electrolysis system to convert waste into water, hydrogen, and solid fertilizer. Eco-San is piloting three units in China, and two in South Africa. Eco-San's sister company, Yixing Entrustech, is producing and reducing the cost of the electrodes that drive the electrolysis treatment process to make available to all partners.

2017 EcoSan prototype of public toilets, also available in a fully containerized solution.

Key features:

- Design can be fully containerized, or with separate digestion tank
- Patented electrochemical cells process mixed wastewater
- Can recycle process effluent as toilet flush water, notable in water scarce areas
- Compatible with any type of flush toilets (squat pan, western style, urinals, etc.)

Status of development

TRL

CONCEPT › PROTOTYPE › **PRODUCT AVAILABLE**

- Eco-San is piloting three units in China, two at tourist locations-a park, and a temple-and one at an elementary school.
- Two units are being commissioned as community ablution blocks in Durban, South Africa

Use Cases

- **Multi-unit:** Core processing technology scalable for school, or public/community application; capable of servicing 50-800 users per day with one system.

Product is Appropriate For:

Squat · Pedestal · Wipe · Wash

800	$.02	5-10
Capacity (flushes/day)	Est. Cost ($/flush/day)	Life Expectancy (Years)

How does it work?

1.Frontend

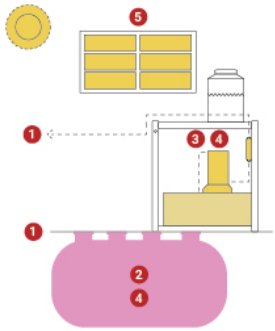
Includes up to 8 toilets and urinals located near the backend processing components.

2.Urine/Feces Separation

No urine/feces separation. Mixed waste passively settles in a septic tank with anaerobic digestion. Active pre-processing with an anaerobic/aerobic system is available.

3. Liquid Processing

An electrochemical system oxidizes the effluent from the septic tank and biological treatment unit at a semiconductor anode and water is reduced at the metal cathode to form H2. Chloride, from table salt, can be added if there is an insufficient amount in the waste. Membrane microfiltration is currently included for polishing the final effluent.



4. Solids Processing

Feces are macerated with the urine and flush water, all are processed together. Undigested solids that have settled in the septic tank are estimated to require evacuation once a year.

5. Power System

Solar panels, with energy storage via battery stack, and/or grid electricity. Estimated 18kwh required per m³

Inputs

Does the system require an external source of electricity?
Yes. Provided by solar panels or grid.

Does the system require the use of water?
No

Does the system require any other "consumable" inputs?
No

Outputs

How much energy will be recovered?
None. Energy is used in process

How much water will be recovered?
4-5 m³/day usable, not potable

How much fertilizer or other by products will be produced?
1 ton per year

Treatment

Treats Solids and liquids
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
$0.02/flush/day
Estimated Capex (not available)
Size L 12m **x W** 2.2m **x H** 2.7m
Maintenance requirements
Solid wastes to be emptied half a year (by user).
Membrane filters to be replaced once a quarter.
Life expectancy 10 years

For More Information

Yixing Eco-Sanitary Manufacture Co., Ltd (Eco-San)
Mr. Xiaokang Zhou (zhouxiaokang@hotmail.com)
Yixing, Jiangsu **China**

Eco–san

Seeking: Partners to purchase and operate units

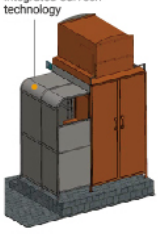
- Patents pending from CalTech on the electrochemical process in the United States, India, and China. See WO 2014/058825 A1 for further information.
- Eco-San anticipating commercial license by November 2018

Available for Purchase · Pending Licensee

ETOILET | ERAM SCIENTIFIC SOLUTIONS

Electrochemical Reinvented Toilet

Eram eToilet with integrated CalTech technology



Design for Eram eToilet with USF technology

Eram Scientific's eToilet incorporates a full treatment solution by integrating the existing eToilet technology deployed in over 3500 sites with novel treatment technologies stemming from the Reinvent the Toilet Challenge. The current prototype incorporates the CalTech electrochemical reactor to process the black water and produce reusable effluent, also safe for discharge. Additional prototypes incorporating the University of South Florida treatment technology is also under development.

Key features:

- eToilet features automated entry and self-cleaning of toilet bowls and floors for automated and unmanned operations
- Remote monitoring capabilities
- Sensor-enabled water minimization system
- Treated water from CalTech reactor is recycled back for toilet flush and floor wash
- Multiple potential business models being explored to support scale up of treatment units

Status of development

TRL 6

CONCEPT | **PROTOTYPE IN TESTING** | PRODUCT ANNOUNCED

- eToilet with CalTech integrated treatment system prototype field testing in Coimbatore, India in late 2018 through 2019
- Additional prototypes incorporating USF technology to be built and tested in 2019
- Goal is for product availability by early 2020

Use Cases

- **Single unit:** Designed as a automated self-contained, toilet unit deployed in public sites, schools, or transport centers, capable of handling up to 100 users per day

Product is Appropriate For:

Squat | Wipe | Wash

100	$.07	10
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

Frontend

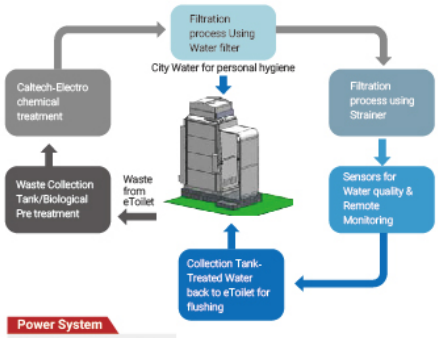
Eram Scientific's eToilet, an unattended and automated self-cleaning electronic toilet cabin with remote monitoring and sensor enabled water minimization capability.

Urine/Feces Separation

No separation is required.

Liquid/Solids Processing

Waste stream is flushed and sent to the biological pretreatment holding tank. Waste is then pumped to the electro-chemical reactor(ECR) based on the CalTech technology. The quality of the effluent following final filtration using water filters and strainer is confirmed using sensors and remote monitoring. Water is then stored for reuse as flushing water in eToilet.



Power System

Currently powered by grid power.

Inputs

Does the system require an external source of electricity?
Yes, grid electricity is required.

Does the system require the use of water?
Yes, the personal hygiene taps and faucets require water.

Does the system require any other "consumable" inputs? No

Outputs

How much energy will be recovered?
None. Energy is used in process

How much water will be recovered?
All water used in the toilet is recycled for flushing and cleaning

How much fertilizer or other by products will be produced?
None

Treatment

Treatment Biological pretreatment and electrochemical disinfection
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used?
Yes, Water filter
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
$0.07/user/day

Estimated Capex
~US$ 13 500

Size L 2.2m **x W** 1.7m **x H** 3.1m

Maintenance requirements
(not available)

Life expectancy 10 years

For More Information

Eram Scientific Solutions Pvt. Ltd
Bincy Baby(bincy@eramscientific.com)
www.eramscientific.com
KEK Towers, 5TH Floor, Vazhuthacadu
Trivandrum, Kerala, **India**

Eram Scientific

Seeking: Purchasers for product deployment, and/or distributors and operators to support scale up

- Prototype and business model testing to be completed in 2019, with units in production by early 2020.

HTCLEAN | HELBLING WITH GATES FOUNDATION

High Temperature Processing Reinvented Toilet

Helbling has been engaged by the Gates Foundation to develop HTClean, a next-generation Reinvented Toilet based on a high temperature and high pressure processing design. The toilet is being engineered specifically for the household. Intuitive visual cues on operation, maintenance, status, and usability are integrated.

