

# NEWGENERATOR™

Technology for the global sanitation challenge



INTERNATIONAL SYMPOSIUM ON  
**URBAN SANITATION CHALLENGES IN THE DEVELOPING WORLD:  
INITIATIVES AND INNOVATIONS**

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# The Team



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# Grand Challenges

Water



Sanitation



Energy



Food



# How did we get here?

- To address these grand challenges, we need to understand how they **interconnect**, develop solutions targeting their **nexus**.
- This is fundamentally a **resource mismanagement** issue.
- More specifically, mismanagement of the Earth's **elements** particularly **CHONP**
- Linear thinking on energy and materials  
**Extract → Produce → Consume → Dispose**



# Our Guiding Principles

- The Earth is a **closed system** with finite resources. Laws of thermodynamics need to be obeyed.
- All elements on Earth are recycled and recyclable. **There is no such thing as waste in nature** (**waste = resource**).
- Energy and matter are **interchangeable**.
- The **natural cycling of elements** must be incorporated into the built environment,  
into the urban landscape  
into the **urban metabolism**.

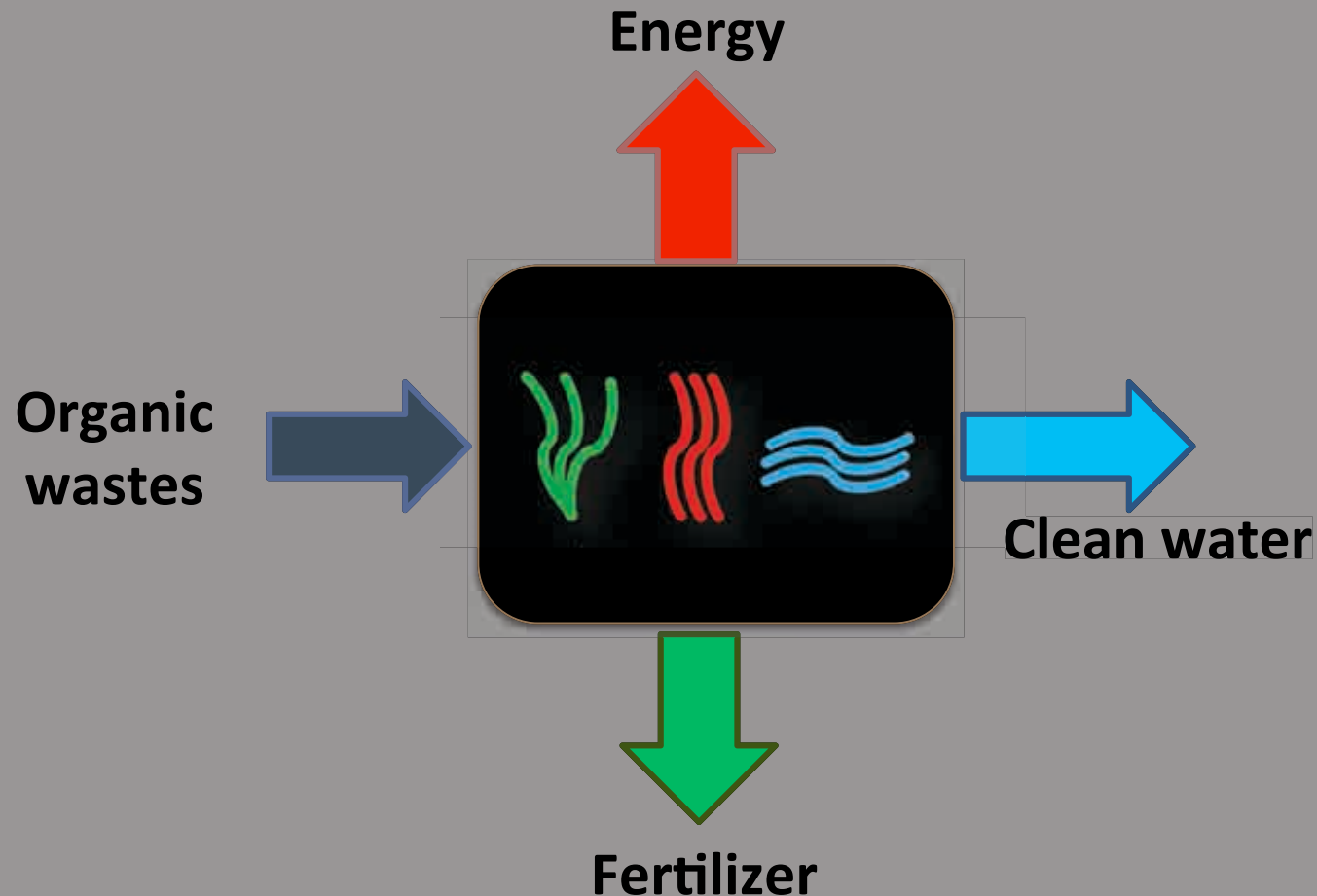
# Our Design Challenge

- **Mimic nature** in a compact high-performance, engineered package that fits into the built environment (e.g., cities).
- Safely and rapidly **break down** wastes and **recycle** back into beneficial forms of water, energy and nutrients.
- The device has to operate without external electricity, in other words, operate **off the grid** using harnessed energy.
- Safe, reliable, low-cost, easy to operate, low-O&M, robust, passive.

transformative, disruptive, game changer

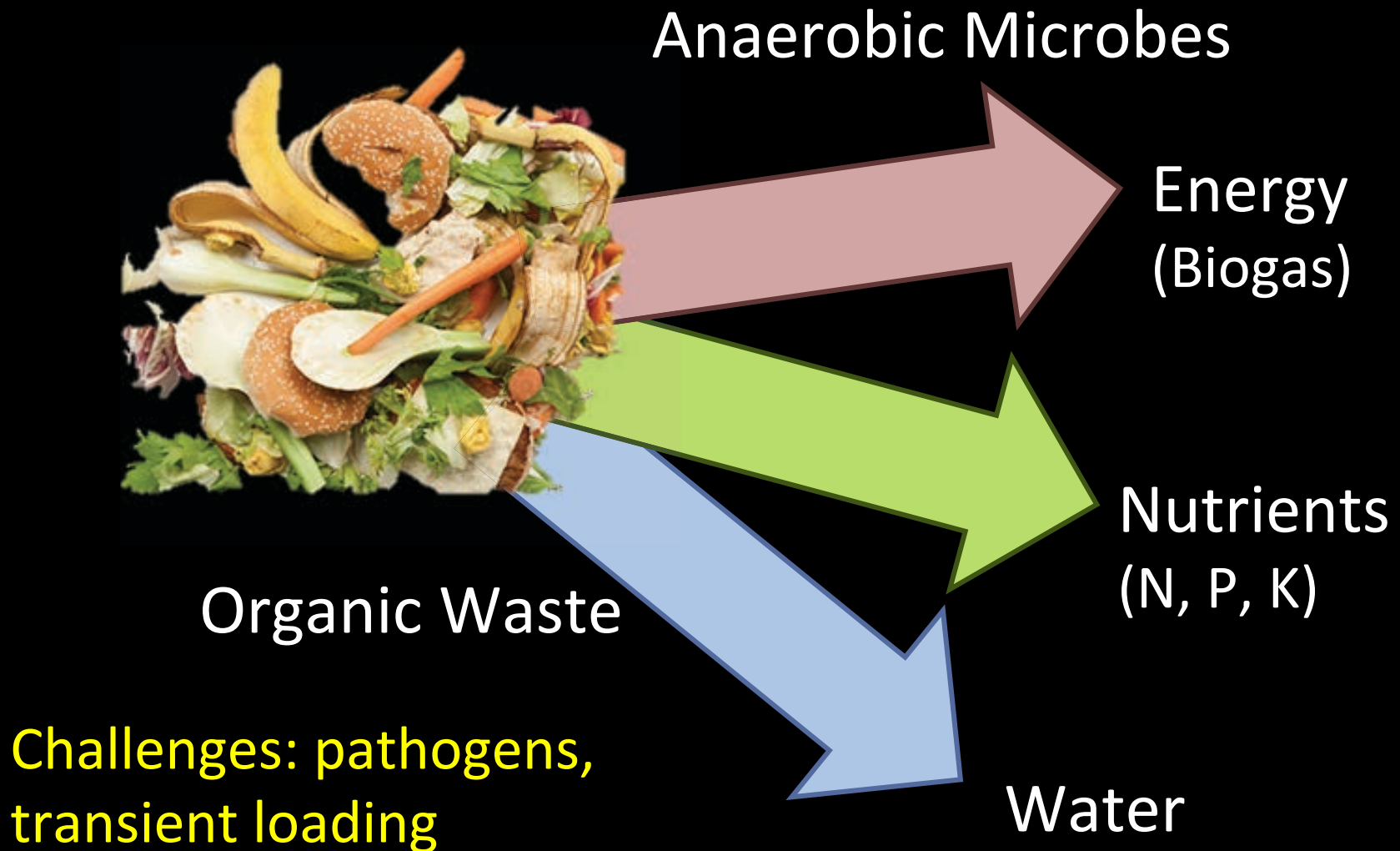
# The Technology: Anaerobic Membrane Bioreactor

