

Sustainability As A Key Component To Addressing The Sanitation Crisis In The Developing World

Carl Hensman, Ph.D.
Program Officer
Water, Sanitation & Hygiene (WSH)

BILL & MELINDA
GATES *foundation*

The Sanitation Crisis

- ~2.5 billion people around the world do not have access to “improved” sanitation.
- ~1 billion people still defecate in the open
- Diarrheal disease is the second largest killer of children, > 1.5 million die every year.



The opportunity to prevent disease and death and to enhance the quality of people's lives through improved sanitation in the developing world is greater than ever.

Women and young girls

- **Freedom from imprisonment by daylight**

In many cultures, the only time available for women or girls to defecate is after dark.

- **School enrolment and attendance**

The lack of safe, separate and private sanitation and washing facilities during menstruation.

- **Reduce the burden of caring for the sick**

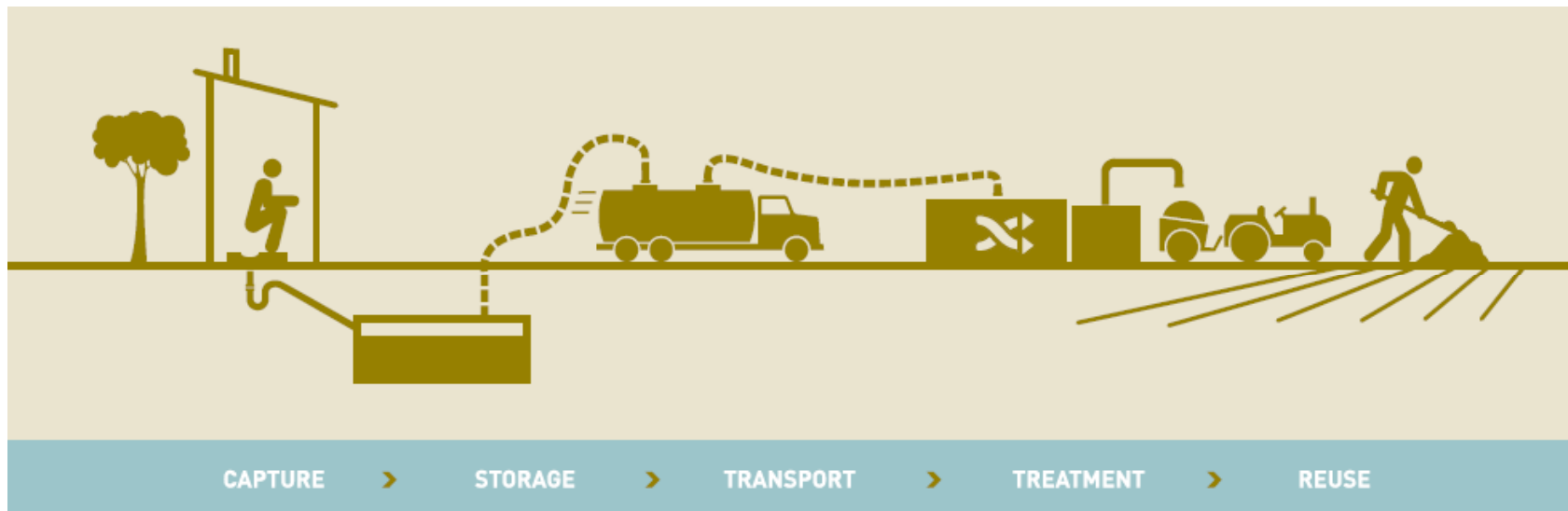
Caring for sick children adds to the already heavy workload.

- **Protect pregnant women from diseases**

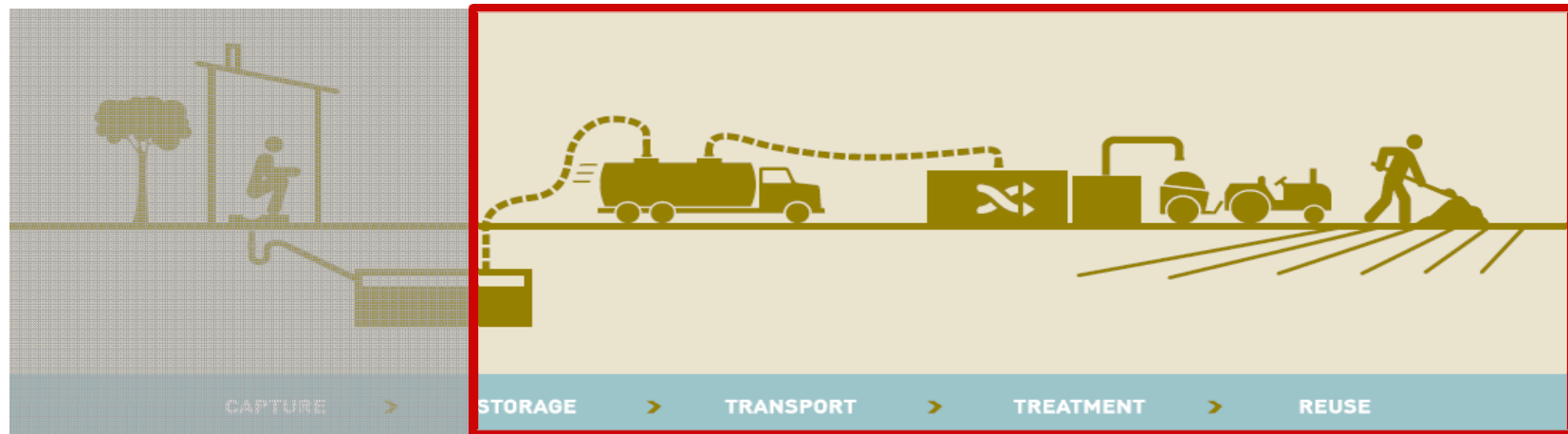
About 44 million pregnant women have sanitation-related hookworm infections that pose a considerable health burden in developing societies.



The Sanitation Value Chain

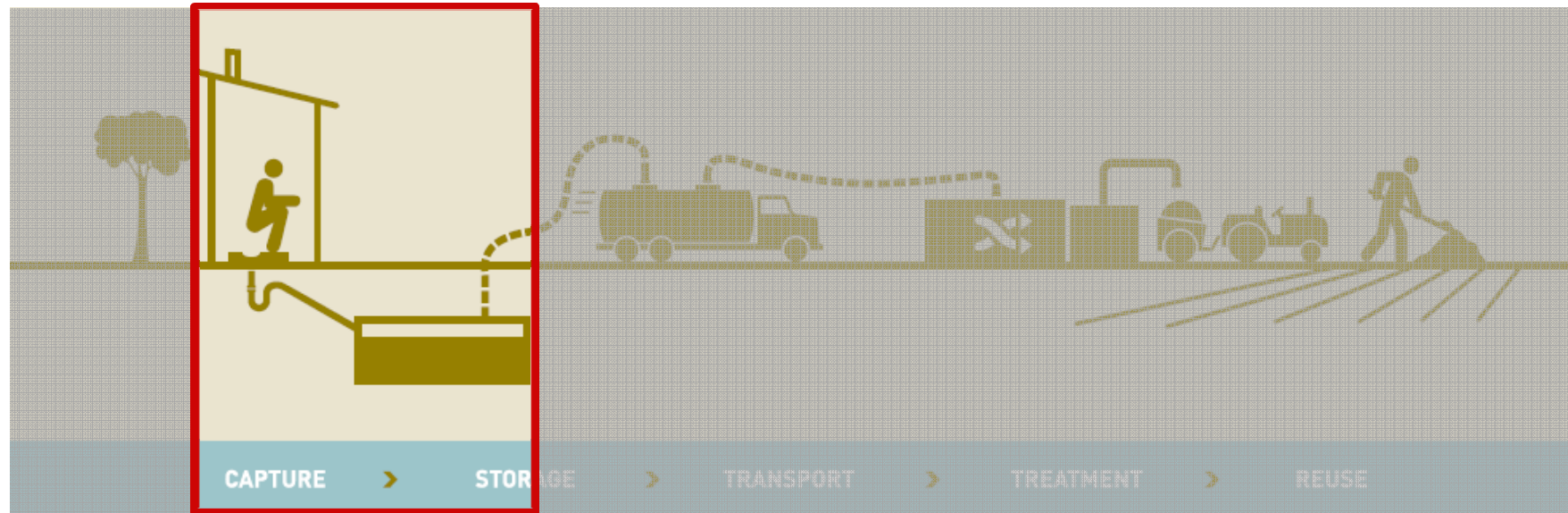


Moving sanitation products and services to scale



- Completely remove pit contents (sludge & trash)
- Separate trash and sand from sludge and treat water for local reuse
- 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

Reinvent the Toilet Program



- Affordable: less than \$0.05/person/day
- Safe: remove all pathogens from the environment.
- 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).