Key features:

- Self-sustaining toilet without water and sewage connection
- Single household system designed for 4-6 users/day, up to 10 users/day
- Vacuum flush system greatly reduces the flush water required (0.2-0.9 L)
- A unique, intuitive human machine interface (HMI)

Status of development

TRL

CONCEPT | **EARLY PROTOTYPE** | PRODUCT ANNOUNCED

- Demonstrator unit developed and lab tested in Zurich, Switzerland
- Additional prototype testing and design improvements planed starting from January 2019.

Use Cases

- **Household:** Designed as a self-contained household unit for up to 10 users per day
- **Multi-unit:** Core processing technology could be scaled for school or public/community application or by installing units in each stall

Product is Appropriate For:

Squat | Pedestal | Wipe | Wash

10	TBD	20
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

Frontend

The input tank (10) is fed by the user input of the toilet (frontend, 11) through a vacuum pump including a macerator (19).

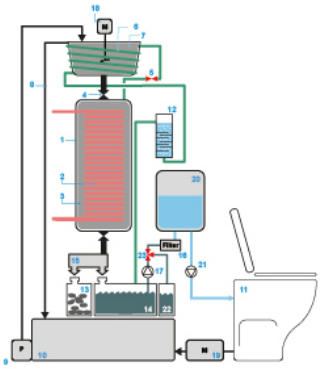
Urine/Feces Separation

Solid/liquid separation is conducted after processing by a mechanical filter press (15).

Processing

The user input is initially stored in a holding tank (10). The composited material from the storage tank is passed through a pre-heater (7), then loaded into a reactor chamber (4) and heated above 160°C* (2), at a pressure up to 25 bar*. After cooling the reactor is discharged and solids and liquids are separated (15), resulting in a small filter 'cake' (13). The produced liquid is retained (14) and then cleaned for use in the toilet flushing system.Water vapor released from the reactor after processing is used for pre-heating (6) quenched in a bubble tank (12). The quenched water in (12) is also cleaned and combined with the flush water (20).

* Optimum operational conditions are currently being identified



Inputs

Does the system require an external source of electricity?
Yes.

Does the system require the use of plumbed water?
No, water is recycled within the system.

Does the system require any other "consumable" inputs?
No

Outputs

How much energy will be recovered?*
To be determined when optimal operation conditions are finalized

How much water will be recovered?*
The flush water is a closed loop. Any excess water collected, due to urine deposits will be discharged

How much fertilizer or other by products will be produced?
20 g filter cake/user/day

Treatment

Treats Solids and liquids combined
Pathogen treatment success?
Total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily cost (not available)
Estimated Capex (not available)
Size L 1.2 m **x W** 1.0 m **x H** 1.9 m
Maintenance requirements
Non-hazardous, non-odorous, solid waste cakes and excess liquids to be regularly disposed by user.
Life expectancy 20 years

For More Information

Christian Seiler, PhD
(christian.seiler@helbling.ch)
www.helbling.ch
Zurich, **Switzerland**

helbling

Seeking: Commercialization partners for product localization, manufacturing, and launch in global markets

- Technology is available for licensing for further product development, manufacturing, and launch from the Gates Foundation

ZYCLONE CUBE | SCG CHEMICALS CO., LTD

Biological and Electrochemical Reinvented Toilet

Integrating with a conventional flushing toilet, the Zyclone Cube is designed for efficiently separating and effectively treating both solid and liquid fractions. The unique Zyclone shape achieves liquid separation at greater than 98%. The solids fraction is dropped into a screw heating device that operates intermittently in dehumidifying and inactivating pathogenic contents. The liquid is further treated by integrated adsorptive media (e.g.modified soil and zeolite) in a series of anaerobic, aerobic, and anoxic chambers prior to a final step of electrochemical disinfection.

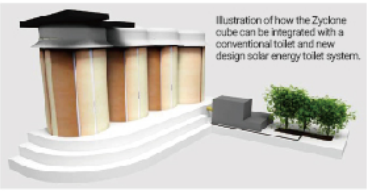


Illustration of how the Zyclone cube can be integrated with a conventional toilet and new design solar energy toilet system.

Key features:

- Toilet system (1-4 toilets per one Unit)
- Pour flush (1.5 Liters) up to 130 users/day
- Flushing (3.0 Liters) up to 70 Users/day
- Ability to retrofit in existing systems
- Encourages environmentally friendly fecal sludge management (FSM) practices in areas with limited access to FSM services or with temporary solutions (e.g., camp, natural sites, temporary festival event, refugee camp, medical triage)

Status of development

TRL

CONCEPT → EARLY PROTOTYPE → **PRODUCT AVAILABLE**

- Original design by AIT initially tested in Thailand
- Design then adapted by SCG Chemicals to meet ISO 30500 standards and cost-efficient manufacturing
- 50 initial prototype units to be tested in Thailand in 2019

Use Cases

- **Household and public toilets:** Designed to serve 4 toilets stall processing the waste of 130 users per day

Product is Appropriate For:

Squat · Pedestal · Wipe · Wash

130	0.10	15
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

Frontend

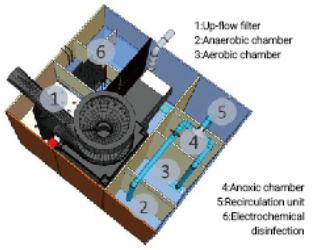
User encounters a conventional flush toilet. It is possible to adapt to both a pedestal and squat plate flush interface.

Urine/Feces Separation

The unique shape of the Zyclone results in a solid/liquid separation effectiveness of greater than 98%.

Liquid Processing

The separated liquid is firstly filtered in a plastic media chamber (1) to remove coarse solid particles. The next two chambers (2, 3) are filled with synthesized media at 2 cm and 1 cm diameter, respectively. In the anaerobic chamber (2), the organic loading is reduced prior to an aerobic chamber (3) equipped with microbubble aeration that further remove COD, TN, and TP contents. In the next chamber (4), TN is greatly reduced by zeolite media in an anoxic condition. Chamber 5 (5) is designed to recirculate the treated liquid to the anaerobic chamber (2) in order to increase the overall treatment performance. The final chamber (6) is equipped with electrochemical electrodes that inactivate the pathogens remained in liquid prior to discharge.



Solids Processing

The separated fresh fecal matter (solid) is collected in a chamber located below the Zyclone separator and be disinfected and reduced the moisture content by screw heating device. The heating device could inactivate helminths 4-5 log values and E. coli by 6 log value.

Power System

The system requires electricity

Inputs

Does the system require an external source of electricity?
Yes

Does the system require the use of water?
Yes, flush water

Does the system require any other "consumable" inputs?
Yes, media

Outputs

How much energy will be recovered?
None.

How much water will be recovered?
200 liters/day

How much fertilizer or other by products will be produced?
10 kg solids/month

Treatment

Solids Treatment Thermal disinfection
Liquid Treatment Biological and electrochemical
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes, separation
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
US$0.10/day
Estimated Capex (not available)
Size L 1.45m **x W** 1.25m **x H** 1.35m
Maintenance requirements
Media to be replaced every 3 years
Electrodes to be changed every 3 years
Fertilizers to be collected every month
Life expectancy 15 years

For More Information

Attawut Kumkrong (attawutk@scg.com)
www.scgchemicals.com
1 Siam Cement Rd, Bangsue, Bangkok **Thailand**

SCG

Seeking: Partners to purchase and implement

- Technology is licensed from AIT to be manufactured and made available globally by SCG Chemicals
- Now available for purchase

Available for Purchase

Licensee of Patent

NEWGENERATOR | UNIV. OF SOUTH FLORIDA (USF)

Biological and Physicochemical Reinvented Toilet

The NEWgenerator is a compact, portable, and modular resource recovery machine that eliminates waste while recovering fertilizer nutrients, renewable energy, and clean water.The system uses an anaerobic baffled reactor design followed by a nanomembrane filter operated at sub-critical water flux to extend the longevity. Permeate from the filter is treated for reuse as flush water by electrochemical chlorine production from table salt.