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Existing Technology:

# Anaerobic Digestion





Moving beyond AD limitations:

# Membrane Filtration

**Safely removes bacteria and viruses**

- regardless of temperature
- regardless of loading
- Enhances safety and reliability

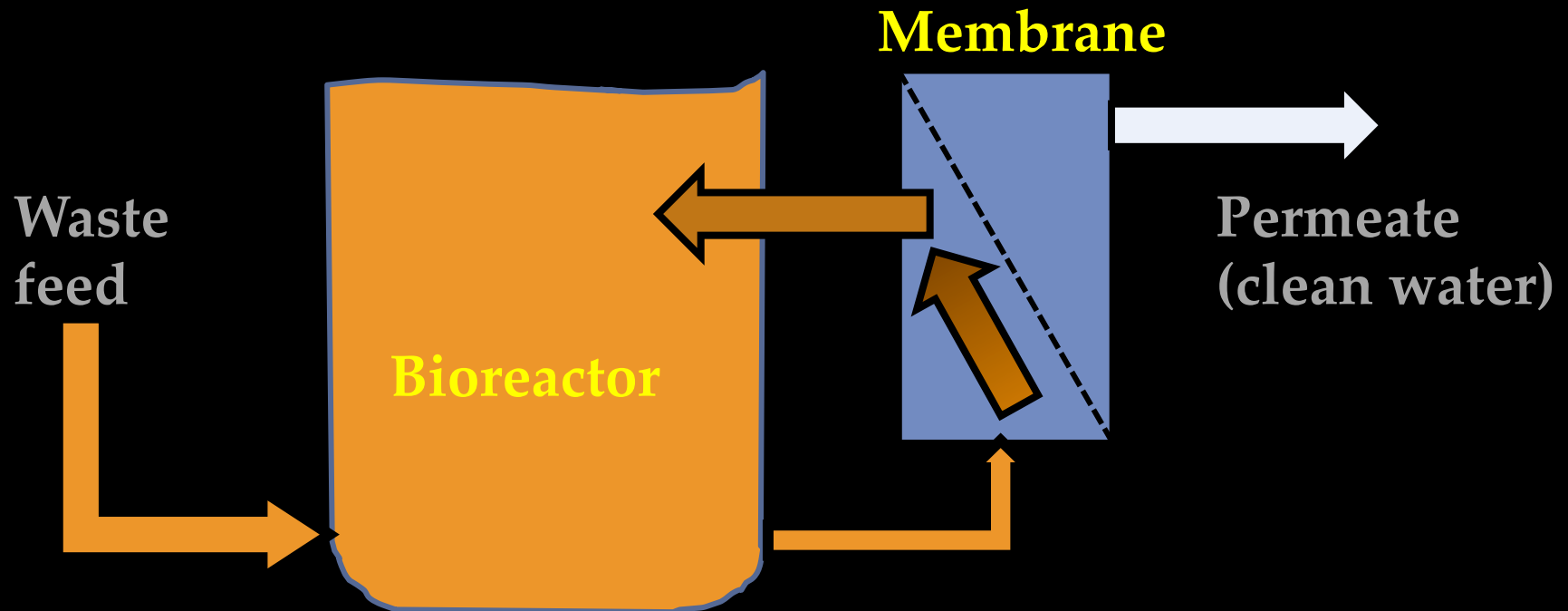


Ultrafiltration (0.03 micron)

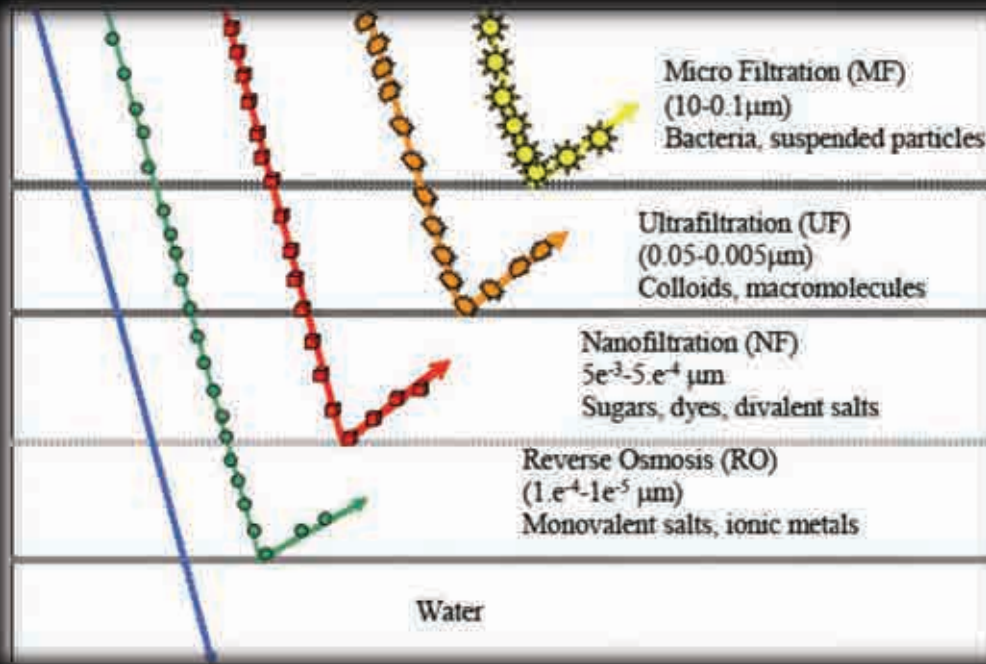
# Anaerobic Membrane Bioreactor (AnMBR)

A coupling of anaerobic processes and membrane filtration, resulting in synergistic effects not possible by each process alone.