Sustainability

- **The developed world currently makes a cultural choice to be sustainable**
- **The developing world lives within the boundaries of having to be sustainable**

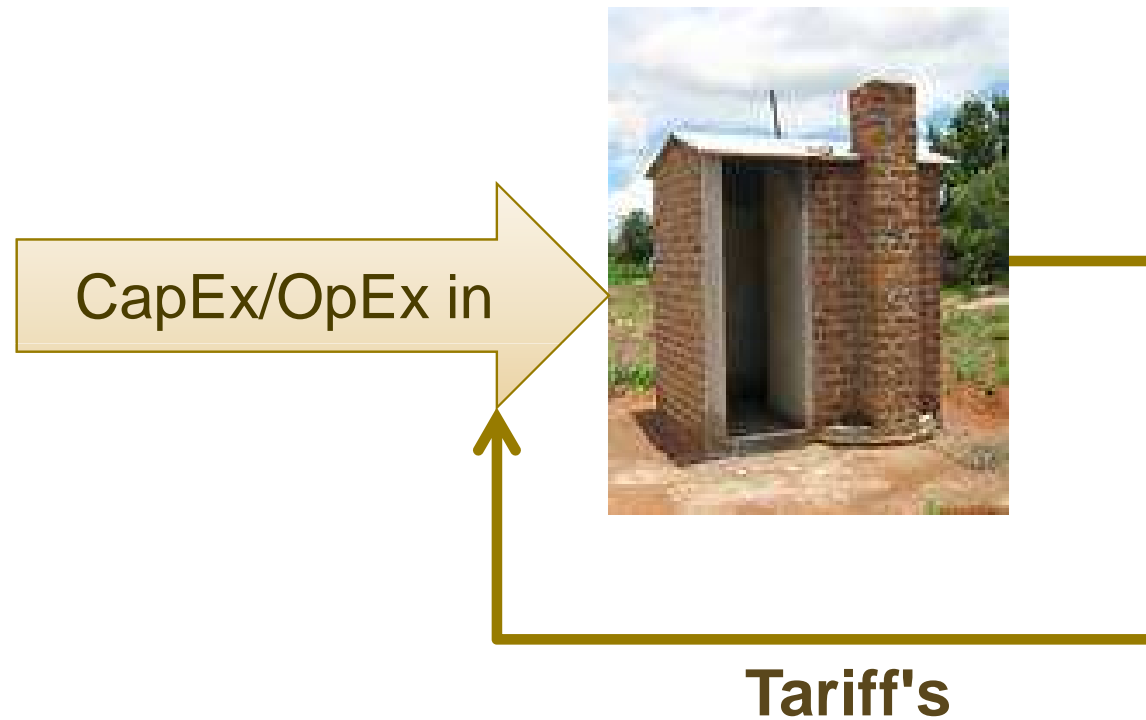


Sustainability

CapEx in



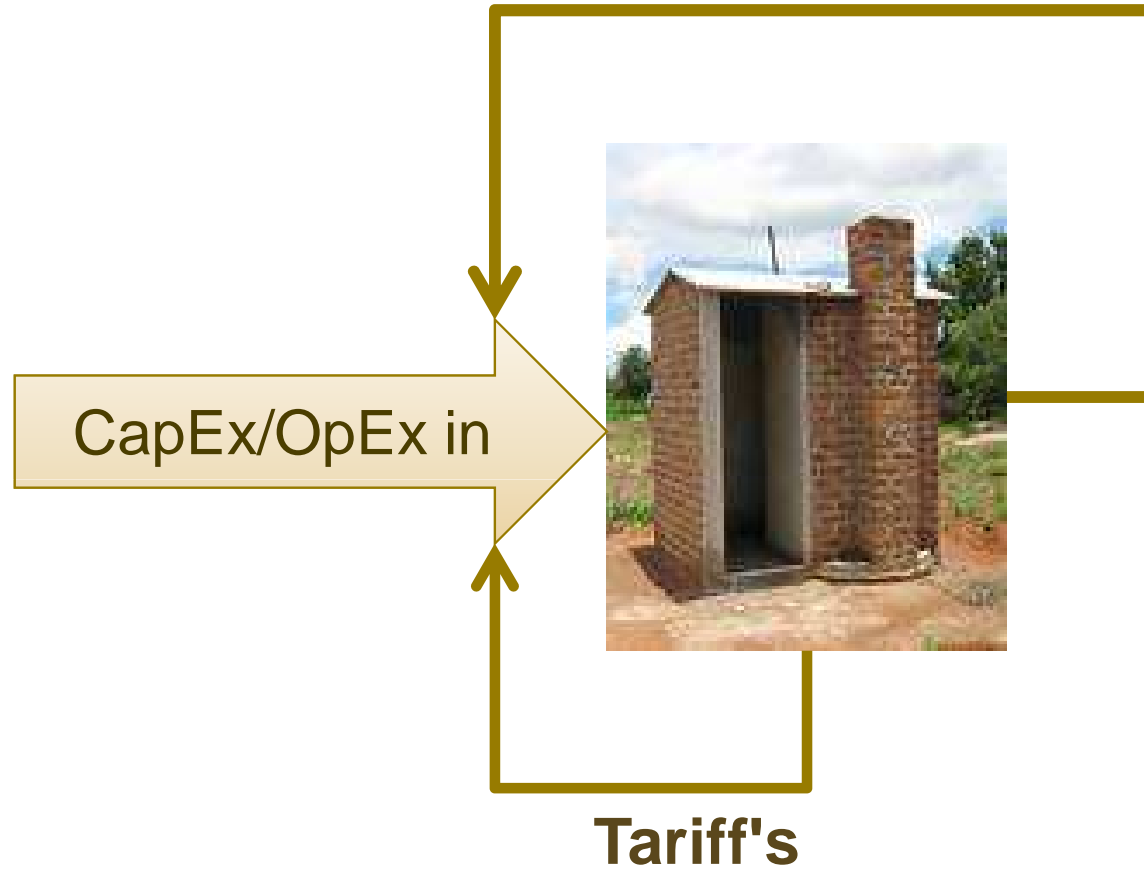