Key features:

- Anaerobic membrane bioreactor processes solid and liquid in a single, dilute waste stream
- Minerals and nutrients are removed from the wastewater by a hydroponic/biosorption system
- Biogas from waste product digestion is collected for use outside of the system (e.g. cooking,heating)

NEWgenerator 100 v.1 (white unit) undergoing field-testing at a school in Kerala, India. The orange units are Eram eToilets serving as front-end units.

- Operates off the grid on solar photovoltaic and is housed in a quadcon for small footprint and high service density, recycling~1100 L/day of flush water

Status of development

TRL

CONCEPT → **PILOTED PROTOTYPE** → PRODUCT ANNOUNCED

- Pilots in Kerala, India (2016) and in an informal settlement in Durban, South Africa (Fall 2018)
- A next-generation, high-capacity unit (1000 uses/day) to be tested in South Africa in 2019
- Partnering with Eram Scientific and BIRAC (India) to produce integrated treatment unit with Eram eToilet

Use Cases

Scalable system from single household (less than 10 users) and up to 1000+ users a day. Current design for 300 uses/day, or~60 users)

- **Multi-unit:** As an exterior system, most common use cases include community toilets, schools, and multi-unit dwellings.

Product is Appropriate For:

Squat · Pedestal · Wipe · Wash

60+	$.09	15+
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

Frontend

Agnostic to user interface; can be paired with a variety of designs.

Urine/Feces Separation

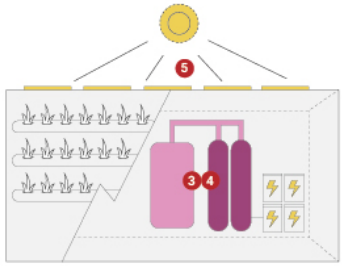
No separation is required, urine, feces, and wash/flush water are processed as a single stream.

3. Liquid Processing

Mixed waste enters an anaerobic membrane bioreactor (AnMBR). Liquid is filtered with a commercially available nanomembrane, operated at sub-critical flux to optimize longevity of the membrane. Biosorption and hydroponic processing is used to remove additional organics and minerals. Electro-chlorination is the final polishing step.

4. Solids Processing

Mixed waste stream (TSS range 100-15,000 mg/L) is processed by an anaerobic microbial baffled reactor, where the organic materials are digested. Residual, undegraded solids will need to be removed; modelling indicates every 6-18 months, depending on waste composition.



5. Power System

Currently using solar panels to charge deep-cycle batteries that power the system. Biogas generated is dependent on strength of the influent COD and can be used for various uses such as heating and cooking fuel. Estimated requirement of 0.5-1.7 kWh per day.

Inputs

Does the system require an external source of electricity?
Yes, supplied by solar panels.

Does the system require the use of water?
Yes, small input required to make up for any losses in system

Does the system require any other "consumable" inputs?
Yes, salt for electrochlorination

Outputs

How much energy will be recovered?
3 kWh/d (as biogas) at 800 mg COD/L

How much water will be recovered?
Up to 100% of influent can be recycled for reuse

How much fertilizer or other by products will be produced?
N, P recovered for onsite horticulture

Treatment

Solids treatment Yes, anaerobic digestion
Liquids treatment Yes, nanomembrane filtration followed by electrochlorination
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? No
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
US$4-$5
Estimated Capex US$45 000 (prototype)
Size L 2.4m **x W** 1.5m **x H** 2.4m
Maintenance requirements
Leveling tank cleaning every 6-18 months; preventative maintenance every 6 months
Life expectancy 15+ years

For More Information

Daniel Yeh, PhD
(dhyeh@usf.edu)
http://www.newgenerator.net
Tampa, FL **USA**

NEWgenerator · USF UNIVERSITY OF SOUTH FLORIDA

Seeking: Additional commercialization partners for product development, manufacturing, and launch

- Nonprovisional patents: WO 2015143160 A1; WO 2015134501 A1; WO 2016141369 A1.
- Provisional patent: 62/365,729.

Patent

THE TORONTO TOILET | UNIVERSITY OF TORONTO (UT)

Dry combustion Reinvented Toilet

A household-scale system with solid and liquid disinfection in the backend. In the frontend, feces and urine/wash water are mechanically separated by a specially designed mechanism that can be attached to standard squat plates. Attachment to pedestals is also possible. Dewatered fecal material is then mixed with granular particles and smoldered. Catalytic conversion of the generated pyrolysis gases supplies additional heat and mitigates emission. Heat generated is used to dry incoming fecal material in situ, and thermally disinfect liquid waste.

Key features:

- Self-sustaining smoldering technology, under development since 2011, with TRL 4 results published in the journal Fuel in 2015.
- Continuous smoldering process for processing of fecal matter and consistent heat production.
- Catalytic conversion of the generated pyrolysis gases supplies additional heat, and mitigates emissions.

Status of development

TRL 6

CONCEPT → **EARLY PROTOTYPE** → PRODUCT ANNOUNCED

- System integration work has led to iterative development of functional prototypes for laboratory testing in Toronto, and multiple field tests in Coimbatore, India with local workers user group.

Use Cases

- **Household:** Designed as a self-contained, household unit, ranging from 5 to 20 users, accommodates variable input rates
- **Multi-unit:** Can be scaled up to multi-stall community applications with one front end per stall, and a shared processing stall.

Product is Appropriate For:

Squat · Pedestal · Wipe · Wash

5+	$.07	10-15
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?

1.Frontend

Currently used with a standard squat plate. Can be adapted to a pedestal.

2.Urine/Feces Separation

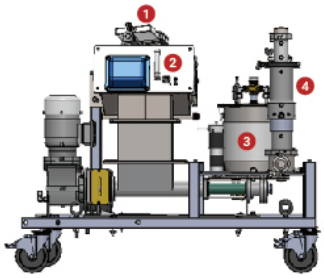
Multiple gravity-based solid/liquid separation designs have been evaluated and field tested. Effective solid/liquid separation is achieved without modifying user behavior.

3. Liquid Processing

Liquid pasteurization is achieved by recovering the heat captured in steam during solid drying process. Further effluent treatment is intended to be adopted from other projects being conducted in the BMGF portfolio.

4. Solids Processing

Solid fecal material (fuel) is transferred via a pump and is injected into a column where it is in-situ mixed with granular beads which are still hot from the preceding smoldering cycle. Once the mixing/drying process concludes, air is introduced and smoldering begins. Post smoldering gases pass through a catalyst for further treatment and heat generation.



Power System

Solar panels or other off-grid energy sources may be used to supply the <200 watts per day required. The aspirational goal that projections show is possible is to achieve a power requirement low enough to fit within the capacity of solar or other off-grid home systems that are common in many regions.

Inputs

Does the system require an external source of electricity?
Yes, Solar panels or other power source.

Does the system require the use of water?
Not required. Accepts 30L flush/wash water.

Does the system require any other "consumable" inputs?
No

Outputs

How much energy will be recovered?
None. Energy is used in process.

How much water will be recovered?
10-50 litres/day, not potable.

How much fertilizer or other by products will be produced?
10g ash per person, per day produced by solids processing, emptied monthly by user

Treatment

Solids Thermal processing
(0.6-3 kg/day capacity)
Liquids Pasteurization with 35 L/day capacity
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost
$0.07/user/day (initial estimate based on electricity use and six users)
Estimated Capex (not available)
Size L 1.7m **x W** 1.5m **x H** 1.0m
Maintenance requirements
Solids (ash) to be emptied monthly by user
Life expectancy 10-15 years
Other features Catalytic conversion of outlet air from smoldering process to reduce.