Resilience, transient loading, safety barrier, high rate, greater performance, compact design

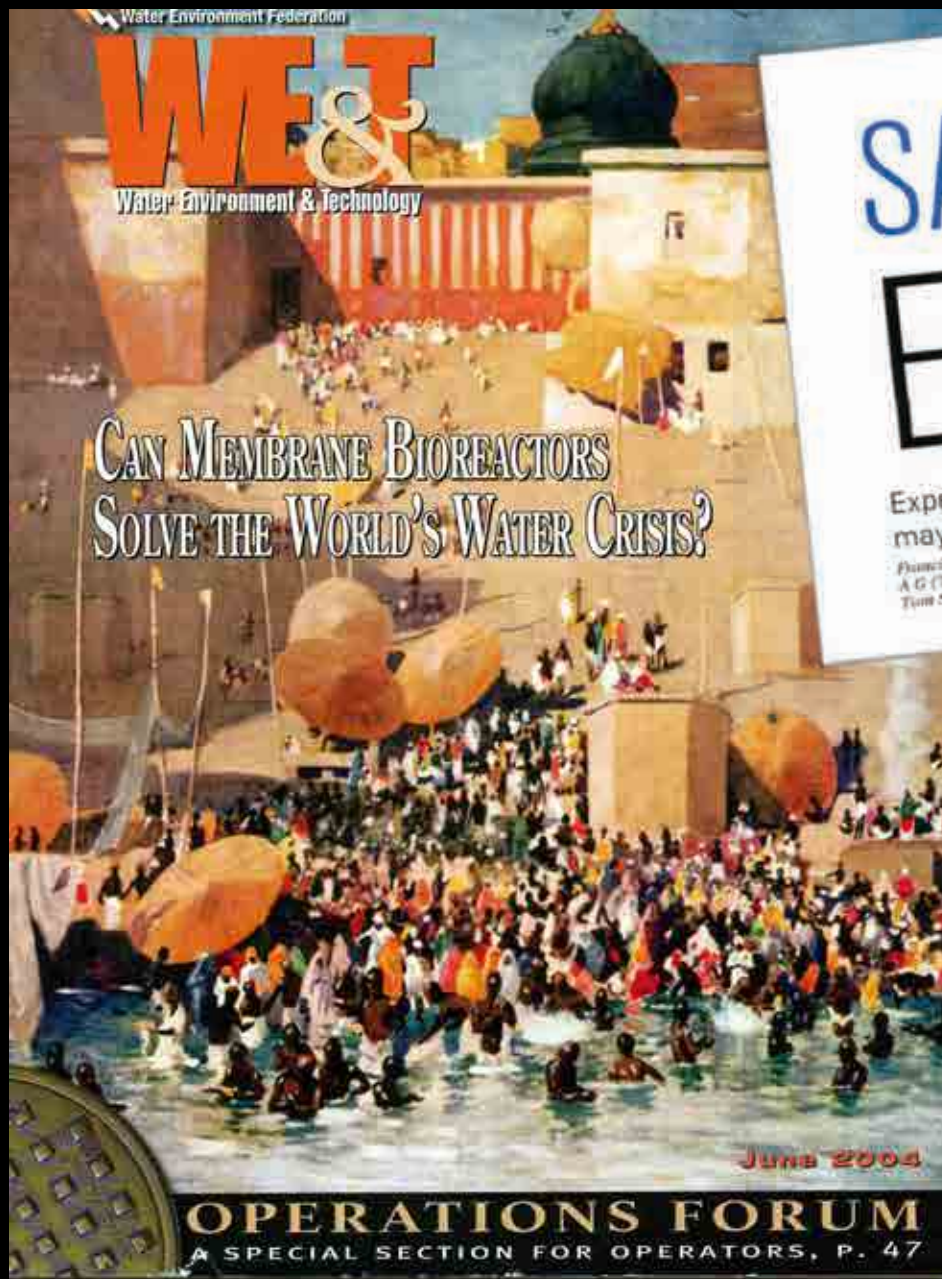


# UF Membrane



- Pentair X-Flow Membranes
- Tubular 5.2 mm PVDF membranes
- .03  $\mu$ m average pore size
- Used in full-scale applications
- 5 year or longer replacement schedule
- Anticipated cleaning schedule 4-6 times a year as needed
- Our lab group has 6+ years of experience working with these membrane modules