Sustainability



$$\text{CapEx} + \text{OpEx} \geq \sum \text{Tariff's}$$

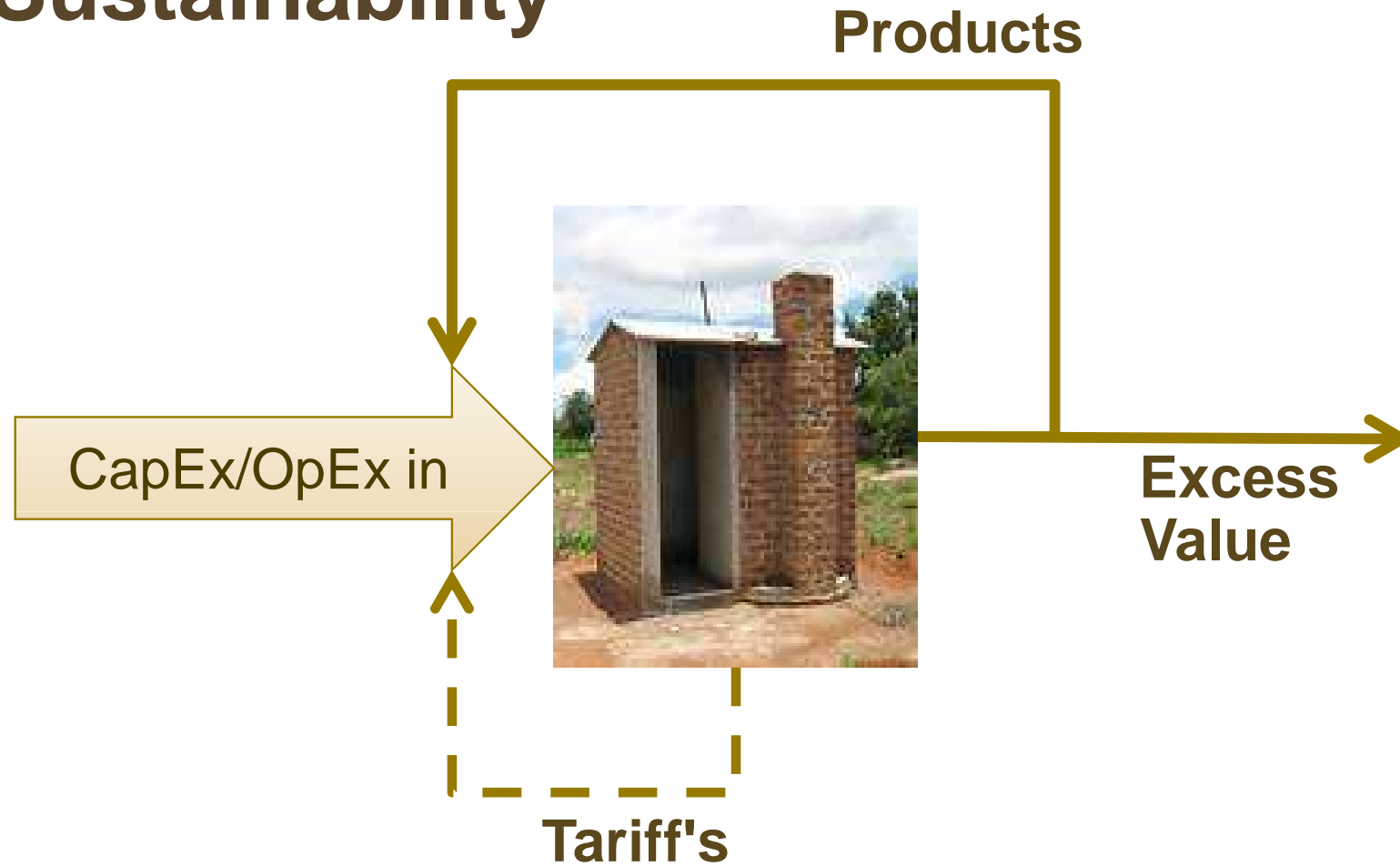
Sustainability

Products



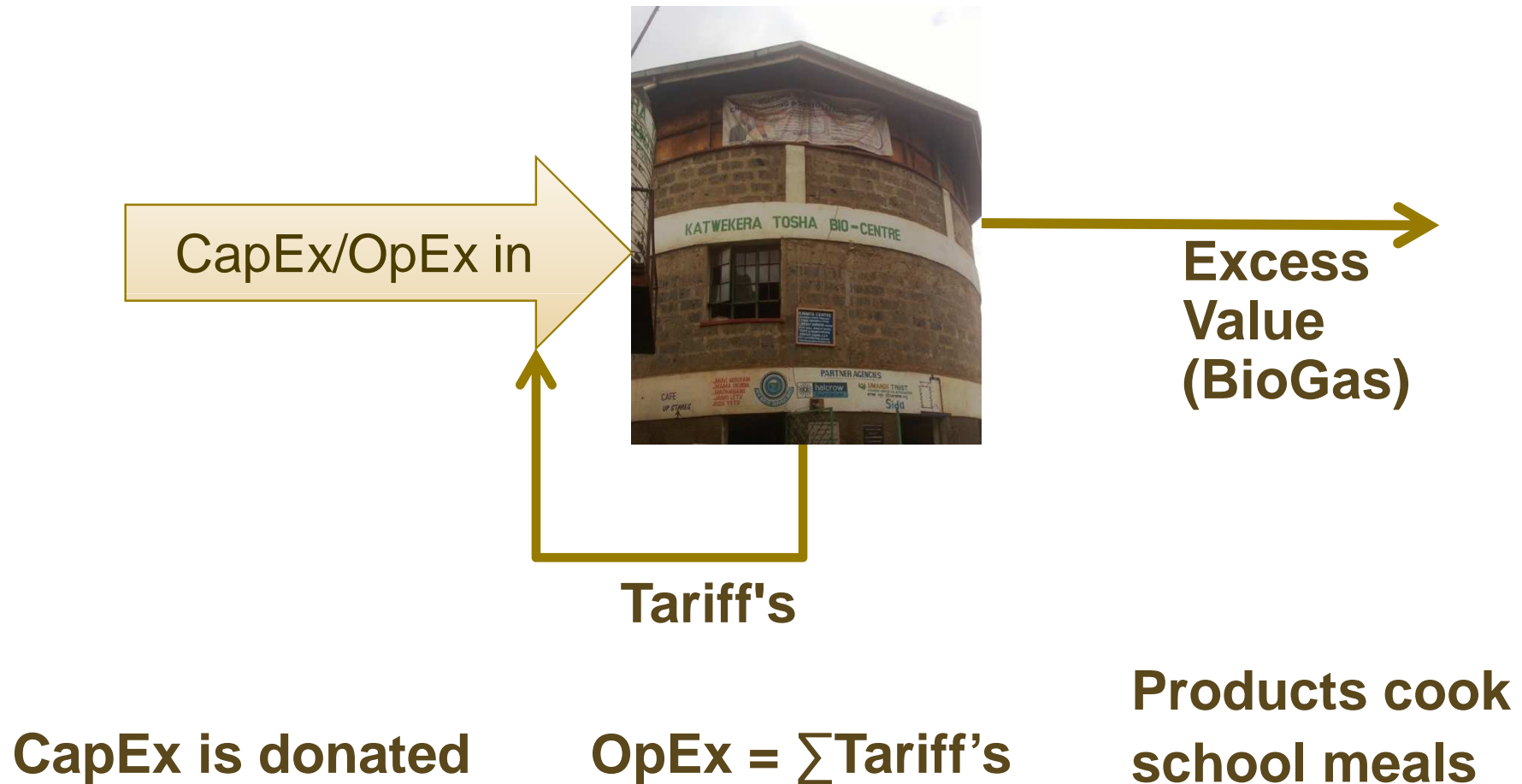
$$\text{CapEx} + \text{OpEx} \leq \sum \text{Tariff's} + \text{Product Value}$$