For More Information

University of Toronto Centre for Global Engineering
Dr. Yu-Ling Cheng (yuling.cheng@utoronto.ca)
200 College Street | Toronto, Ontario M5S 1A4 **Canada**
Spinout: Sankoya Technologies www.sankoya.com/toilet

UNIVERSITY OF TORONTO

Seeking: Commercialization partners to license technology for further product development, manufacturing, and launch

- PCT patent filed for solids processing.
- Seeking partners to integrate liquid treatment and develop products

Patent-pending

ANKUR OMNI-PROCESSOR | ANKUR SCIENTIFIC

Omni-Processor with municipal solid waste gasifier

Gujarat Chief Minister inaugurated the pilot site in Vadodara on 9 June 2018

Ankur Scientific is a pending commercial licensee of the Gates Foundation's patented omni-processor technology. Ankur's product incorporates the core omni-processor technology into a comprehensive fecal sludge treatment plant (FSTP) and municipal solid waste (MSW) solution, localized to the Indian context. The unit can accept fecal sludge, biosolids, and other biomass into the main processing system, and municipal solid waste into the added gasifier, part of Ankur's existing products. Different input modes produce different outputs and remains environmentally safe-all discharge meet EU and local norms.

Key features:

- Current design input is 200 KLD (wet sludge), with ability to scale size smaller or larger as needed by city
- Greater than 97% reduction by volume
- Proprietary municipal solid waste (MSW) gasifier addition enables co-treatment in integrated sludge and MSW mode
- MBBR pre-treatment process maximizes industrial grade water extraction for reuse, and reduces footprint
- Automatic and efficient: Processing time of sludge from its arrival to disposal is 6-10 hours

Status of development

TRL

CONCEPT | EARLY PROTOTYPE | PRODUCT AVAILABLE

- Pilot site announced and launched in June 2018 in Vadodara with Vadodara Municipal Corporation (VMC), commission Q1 2019
- Commercial license expected November 2018

Use Cases

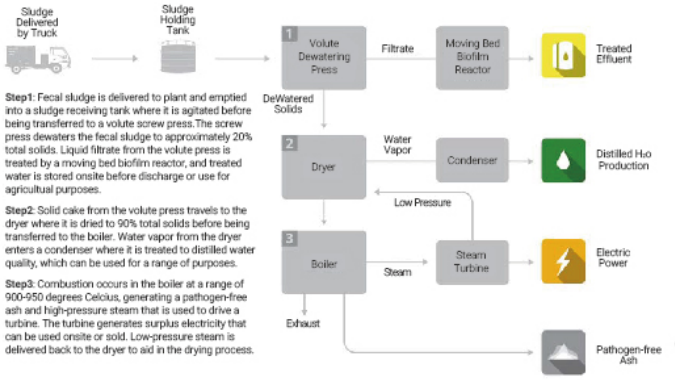
- **Standalone FSTP:** Design can be a standalone FSTP taking direct input from vacuum trucks, processing liquid waste in MBBR, and solids through the OP.
- **Colocation with STP:** Treat liquid effluent (beyond existing capacity of OP), and treat STP biosolids.
- **Integration of sludge treatment with MSW.**

Product is Appropriate For:

Fecal sludge | Biosolids | Other biomass | MSW

200KLD	300K-500K	20
Capacity (Wet Sludge)	Est. population served	Life Expectancy (Years)

How does it work?



Step1: Fecal sludge is delivered to plant and emptied into a sludge receiving tank where it is agitated before being transferred to a volute screw press.The screw press dewaters the fecal sludge to approximately 20% total solids. Liquid filtrate from the volute press is treated by a moving bed biofilm reactor, and treated water is stored onsite before discharge or use for agricultual purposes.

Step2: Solid cake from the volute press travels to the dryer where it is dried to 90% total solids before being transferred to the boiler. Water vapor from the dryer enters a condenser where it is treated to distilled water quality, which can be used for a range of purposes.

Step3: Combustion occurs in the boiler at a range of 900-950 degrees Celcius, generating a pathogen-free ash and high-pressure steam that is used to drive a turbine. The turbine generates surplus electricity that can be used onsite or sold. Low-pressure steam is delivered back to the dryer to aid in the drying process.

Inputs

Types of inputs
Fecal sludge, biosolids, municipal solid waste, other biomass if needed
Does the system require electricity? No
Does the system require water? No
Does the system require any other "consumable" inputs?
Auxiliary fuel for startup, lime and urea for emissions, and acids/bases for pH control

Outputs

How much energy will be recovered?
170 kWe (stand-alone sludge mode)
290 kWe (integrated sludge and MSW)
How much water will be recovered?
130 KLD discharge (industrial use), 14 KLD distilled
How much fertilizer or other by products will be produced? 2,000-4,000 Kg/day of non-hazardous ash (stand-alone sludge mode), or biochar (integrated sludge and MSW)

Treatment

Solids treatment Thermal process
Liquid treatment Biological
Pathogen treatment success
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated annual operating cost
~$100k (dependent on application)
Estimated Capex $2M-$3M (dependent on configuration)
Site requirement 1600 m^2-4000 m^2 depending on variation and adaptation
Life expectancy 20 years
Other features Remote monitoring and controls

For More Information

Ankur Scientific Energy Technologies Pvt. Ltd.
Mr. Ankur Jain (info@ankurscientific.com)
https://www.ankurscientific.com/
Near Navrachana School, Sama, Vadodara, **India**

ankur

Seeking: Municipalities and utilities seeking to process fecal sludge, biosolids, and MSW

- Based on US Patent 9,708,937. Commercial license from BMGF expected November 2018
- MSW Gasifier proprietary of Ankur

Available for partners | Licensee of Patent

JANICKI OMNI-PROCESSOR S250 | SEDRON TECHNOLOGIES

Janicki Omni-Processor

Sedron Technologies, formerly Janicki Bioenergy, is a pending commercial licensee of the Gates Foundation's patented omni-processor technology.
The Omni-Processor uses a Rankine cycle to process fecal sludge and other waste streams into water, ash, and energy. The unit is flexible and robust to a variety of feedstocks and contexts, dependent on the desired business case. The Janicki Omni-Processor S250 is designed to be used as a component in a full fecal sludge treatment plant (FSTP). The S250 will be offered with an additional dryer compared to the S200.

Key features:

- S250 model can process 54 kiloliter per day (kld) of dewatered sludge , supporting a FSTP receiving 200 KLD of wet sludge
- Scalable to smaller or larger capacities
- Sustainable solution to reduce carbon footprint and green-house gas emissions
- Net energy producer-no electricity or auxiliary fuel is required. Excess energy produced is available for sales as electricity and/or heat.

Status of development

TRL

CONCEPT | EARLY PROTOTYPE | PRODUCT AVAILABLE

- Pilot site launched in May 2015 in Dakar, Senegal with ONAS (National Sanitation Office of Senegal)
- First commercial unit (S200 model) slated for shipment to Dakar, Senegal in 2019
- Commercial license expected November 2018

Use Cases

- **Standalone FSTP:** If feedstock can be supplemented with biomass to 20% solids, can be fed directly into OP
- **Colocation with STP:** Current system in Senegal uses STP to treat effluent from drying beds and then processes dry solids

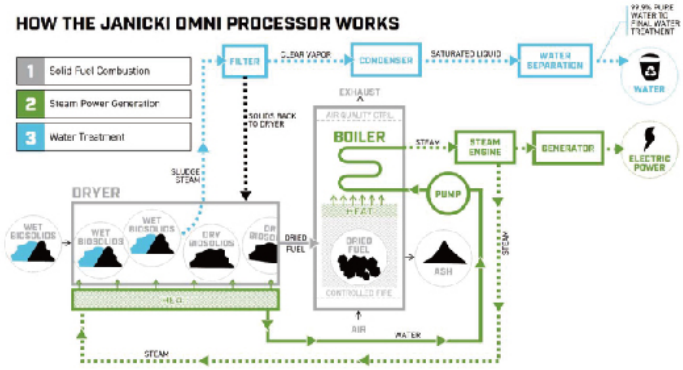
Product is Appropriate For:

Fecal sludge | Biosolids | Other biomass | MSW

54KLD	300K-500K	20
Capacity (dewatered sludge)	Est. population served	Life Expectancy (Years)

How does it work?