Pathogen	Log removal
Helminths	8 (99.999999%)
Bacteria	6 (99.9999%)
Viruses	4 (99.99%)



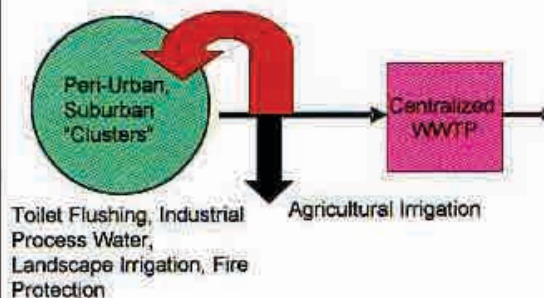
# SAFE WATER FOR EVERYONE

Experts suggest that membrane bioreactors may be a key to global water sustainability

*Paolino A. DiGiuseppe, Gianni Andreaceto, Sumar Adham, Chris Buckley, Peter Cornell, Glen T. Duggel, A G (Tony) Fane, Neesh Gullil, Joseph G. Jacangelo, Albert Poller, Bruce E. Rittmann, Alberto Rozzi, Tom Stephenson, and Zehai Ujima*

## Figure 2. Wastewater Reuse in Decentralized MBR Systems

Sewer Mining- Extraction of Raw Wastewater at Constant Flow Rate for Reuse After MBR Treatment







# Beneficial uses for agriculture (profit)

Microalgae (animal feed, biofuel)

Aquaponics

Hydroponics for crops

Urban greenscape



# Sanitation Technologies

## Spectrum across scale

Low-tech sanitation (latrines)