Sustainability

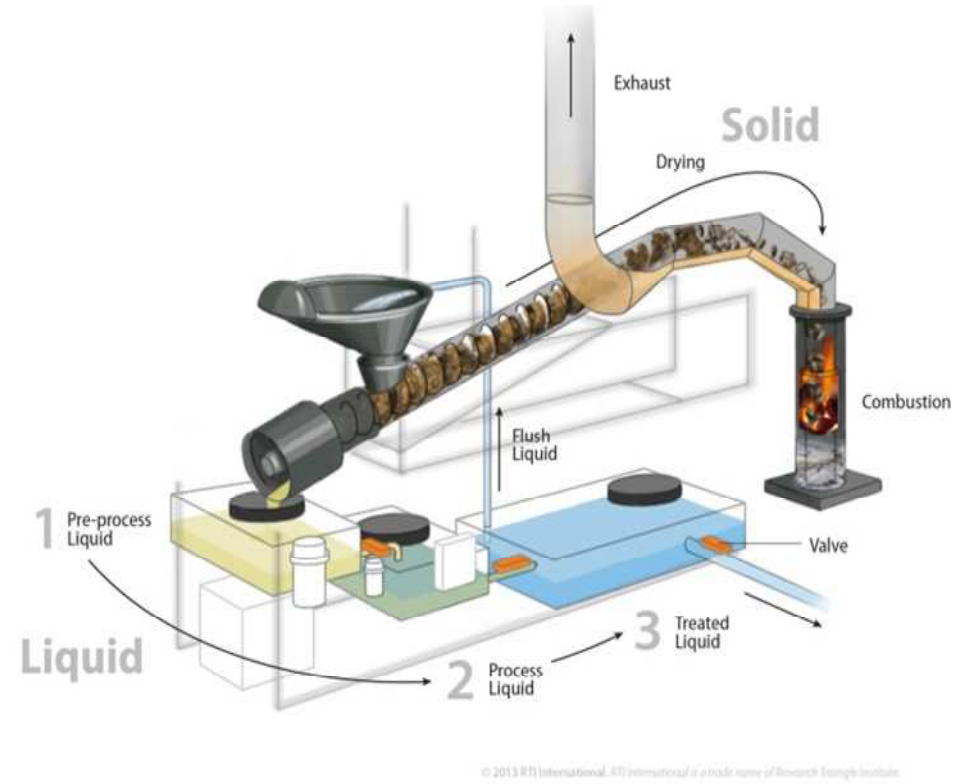
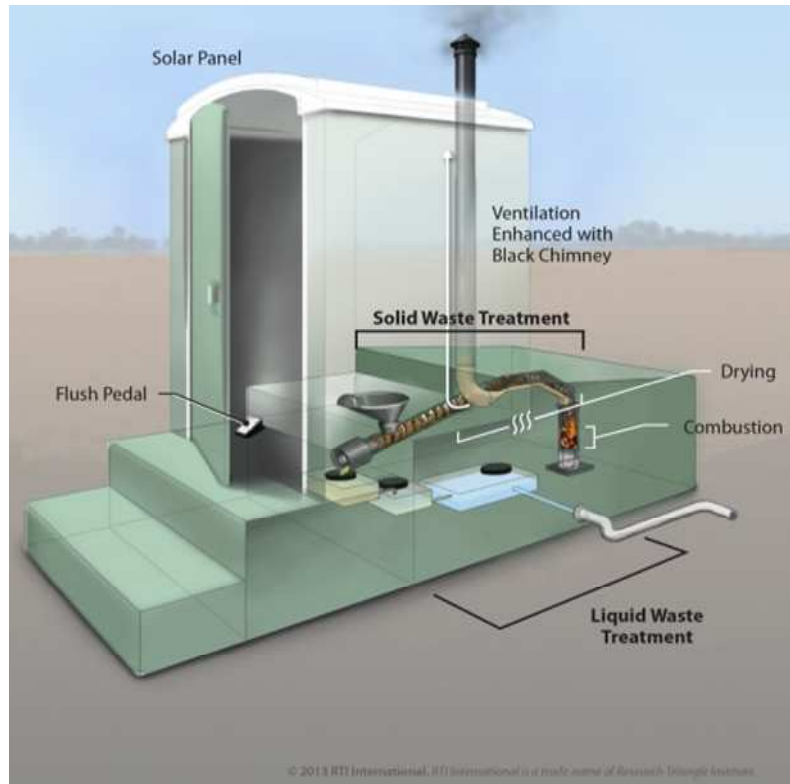


