Potential Impacts of the Reinvented Toilet

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Water, Sanitation & Hygiene Strategy
Access to sustainable sanitation is achieved by products and services delivered along the entire value chain at scale. Technologies and services meet users’ preferences and national requirements.
Reinvent the Toilet Program
Reinvent the Toilet: a waterless, hygienic toilet

Overall Specifications:

- Affordable: less than $0.05/person/day (capital + O&M) now, moving towards $0.01/person/day (end goal).
- Safe: remove all pathogens from the environment.
- Recovers resources from human waste (energy, fertilizer, water, …)
- Not connected to existing utilities (water, Electricity, Sewer)
- Appealing: sustained use > 5 years.
- User-centered: users create demand.
- Sustainable: service providers (public or private) can recoup complete lifecycle costs (make a business work).
Reinvent the toilet for whom?
At what cost?
Reinventing the Toilet –
Innovations can save billions of lives
by turning human waste into...

Pure Water
Safe Fertilizer
Electricity
Heat
Fuel
Salt

NaCl
Approach to reinvent the toilet
Caltech: PV + Electrochemical process
What’s included...

- Water treatment/recycling system
  - Holding tank
  - Separation tank
  - Electrochemical reactors
  - Filter
  - Flush water storage tank

- Electrical system
  - Laminate solar panels, charge controller (24V)
  - Batteries (24V)
  - Grid power (110V/240V)
  - Electrochemical reactor power supplies (24V)

- Control system
  - Pump control system
  - Sensors
  - Data acquisition system
Real-time monitoring
Reinvent the toilet: Loughborough University
Exhibition design

- Exhibition stand designed and built for the Delhi fair
## Description of the process

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<td>1</td>
<td>The system takes 6L of feedstock including faecal sludge (liquid with solids) from an input tank</td>
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<td>2</td>
<td>It warms up until it reaches prescribe temperature, then cooks the sewage at 150-180°C, 10-20 Bar in a pressure vessel, for a set time</td>
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<td>After approximately 6 hours (warming up time and cooking time) the sewage starts to carbonise and coffee grain size particles of carbon form, suspended in the fluid</td>
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<td>After the initial period the system dispenses small volumes (75 ml +/- 2.5%) of the media from the pressure vessel into an expansion chamber where the processed material condenses before it is drained.</td>
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<td>After dispensing the pump refills the pressure vessel with fresh feed to maintain a constant working volume</td>
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<td>6</td>
<td>The system will continue to operate in this manner until it has processed the contents of the input tank</td>
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Advantages of Loughborough System

- Simple approach: single stage process does not require pre-separation of liquid and solids
- Moderate process conditions (~150-180°C, 10-20 bar, time varies): ensure safe and reliable operation and mitigate potential for corrosion
- Potential for use of low cost, off-the-shelf components
- Low overall energy requirements
- Ease of char recovery
- Complete pathogen elimination
- Effective odor elimination
- Easy to scale
1. Feces Drying

2. Liquid Disinfection

3. Energy Conversion

4. Load Management
Eawag / EOOS – Gravity driven ultrafiltration for clean water production
Moving sanitation products and services to scale

Omni-Ingestor program

- Completely remove pit contents (sludge & trash)
- Separate trash and sand from sludge and treat water for local reuse
- Be robust such that the OI doesn't break down
- Inexpensive to operate; Inexpensive to purchase; superior business model compared to Vacuum trucks and manual emptiers
Emptying Pits

- Faster, safer emptying = more money to the Pit Emptiers
- Localized scheduled emptying = reduction of cost
- Pumping out to a ‘transfer station’ = greater access

Moving sanitation products and services to scale

Omni-Ingestor
Omni-ingestor prototypes

**MOBILE CONTAINER UNIT**

- Design prevents spillage when hose is not connected to container
- Integrates with custom or off-the-shelf containers
Moving sanitation products and services to scale

Omni-Processor Program

- Remove 100% pathogens from fecal sludge
- Community power/resource plant? - Recover energy (fuel, electricity, biochar, biogas, biodiesel), nutrient/fertilizer and clean water...
- Profitable business for investors and operators
- Reduced service fees for poor families living on latrines
Fecal Sludge Omni-Processor

Tuning FS to fertilizer or electricity depending on market

Current Processor Design Specifications

- Sludge Processed (at 75% water)
- 9 m³ per day
- Electricity Produced
- 150 kW continuous

Possible Auxiliary Outputs:
- Ash: 50 kg/hour
- Hot grey water (100°C): 1000 kg/hour
- Grey sat steam: 1000 kg/hour
- Dry sterile sludge: 250 kg/hour
Technical Specifications

Shipping Weight: 38 tons