Centralized wastewater treatment



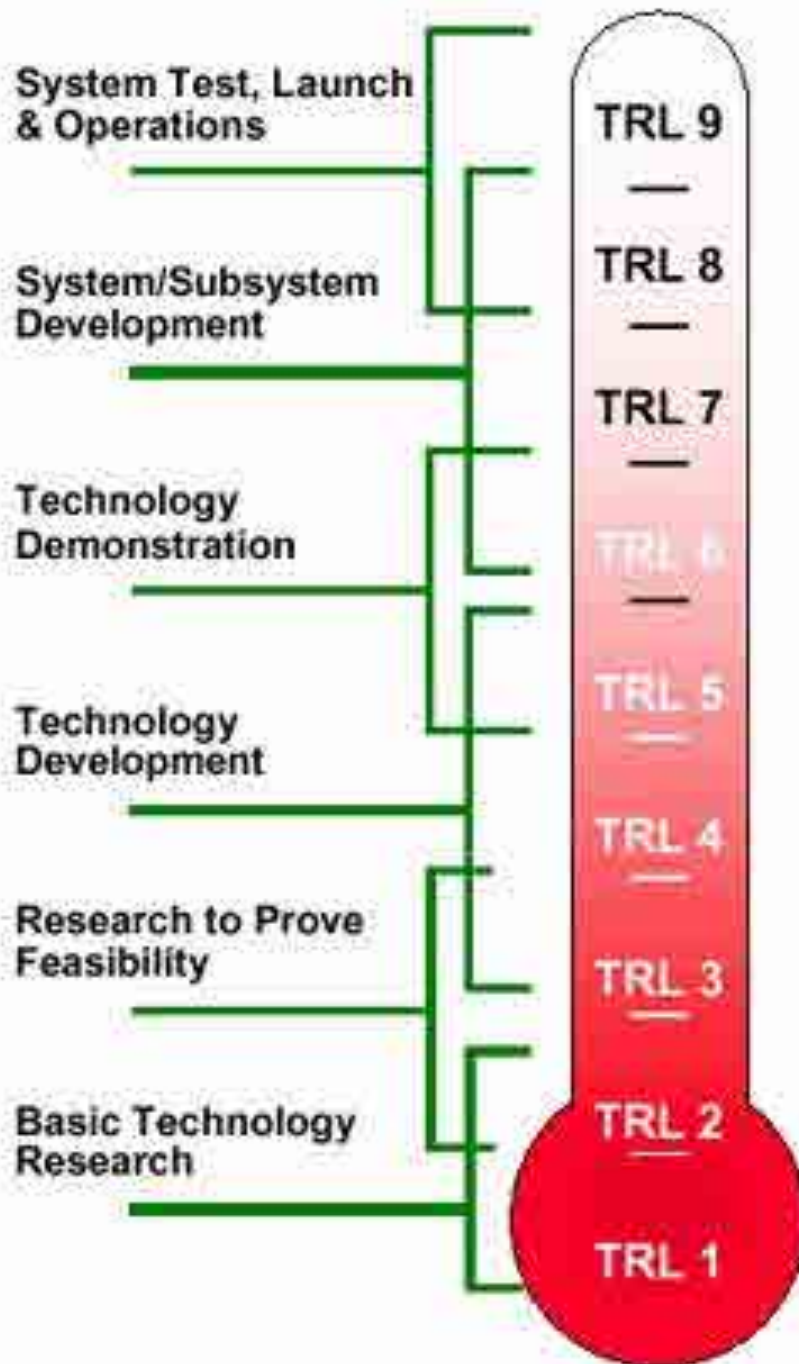
*NEW*GENERATOR™

Treatment

+

Recovery





# NASA's TRL

## Technology Readiness Levels

Describes steps to mission readiness and commercialization