$$\text{CapEx} + \text{OpEx} < \sum \text{Tariff's} + \text{Product Value}$$

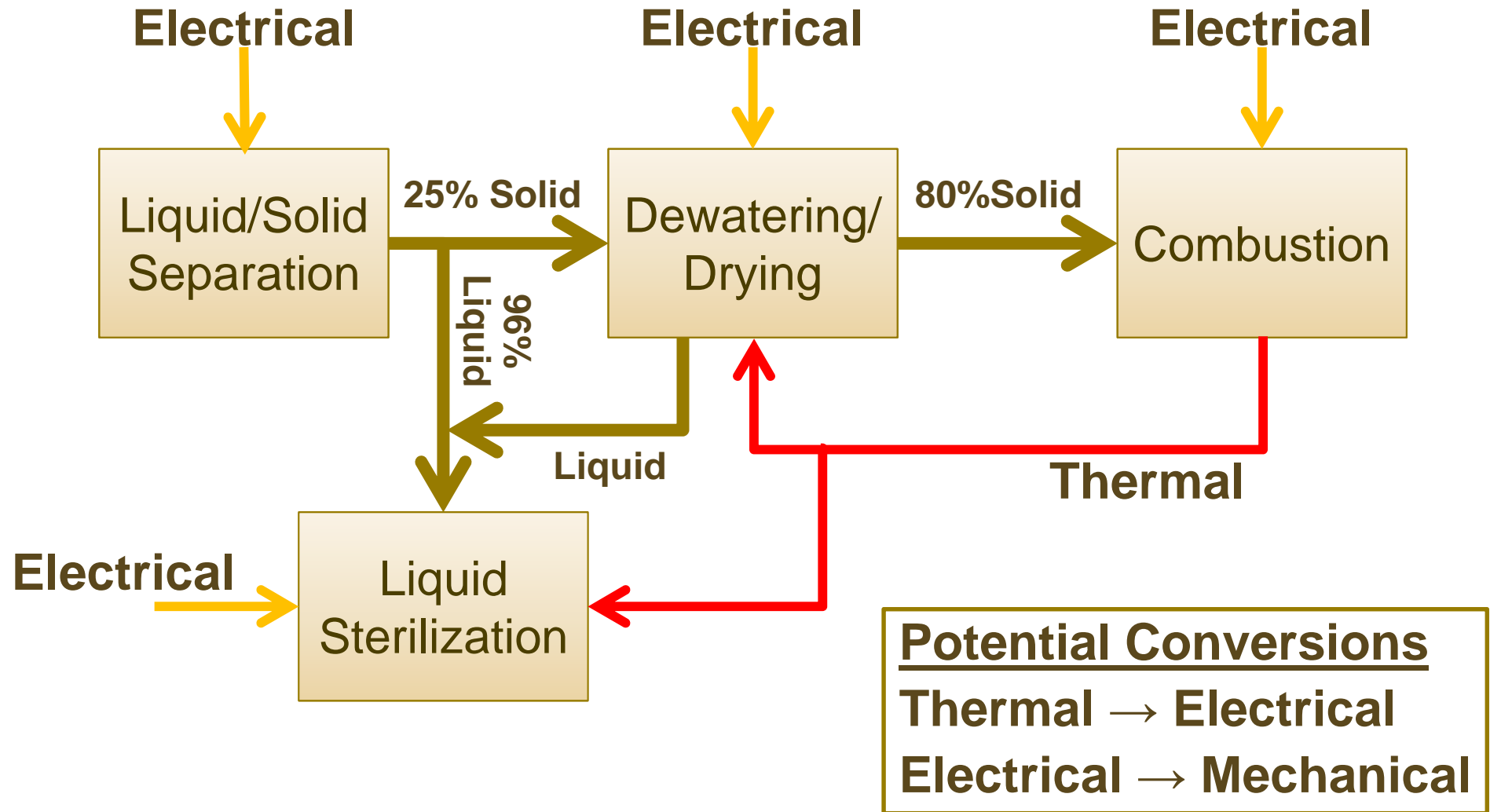
Sustainability – UMANDE Trust



Self-Sustaining Operation

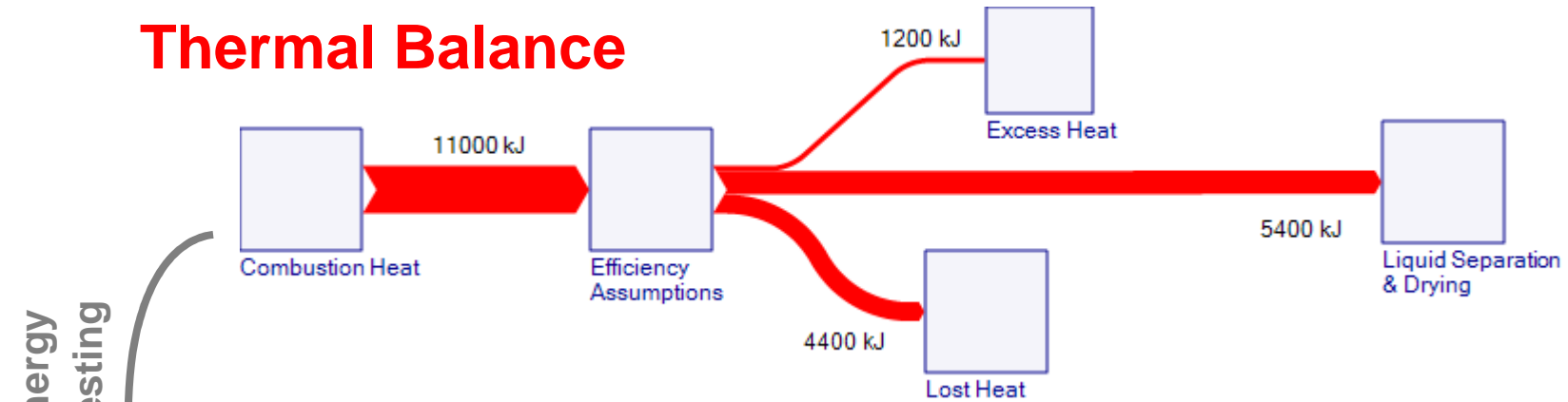


Energy Balance (Combustion)

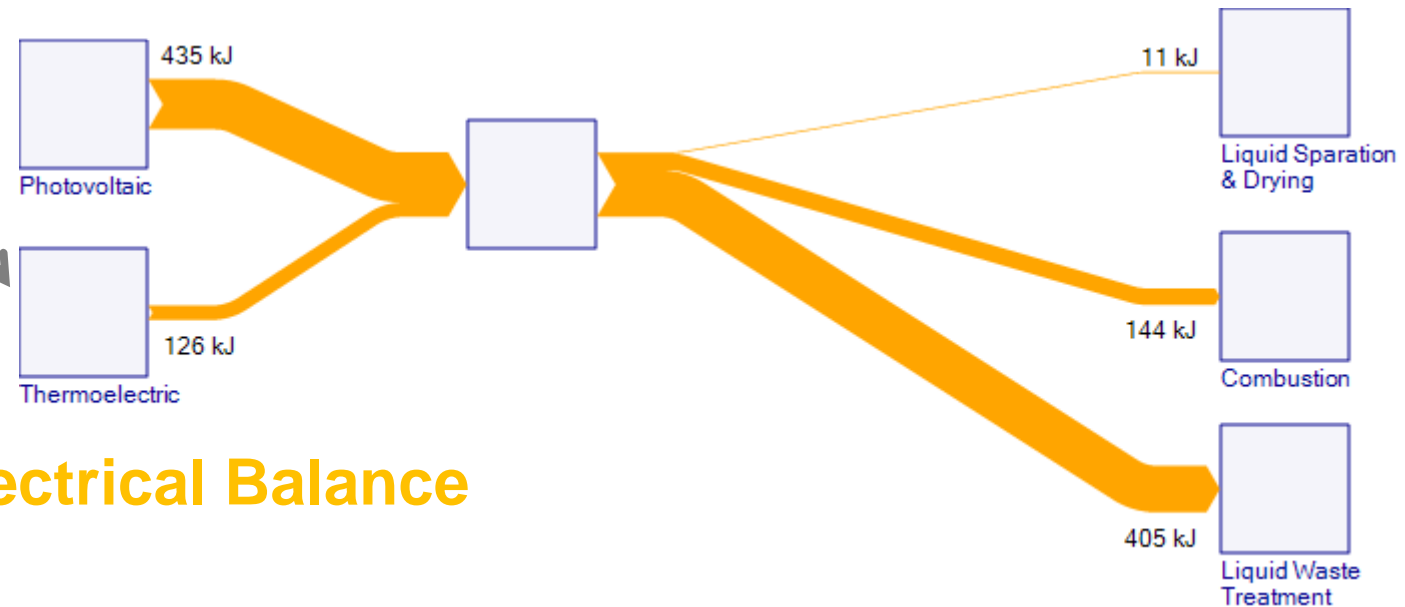


Energy Balance 1 kg Feces (75% H₂O)