HOW THE JANICKI OMNI PROCESSOR WORKS



Inputs

Types of inputs
Fecal sludge. Can be configured to accept other biosolids and waste (e.g. plastic, sorted garbage), based on business case
Does the system require electricity? No
Does the system require water? No
Does the system require any other "consumable"inputs? Auxiliary fuel for startup, lime for emissions controls, and acids/bases for pH control

Outputs

How much energy will be recovered?
100-200 kW net electricity (feedstock dependent)
How much water will be recovered?
Up to 22 KLD clean water (when optimizing water production)
How much fertilizer or other by-products will be produced?
~2350kg ash/day (feedstock dependent)

Treatment

Pathogen treatment success
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? No (though may be dependent on feedstock)

Business considerations

Estimated annual operating cost
~$200k (dependent on application)
Estimated Capex $3M-$4M (dependent on configuration)
Site requirement 21m x 27m
Life expectancy 20 years
Other features Remote monitoring and controls

For More Information

Contact Us (info@sedron.com)
www.sedron.com/janicki-omni-processor/
Sedro-Woolley, WA **USA**

SEDRON TECHNOLOGIES
Formerly: JANICKI BIOENERGY

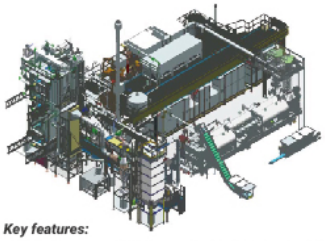
Seeking: Municipalities and utilities seeking to process fecal sludge and biosolids

- Based on US Patent 9,708,937. Commercial license from BMGF expected November 2018
- Planning certification to upcoming ISO standard being developed under ISO/PC 318

Available for Purchase | Licensee of Patent

CRRC OMNI-PROCESSOR CS50 | CRRC

Omni-Processor adapted for China



CRRC is a pending commercial licensee of the Gates Foundation's patented omni-processor technology. CRRC is adapting the technology to produce an omni-processor localized to the Chinese context, specifically focusing on the processing of biosolids and sorted organic waste. The CRRC Omni-Processor is designed to be used as a component in a full fecal sludge treatment plant (FSTP).

Key features:

- Designed to support FSTP processing 200 KLD (wet sludge)
- Omni-Processor can be scaled smaller or larger to meet requirements
- Will be tested with 20 to 40 tons per day of dewatered sludge at 40% total solids
- Sustainable solution to reduce carbon footprint and green-house gas emissions

Status of development

TRL

CONCEPT | EARLY PROTOTYPE | PRODUCT ANNOUNCED

- In design and tech transfer phase
- Pilot unit will be built and commissioned at Wu He county of Beng Bu City <An Hui Province> in December 2018
- Commercial License expected Nov 2018

Use Cases

- **Standalone FSTP:** Fecal sludge feedstock can be supplemented with biomass (e.g., organic waste) to reach 20% solids
- **Colocation with STP:** Pairing of OP with existing sewage treatment plant in China will enable treatment of biosolids for complete pathogen destruction.

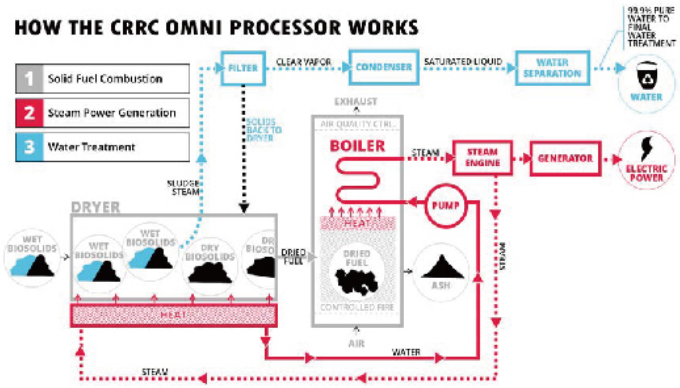
Product is Appropriate For:

Fecal sludge | Biosolids | Other biomass | MSW

27KLD	300K-500K	20
Capacity (dewatered sludge)	Est. population served	Life Expectancy (Years)

How does it work?

HOW THE CRRC OMNI PROCESSOR WORKS



Inputs

Types of inputs
Fecal sludge, biosolids, other biomass if needed
Does the system require electricity? No
Does the system require water? No
Does the system require any other "consumable"inputs? Auxiliary fuel for startup, lime for emissions controls, and acids/bases for pH control

Outputs

How much energy will be recovered?
300 kW electricity (gross, estimated)
How much water will be recovered?
6 KLD distilled water
How much fertilizer or other by products will be produced?
1000-2000kg ash/day

Treatment

Pathogen treatment success
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? No.

Business considerations

Estimated annual operating cost
(not available)
Estimated Capex (not available)
Site requirement 27m x 20m
Life expectancy 20 years
Other features
Remote monitoring and controls

For More Information

CRRC
Mr. Chen Zhaohui
(zhaohuichen1971@sohu.com)
Beijing, **China**

中国中车 CRRC

Seeking: Municipalities and utilities seeking to process fecal sludge and biosolids

- Based on US Patent 9,708,937. Commercial license from BMGF expected November 2018

Licensee of Patent

TIDE FECAL SLUDGE PROCESSOR | TIDE TECHNOCRATS

Pyrolysis-based fecal sludge treatment plant (FSTP)

Key features:

- 30,000 (15 KLD)-60,000 (30 KLD) people served
- Biosafe process that kills all pathogens with no harmful emissions
- Quick setup time, modular and scalable
- Works in dry, wet, hot, and cold weather conditions

Tide Technocrats is a premier environmental and sustainability focused organization, based in Bengaluru, India. Tide Technocrats design for a fecal sludge treatment plant (FSTP) requires only a small footprint to collect and remove liquids from fecal sludge, before using a novel drying and pyrolysis technology to subject solids to extremely high temperatures. The omni-processor component uses pyrolysis technology from partner Biomass Controls. The FSTP produces pathogen-free "biochar," a carbon-rich compound that can be safely used in horticulture to improve soil, and treated liquid effluent that can be used for gardening and landscaping. The technology is currently being piloted in three different urban locations in India to better understand how the process can be improved end-to-end, and established successfully in any urban environment.

Status of development

TRL

CONCEPT › EARLY PROTOTYPE › PRODUCT AVAILABLE

- Initial test site in Bengaluru, India, followed by three city-wide pilots in Wai, Warangal, and Narsapur in 2018.

Use Cases

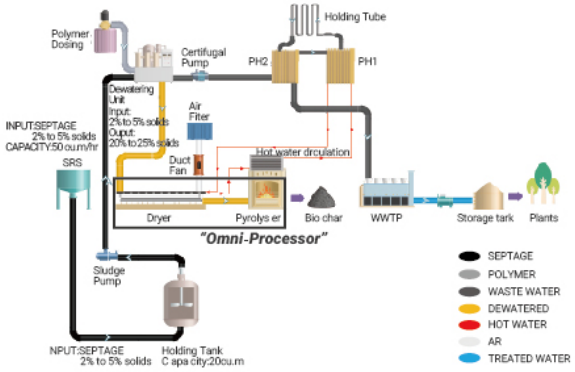
- **Standalone FSTP:** Design of plant can be easily established within municipalities, enabling vacuum trucks to empty faecal sludge and septage

Product is Appropriate For:

Fecal sludge · Biosolids · Other biomass

15-30KLD	30K-60K	20
Capacity (wet sludge)	Est. population served	Life Expectancy (Years)

How does it work?