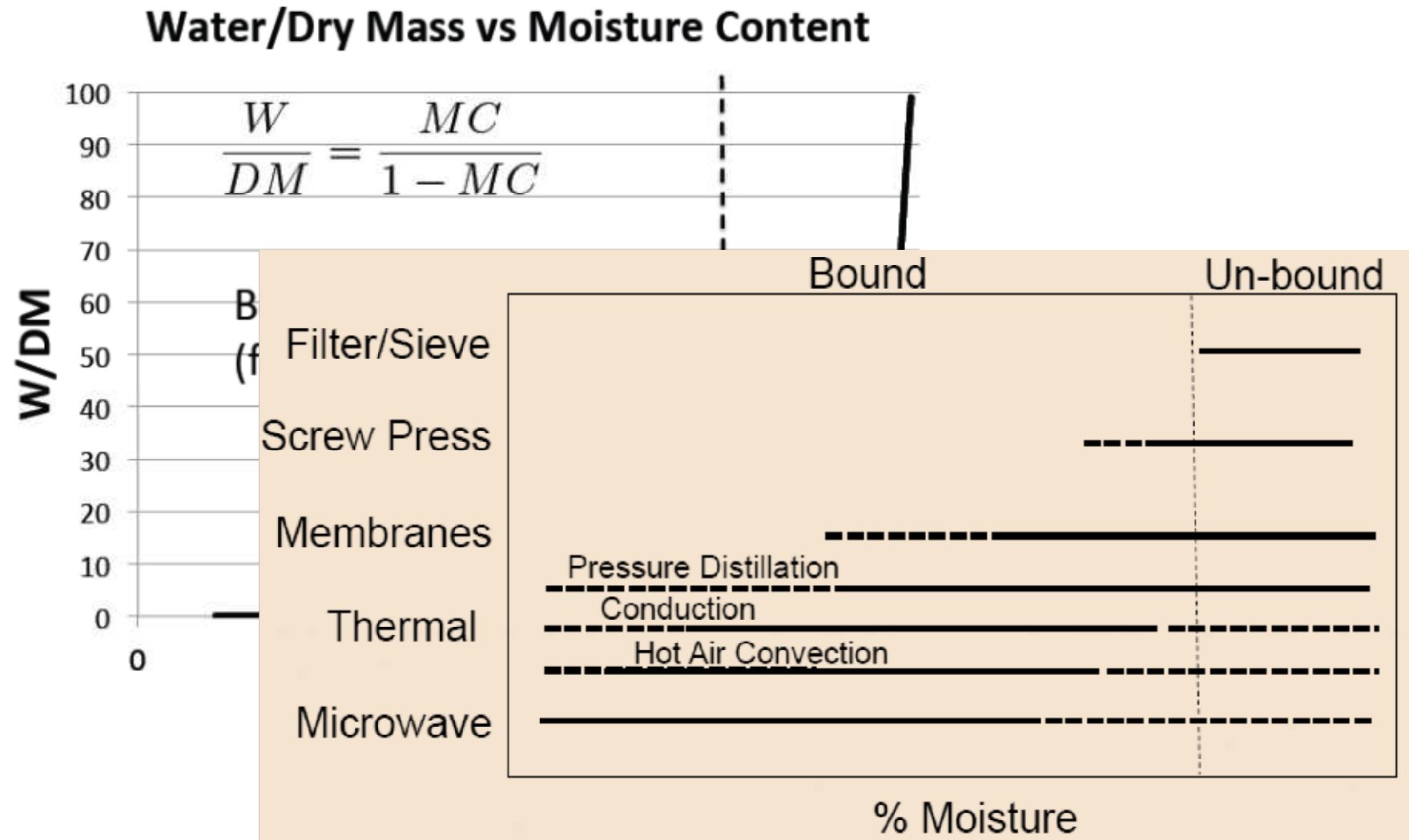
Thermal Balance



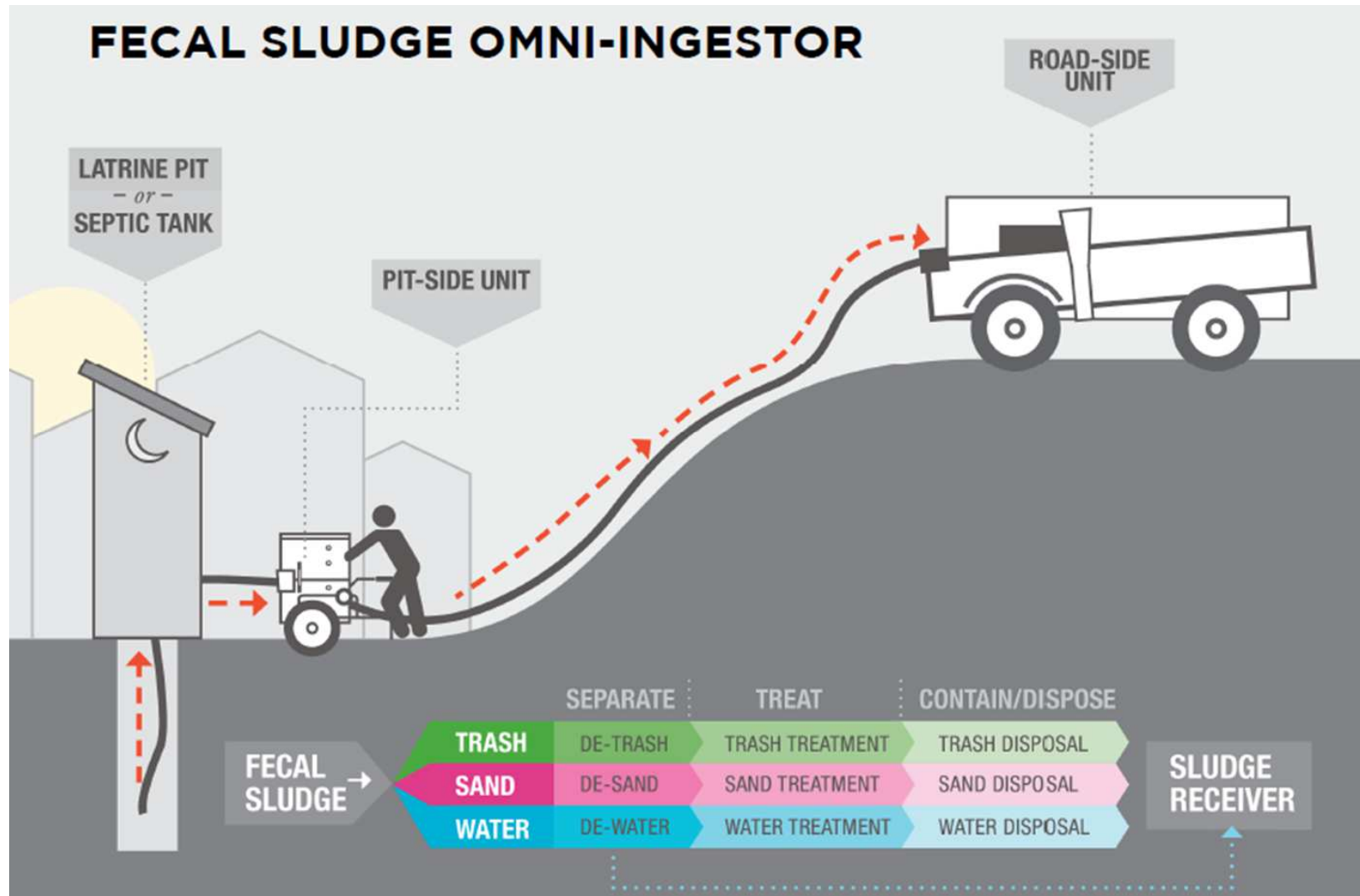
Electrical Balance



Dewatering Energy



Capital Cost Impact



Motivations



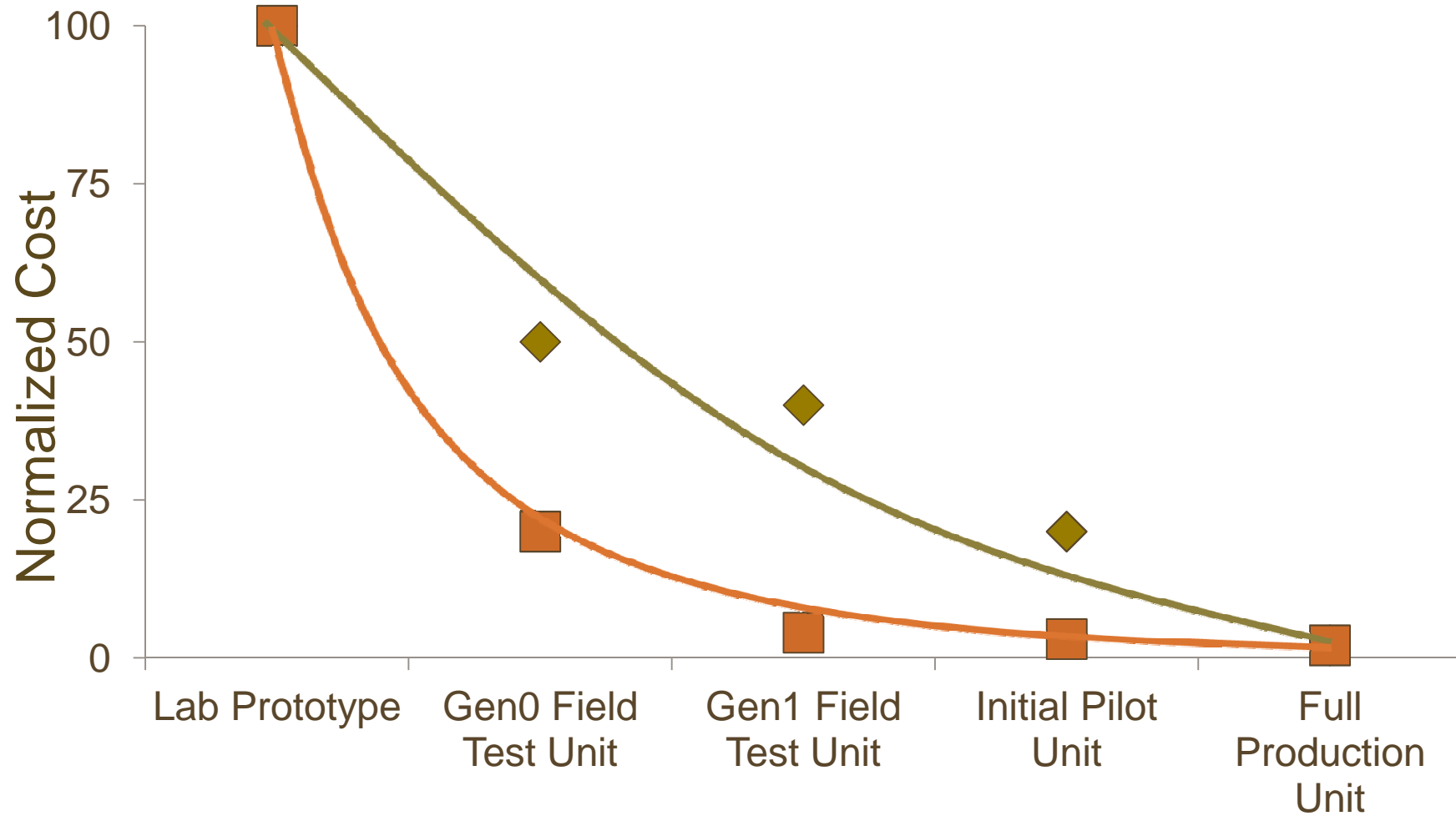
- At current projected cost, for everyone pit manually emptied, six pits must be mechanically emptied