Inputs

Types of inputs
Fecal sludge, biosolids, other biomass
Does the system require electricity?
Yes. Estimated 8.6 kWh at steady state
Does the system require water? No
Does the system require any other "consumable"inputs? Yes. Flocculent for dewatering process

Outputs (for 15 KLD FSTP)

How much energy will be recovered?
208 kW (thermal) at 6% solids in wet sludge
How much water will be recovered?
13 KLD water
How much fertilizer or other by products will be produced?
Approx. 50kg biochar/day

Treatment

Solids Pyrolysis
Liquid Pasteurization followed by biological treatment, secondary and tertiary
Pathogen treatment success
Confirmed total pathogen removal
Are chemical processes used? Yes
Are mechanical processes used? Yes
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations (for 15 KLD FSTP)

Estimated annual operating cost
$40k-$50k
Estimated Capex
$300k-$350k
Site requirement
1000-2000 sq. m
Life expectancy
20 years
Other features
Remote monitoring

For More Information

TIDE Technocrats Private Limited
N. Sampath Kumar (sampath@tidetechnocrats.com)
www.tidetechnocrats.com/
Bangalore **India**

Seeking: Municipalities seeking to establish FSTPs, and operating partners globally

Available for Purchase

TUV SUD

Sector partner

ISO/PC 305 Secretariat (left to right): Vincent Paul Santos (TÜV SÜD), Gerald Kresta (TÜV SÜD), Mei Yee Chan, Doulaye Kone(Bill and Melinda Gates Foundation), Rachel Hawthorne (ANSI), Abdourahmane Ndione (ASN), and Kristen Califra (ANSI)

Headquartered in Munich, Germany and founded in 1866, TÜV SÜD is a leading technical service provider of testing and product certification, inspection, auditing, and system certification as well as training solutions. With over 24,000 employees in 1,000 locations, the TÜV SÜD community of experts is passionate about technology and is inspired by the possibilities of your business. United by the belief that technology should better people's lives, we work alongside our customers to anticipate and capitalise on technological developments, through defining standards and going beyond regulatory compliance and enabling progress for businesses and the society.

TÜV SÜD developed the private technical standard used as the basis for ISO 30500 and in partnership with ANSI, ASN, and other NSBs, established the Project Committee (PC) 305 for the development of the ISO 30500 "Non-sewered sanitations-Prefabricated integrated treatment units-General safety and performance requirements for design and testing. "Within the PC, TÜV SÜD provided project leadership to ensure successful development of the standard and integrate input from the 31 participating member countries and 16 observing member countries on the committee.

This standard sets the minimum performance requirements for existing and prospective RT regardless of the types of technologies used. It presents a measurable means to ensure that your technology is safe for human health and the environment. With the publication of ISO 30500, the industry will have a common benchmark to which the performance and safety considerations of various technologies can be set.

The final ISO PC 305 meeting in Kathmandu, Nepal, attended by 33 countries with 88% of the PC members want to allow ISO 30500 to be an ambitious standard and want it to help accompany product (toilet) manufacturers making this big leap into the future of sanitation.

For More Information

Mei Yee Chan (mei-yee.chan@tuv-sud.sg)
www.tuv-sud.com

ANSI

Sector partner

The American National Standards Institute (ANSI) is the U.S. member body of the International Organization for Standardization (ISO). The U.S. holds leadership of PC 305, the project committee leading the development of ISO 30500, with ANSI serving as secretariat alongside its twinning partner ASN, Senegal's member body of ISO.

ISO 30500, Non-sewered sanitation systems-Prefabricated integrated treatment units-General safety and performance requirements for design and testing, seeks to provide requirements and guidance for the product design and performance testing of non-sewered sanitation systems-any integrated sanitation system that is not attached to a sewer.

> "The era of innovation in the toilet industry has come. On May 24th,120 experts from 33 countries met on top of the World, in Nepal and approved a new standard ISO 30500 that set requirements for toilets that kill pathogens, and do not produce any waste. #ReinventedToilet"

Dr. Doulaye Kone

Deputy Director,
BMGF and Chairman, ISO 305

The standard, expected to be published in October 2018, was developed by experts from 33 countries worldwide who represent stakeholders from industry, government, academia and non-governmental organizations. This robust stakeholder involvement, in addition to the trusted consensus process of ISO, help assure that the standard does its job.

For companies, the ISO 30500 standard is a tool to help reduce costs by minimizing waste and increasing productivity. ISO standards also help companies access new markets, level the playing field in the global market, and facilitate free and fair cross-border trade.

The ISO 30500 standard is also a tool for governments, helping assure regulators that products entering their market are safe and reliable for consumers.

For More Information

American National Standards Institute (ANSI)
Ms. Leslie McDermott (lmcdermott@ansi.org)
www.ansi.org

ENVIVAC | ENVIROSYSTEMS

Low-flush vacuum toilet

Established in 2003, EnviroSystems Engineering and Technology Co., Ltd. is focusing on new type of vacuum drainage technology, sewage, and waste resources recycling technology, as well as ecological town construction technology. The exhibited EnviVac air flush toilet aims to develop a better alternative to a dry composting toilet which has no water consumption, while maximizing the available waste for resource recovery.

Key features:

- Extremely low energy demand (at a level of 1 Wh per use), served by a "mini" vacuum generator with low voltage (24V), driven by a small solar panel (or battery).
- Differentiated from other manufacturers by a patented diaphragm valve without mechanical spring(s), less than 0.1L of water required
- Robust design with no maintenance needed

Status of development

TRL

CONCEPT › PROTOTYPE › PRODUCT AVAILABLE

- Product developed in China in 2015 as part of the Reinvent the Toilet Challenge China
- Multiple tourism, city-level sites, and households at village scale implementing technology in China

Use Cases

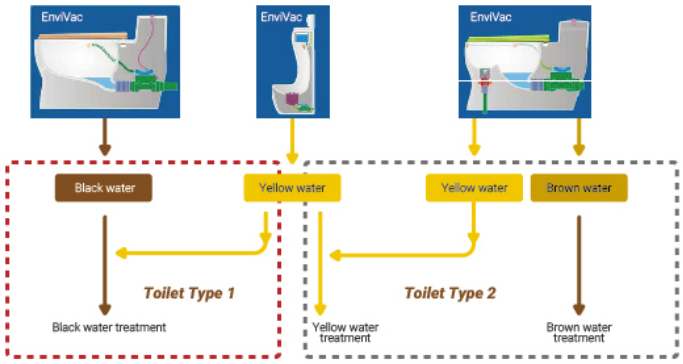
- **Single stall:** Air-flush toilet interface can be used in a single stall as a urinal, squat,standard, or urine-diverting toilet.
- EnviroSystems also offers treatment solutions for backend processing.

Product is Appropriate For:

Squat · Pedestal · Wipe · Wash

200	TBD	10
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?



Inputs

Does the system require an external source ofelectricity?
Yes, 1 Wh per use, can be powered by solar

Does the system require the use of water?
Yes, 0.1L of cleaning water per flush in average

Does the system require any other "consumable" inputs?
No

Outputs

How much energy will be recovered?
None.

How much water will be recovered?
None.

How much fertilizer or other by products will be produced?
None.

Treatment

Treatment No treatment in interface
Pathogen treatment success? Not applicable
Are chemical processes used? No
Are mechanical processes used? Yes
Are biological processes being used? No
Does the system require any off-site or additional processing? Yes, waste must be treated following containment via interface.

Business considerations

Estimated daily operating cost
(not available)
Estimated Capex
(not available)
Size L 1.25**m x W** 0.75**m x H** 1.0**m**
Maintenance requirements
Minimal/no maintenance
Life expectancy 10 years

For More Information

EnviroSystems Engineering & Technology Co., Ltd,
Dr.-Ing. Jian Zhang (j.zhang@envi8.com)
www.envi8.com
China

EnviVac

Seeking: Municipalities and other partners to purchase and deploy interface, and combine with treatment solutions

- EnviroSystems is the owner of 60 patents
- Interface technology has multiple applications, and can be combined with multiple treatment approaches

Available for Purchase

Patent

EOOS SOURCE-SEPARATION INTERFACE | EOOS

Source-separation toilet interface

EOOS offers a novel source-separation interface that can be adapted to multiple squatting and pedestal applications and materials (e.g., ceramics and plastics.) The interface passively separates urine and, when combined with available third party components, also efficiently separates solid feces and flush/wash water.