- Latrine construction ~\$100
- Pit Emptying ~\$30-60/visit
 - Family of 10, requires pit emptied ~1/year

CapEx+OpEx < US\$0.05/user/day

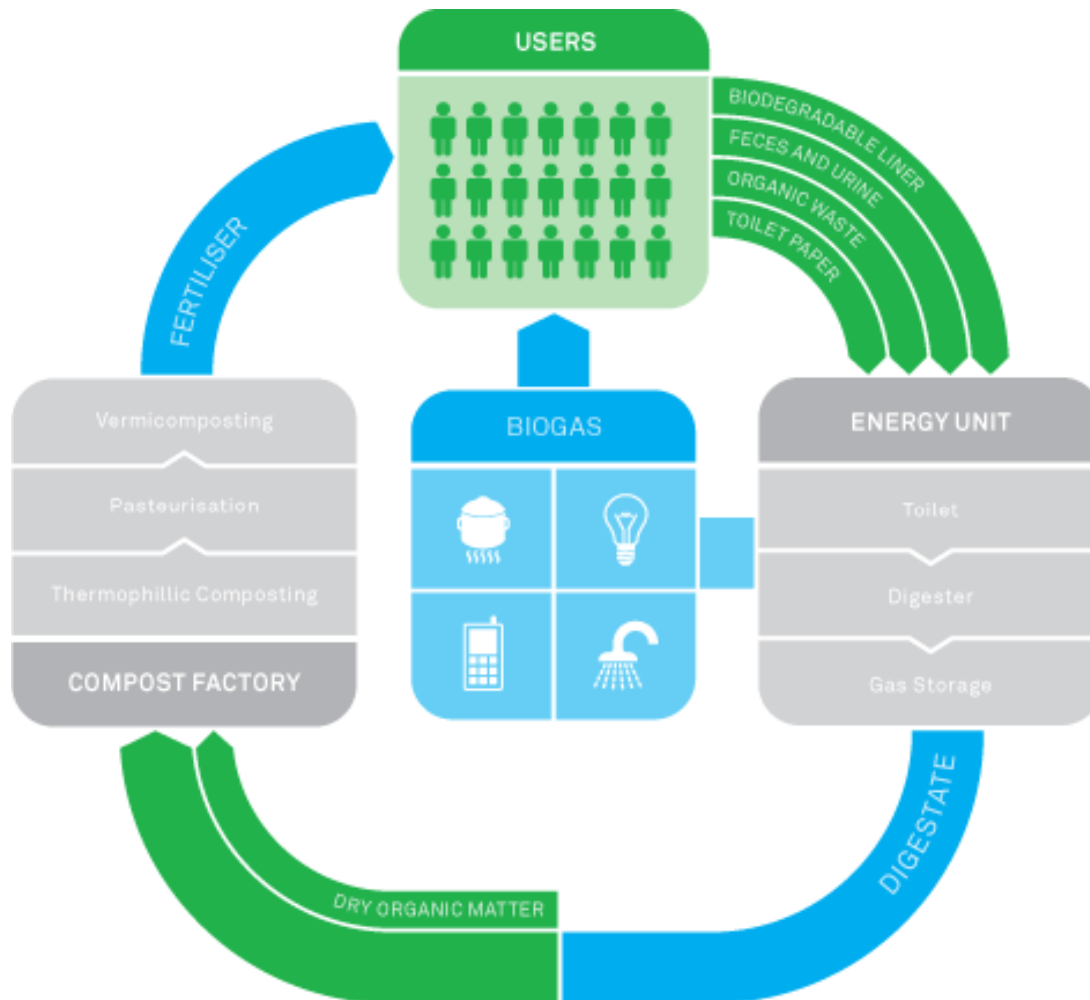
Value Engineering for CapEx



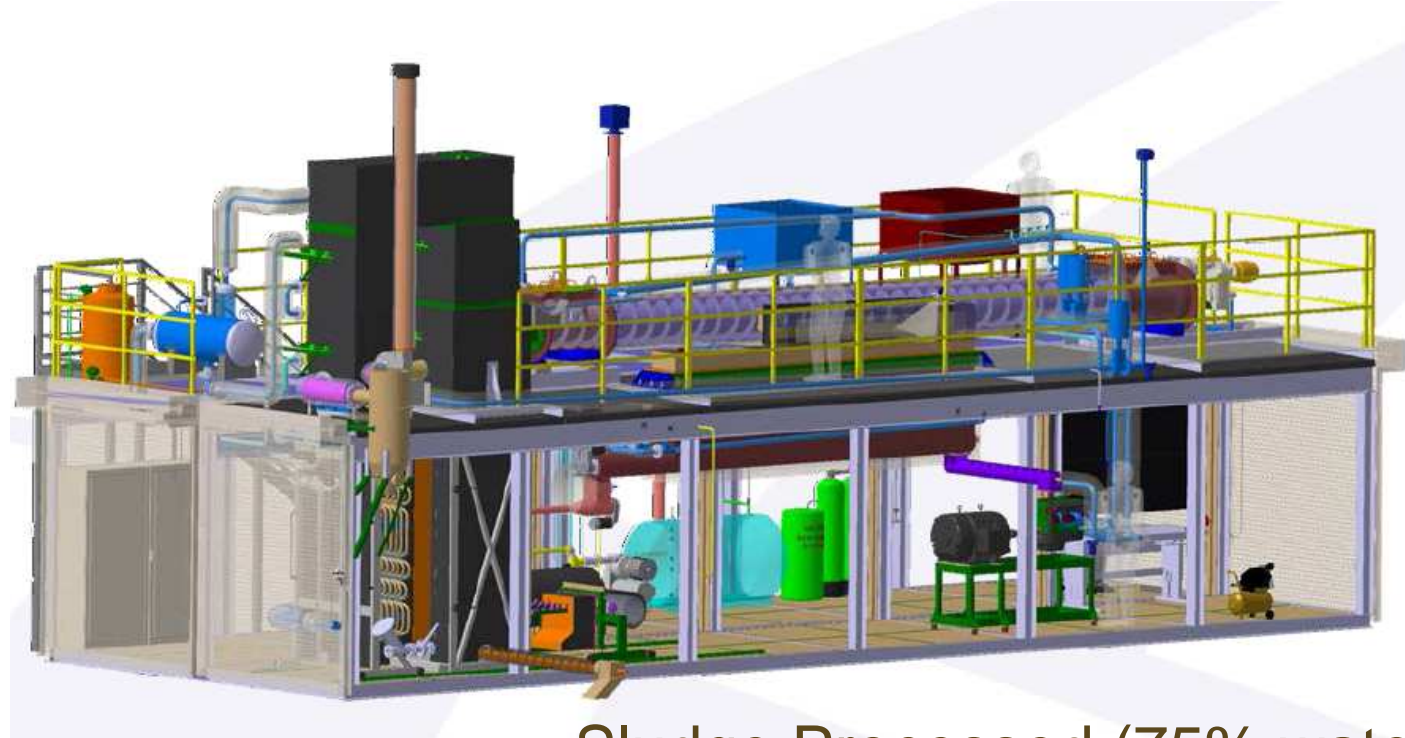
User Interface – Rent or Own?