Status of development

TRL

CONCEPT | EARLY PROTOTYPE | PRODUCT ANNOUNCED

- Initial design developed and lab tested in Austria
- Ceramic pedestal design testing in Durban, South Africa in 2018.
- Adaptations with commercial partner to be tested in key markets prior to launch

Key features:

- "Urine Trap" Technology
- Separation of urine and blackwater waste streams at the source, allow for urine harvesting, and greatly simplify sub-sequent treatment processes, particularly nitrogen
- Adaptable to multiple configurations
- Compatible with wide range of "reinvented toilet" treatment solutions for both liquids

Product is Appropriate For:

Squat | Pedestal | Wipe | Wash

Seeking: Initial Commercialization partner identified. Global availability targeted for 2019

- Patent protection on the interface is being pursued by EOOS

For More Information

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www.eoos.com
Zelinkagasse 2/6, 1010 Vienna, **Austria**

EOOS

Patent pending

MALODOR COUNTERACTING TECHNOLOGY | FIRMENICH

Novel malodor control technology

The Firmenich Malodor Project , highlights how Firmenich brought a multidisciplinary team of scientists together from Sensory and Cognitive Science to Receptor Biology in order to advance its expertise in malodor control. Throughout the project its experts conducted extensive fieldwork in cities and rural regions across India, Kenya, South Africa and Uganda, to confirm the performance of their findings. These years of research resulted in the discovery of breakthrough malodor counteracting technologies that eliminate the foul odor associated with toilets in a cost-effective and sustainable way.

Key features:

- Evidence shows that even when toilets exist, they are often not used due to their unpleasant smell
- Over 200 compounds make up toilet odor, but four in particular drive what we perceive as "fecal odor"
- Novel technology has been developed

Status of development

TRL

CONCEPT | EARLY PROTOTYPE | PRODUCT LAUNCHED

- Research published in the Flavour and Fragrance Journal in 2018 summarized rigorous testing in 2016-2017
- Ongoing user insights and product testing anticipated in 2019 in partnership with clients to bring products to market

Use Cases

- **Firmenich is working with their clients and partners on a range of market products such as bleach powders and other cleaning products incorporating the malodor counteracting technology.**

Patent | Available for Purchase

Seeking: Partners for incorporation into localized products such as cleaning powders

- Malodor technology is available to incorporate into consumer products in partnership with Firmenich

For More Information

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http://www.firmenich.com/en_INT/company/news/Malodor-Project-Video-Launch.html
Geneva, **Switzerland**

Firmenich

URINETRICITY MFC | UNIV OF WEST ENGLAND-BRISTOL (UWE-BRISTOL)

Biological microbial fuel cell (MFC)

The Microbial Fuel Cell (MFC) generates electricity by processing organic waste such as urine and wastewater. It is small enough to be built into a urinal, and multiple MFCs can be linked together in a "stack" to process greater volumes and increase power output.

Compared to traditional MFCs, this technology uses ceramic housing (terracotta) as its membrane, which results in producing disinfectant solutions (ECAS), fertilizer, and is being explored as a platform technology for denitrification and nutrient recovery from urine.

Key features:

- System design can be a retrofit or a small, cubicle cell.
- System produces electricity via microbial breakdown of organic compounds in urine.
- Novel, cheap membranes improve cost effectiveness. Membrane-less is also possible
- Generates a byproduct which can be used as a disinfectant

Status of development

TRL

CONCEPT | **PROTOTYPE IN TESTING** | PRODUCT ANNOUNCED

- Significant laboratory (UK) and field testing (UK, Uganda and Kenya) over the last seven years.
- Pilot systems deployed in both small volume (university campus) and large volume (Glastonbury music festival with 1000 people/-day powering the area lights and information boards)

Use Cases

- **System is scalable; multiple MFCs can be stacked to accommodate large volumes**
- **Single urinal**
- **Multi-unit:** Stacks can process urine from multiple stalls fitted with diversion toilets

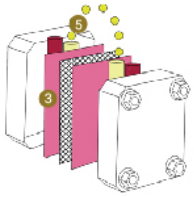
Product is Appropriate For:

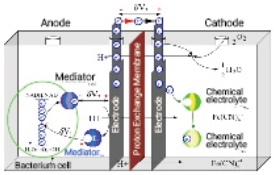
Squat | Pedestal | Wipe | Wash

Assuming urine diversion in place

FLEX	TBD	>10
Capacity (users/day)	Est. Cost ($/users/day)	Life Expectancy (Years)

How does it work?





Frontend

The MFC is a backend processing component that can be integrated with a urinal or solids liquid interface.

Liquid Processing

Organic compounds and pathogens in urine are consumed by a microbial community in the MFC, performing redox reactions. This enables movement of cations through a cation exchange membrane, and results in electrons moving between the electrodes generating current.

Urine/Feces Separation

No separation components, separation must occur upstream of the MFC.

Solids Processing

Can process a small concentration of solids at a low Total Suspended Solids concentration. Has been demonstrated to suppress/kill or even consume pathogens.

Power System

MFCs generate net power from waste.

Inputs

Does the system require an external source of electricity?
No

Does the system require the use of water?
No

Does the system require any other "consumable" inputs?
No

Outputs

How much energy will be recovered?
~>30 mW/L urine

How much water will be recovered?
100% discharge of all processed liquids. Exploring disinfectant production

How much fertilizer or other by products will be produced?
Exploring the potential of processed liquids to be used as fertilizer

Treatment

Treats Organic waste (liquids/urine)
Pathogen treatment success?
Confirmed total pathogen removal
Are chemical processes used? No
Are mechanical processes used? No
Are biological processes being used? Yes
Does the system require any off-site or additional processing? No.

Business considerations

Estimated daily operating cost (not available)
Estimated Capex (not available)
Size varies by number of MFCs in stack
Maintenance requirements
Minimal and only if blockage occurs
Life expectancy >10 years (based on lab tests)
Other features Mass production possible with added benefits

For More Information

Ioannis Ieropoulos (ioannis.ieropoulos@brl.ac.uk)
http://www.brl.ac.uk/researchthemes/bioenergyself-sustaining.aspx Bristol, **United Kingdom**

Seeking: Commercial partners to license technology and bring to market

- Patented in EU (EP2684242B1), Great Britain (GB2011040460D0), China (CN103518282B) Patents pending in the United States (US 2014/0057136 A1) and WO2016120641A1
- Currently scoping commercialization approach

Patent-pending

URINE PROCESSING AND AURIN FERTILIZER | VUNA LTD

Scalable urine processing and resource recovery system

Vuna means "harvest" in isiZulu, the language of the Zulu people. VUNA originated as a research project which endeavoured to find a suitable use for the urine collected in dry toilets in the city of Durban, South Africa. VUNA further developed between Eawag, eThekwini Municipality (greater Durban) and additional partner organisations. The technology to recover nutrients-or rather "harvest" them-has been well established. In 2016, the company Vuna Ltd was founded based on the outcomes of this research project and sells the Aurin fertliser from urine.

For More Information

Bastian Etter (info@vuna.ch)
www.vuna.ch
Dubendorf, Switzerland **Europe**

Seeking: Commercialization partners and purchasers

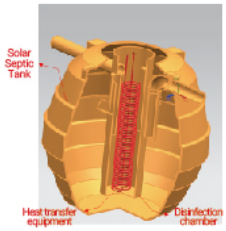
- System in building operations in Switzerland and exploring applications in household and buildings

SOLAR SEPTIC TANK | ASIAN INSTITUTE OF TECHNOLOGY (AIT)

Biological Reinvented Toilet

Solar Septic Tank is a highly efficient, self-contained, and simple technique. This technology uses free energy from the sun to increase temperature inside the system for the treatment of human feces and urine. Solar septic tank could promote natural bio-augmentation to improve the degradation rates in the system and could effectively inactivate harmful pathogens.

- Treatment efficiencies of organic/solids removal and E. coli inactivation are found to be 70-90% and 4-5 log reduction, respectively.
- Coupled with novel constructed wetlands, it could achieve effluent COD and TKN concentrations below 50 and 15 mg/L, respectively.



For More Information

Thammarat Koottatep
(thamarat@ait.asia) Associate Professor
www.serd.ait.ac.th/serd/ **Thailand**

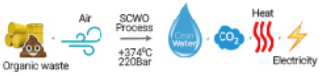
Seeking: Commercialization partners to license and bring technology to market

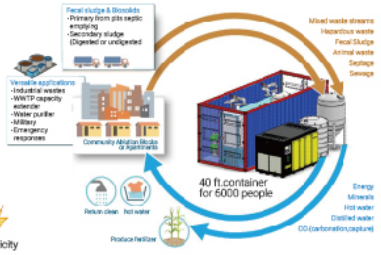
- Thailand Intellectual Property and being applied for PCT: 59587 (granted on 22 December 2017)
- 5 patent applications: 1801003789; 1401003996; 1502004290; 1702000710;1502004291

SUPERCRITICAL WATER OXIDATION | DUKE UNIVERSITY

Wet oxidation system

- Compact, versatile and scalable units for 6k, 30k, and 200k people
- High treatment effectiveness: >99.95% conversion to clean water and CO2
- Kills all pathogens
- Can treat high COD/BOD feedstock and hazardous industrial wastes (e.g. oil, chemical, pharma, etc)
- Zero polluting emissions (no SOx, NOx), no odor, no disinfection by-products





For More Information

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(marc.deshusses@duke.edu)
http://sanitation.pratt.duke.edu
Durham, NC **USA**

Seeking: Engineering and commercial partners for product development, manufacturing, and launch

- Patent pending
- Technology is available for licensing and joint ventures

FIRELIGHT TOILET | SEDRON TECHNOLOGIES

Dry combustion Reinvented Toilet

Self-contained, household scale toilet system. Frontend (pedestal toilet, adaptable to squat plate) is situated above the feces collection area. In the backend, urine, feces, and toilet paper are dried. Shredded trash can also be added to the dried material and it is all combusted in a small~600W fire.The heat from the fire used to generate electricity.

- Continuous, self-powered, and automated operation
- Tolerant of common sanitation waste such as newspaper and feminine hygiene products
- Product is phosphorus rich ash, and sterile water for flushing

For More Information

info@sedron.com
www.sedron.com
Sedro Woolley, WA **USA**

Seeking: Product purchasers and distributors globally to implement once available

- Sedron Technologies to self-commercialize, offer globally
- A TRL 6 prototype is planned for testing in Durban, South Africa in mid-2019

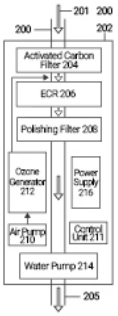
ULTRON SYSTEM | CALTECH

Liquid processing displayed with EcoSan

Caltech

CalTech has built on their existing electrochemical reactor (ECR) technology to develop the ULTRON system for urinal retrofits or liquid disinfection. Both the urinal retrofitting kit and the portable disinfection system contains a number of ECRs connected in parallel in order to reach the desired flow rate and application.

- The influent (urine and/or a combined urine and feces stream) passes through an activated carbon filter then through the CalTech electrochemical reactor (ECR). A final polishing step enables the ULTRON ECR to consistently delivers effluent with COD < 100 mg/L, and a turbidity of <4.
- Ability to process 10L/hour (portable liquid disinfection) up to 30L/hour (urinal retrofit)



For More Information

Mike Hoffman
(mrh@caltech.edu)
http://hoffmann.caltech.edu/
Pasadena, California **USA**

Seeking: Commercialization partners to license as a component, or to bring technology to market

- US Patent Application 20180222781
- Potential to be integrated into existing CalTech partner companies

THE RECLAIMER | DUKE CENTER FOR WASH-AID AND MSR

Liquid treatment component displayed with Duke

The Reclaimer is a stand-alone liquid processing unit designed to rapidly treat and disinfect blackwater to ISO30500 standards for Category B usage. It combines three treatment modalities into a compact, automated system. Influents can include liquid waste from household or community toilets, effluent from dewatered sludge, or septic tank effluent.

- Ultrafiltration for removal of suspended solids
- Activated carbon for removal of soluble organic material
- Electrochemical treatment for additive-free disinfection
- "Buffered batch" processing allows system to accept influent while treating; automated process control
- Runs on external power, no additional water required for operation

MSR

For More Information

Duke University Center for WaSH-AID
Dr. Brian Hawkins
(brian.hawkins@duke.edu)
http://washaid.pratt.duke.edu/
Durham, NC **USA**

Seeking: Product purchasers and distributors globally to implement once available

- Field testing in India, January 2019

S.H.E | DUKE CENTER FOR WASH-AID AND BIOMASS CONTROLS

Thermal module for menstrual hygiene management displayed with Duke

S.H.E. (Safe Hygiene for Everyone) is a fully automated sanitary pad sterile disposal device. Engineered to provide dignity and privacy, waste reduction, safe hygiene, and reduction of clogged toilets, the novel system allows for multiple configurations for use with various fuel sources. Design allows for wall or pedestal mounting and easy access for users. Capacity and cycle time ideal for shared and public settings such as schools, businesses, and factories.

- Batch processes up to 25 pads at a time, cycle time under 15 minutes
- System thermally treats pads with low emissions; yest results show up to 98% reduction in particulate matter (PM2.5)
- Remote monitoring and service notifications and safety features such as insulated surface, user standby during operation, automated shutdown

For More Information

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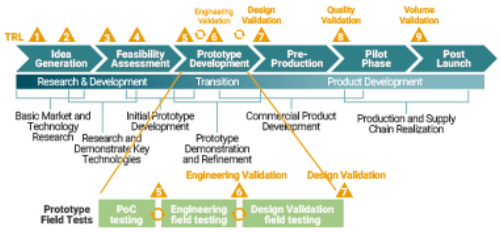
http://washaid.pratt.duke.edu/
Durham, NC **USA**

Seeking: Commercial partners for product manufacturing and distribution

BIOMASS CONTROLS

MANAGING PRODUCT DEVELOPMENT

The Bill & Melinda Gates Foundation WSH team adopts a well-defined, disciplined approach to advancing technologies from the idea stage through to commercialization. Our New Product Development (NPD) framework marries the Technology Readiness Level (TRL) scale-widely used in engineering to track the maturity level of innovative technologies-with processes and definitions used in industrial product development. The NPD and TRL have been shared with all of our partners to ensure technologies have achieved clear milestones and have an increasingly refined global access strategy before we invest in the next phase of development.



- We aim for partner to transition technology testing and product development to a commercial partner during prototype development (by Engineering Validation "EV" phase)
- Prototypes should demonstrate increasing influence of user and market requirements
- Specific requirements for annual updates to the partner's Global Access strategy are detailed as the technology progresses

TRL Stage	TRL	TRL Definition
Research & Development	1	Basic principles observed and reported
	2	Technology concept and/or application formulated
	3	Analytical and experimental critical function and/or characteristic proof-of-concept
Technology Demonstration	4	Component validation in laboratory environment
	5	System/subsystem model or prototype demonstration in a laboratory environment
	6	EV System/subsystem model or prototype demonstration in a relevant environment • EV: Engineering Validation
	7	DV System prototype demonstration in an operational environment • DV: Design Validation
Production & Deployment	8	Actual system completed and qualified through test and demonstration
	9	Actual system proven through successful product launch