LooWatt / Sanergy – Branding/Products

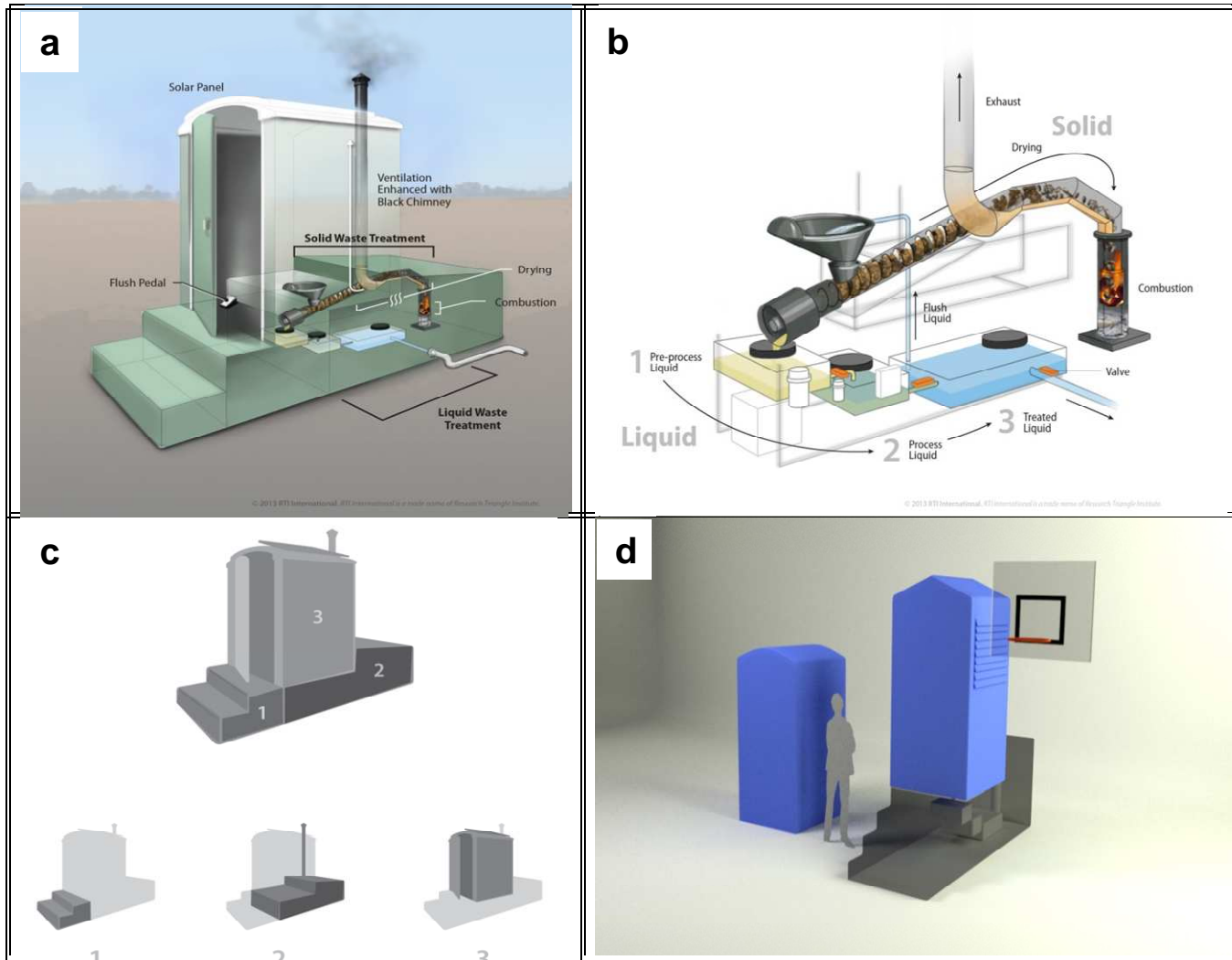


Large Scale Processing



Sludge Processed (75% water) – 9 m³/day
Electricity Produced – 150 kW continuous
Hot grey water (100°C) – 1000 kg/hour
Grey sat steam – 1000 kg/hour
Dry sterile sludge – 250 kg/hour

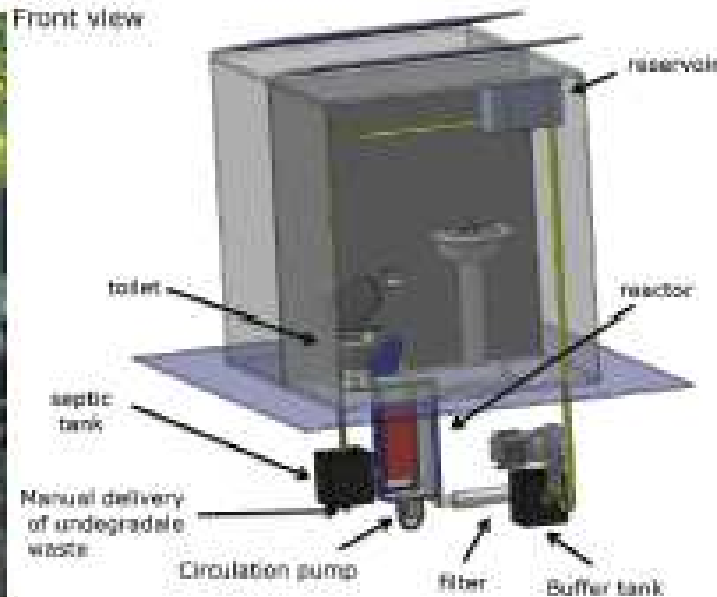
Can all this happen in a single unit?



Combining Cultural Aspiration to Intelligent Processing



Front view



Market Pull

Mobile phone runs on urine power

Issue date: 16 July 2013

Scientists working at the [Bristol Robotics Laboratory](#), which is a collaboration between the University of the West of England (UWE Bristol) and the University of Bristol, have developed a novel way of charging mobile phones using urine as the power source to generate electricity, see [video](#).



Waste to Real Energy: the first MFC powered mobile phone is published in the Royal Society of Chemistry 'Journal of Physical Chemistry Chemical Physics'.

Dr Ioannis Ieropoulos from UWE Bristol is an expert at harnessing power from unusual sources using microbial fuel cells. He says, "We are very excited as this is a world first, no-one has harnessed power from urine to do this so it's an exciting discovery. Using the ultimate waste product as a source of power to produce electricity is about as eco as it gets."

"One product that we can be sure of an unending supply is our own urine. By harnessing this power as urine passes through a cascade of microbial fuel cells (MFCs), we have managed to charge a Samsung mobile phone. The beauty of this fuel source is that we are not relying on the erratic nature of the wind or the sun; we are actually re-using waste to create energy."



Roca