# Technology



5TH ANNUAL

Bio  
ReNEW

## Commercialization Cade Museum Prize

cade museum prize



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GATES foundation

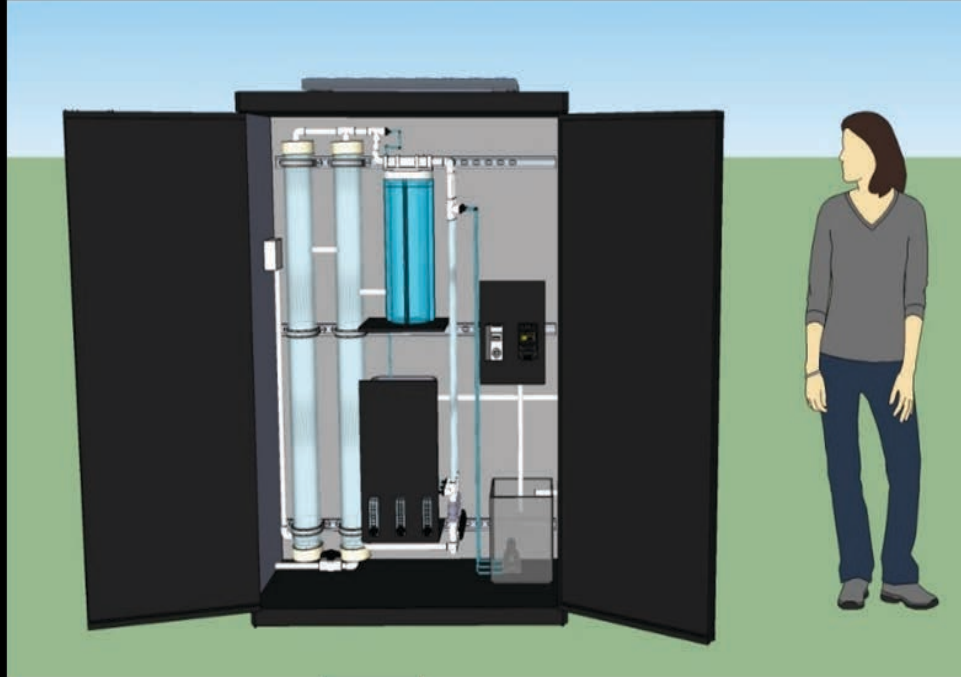


Idea

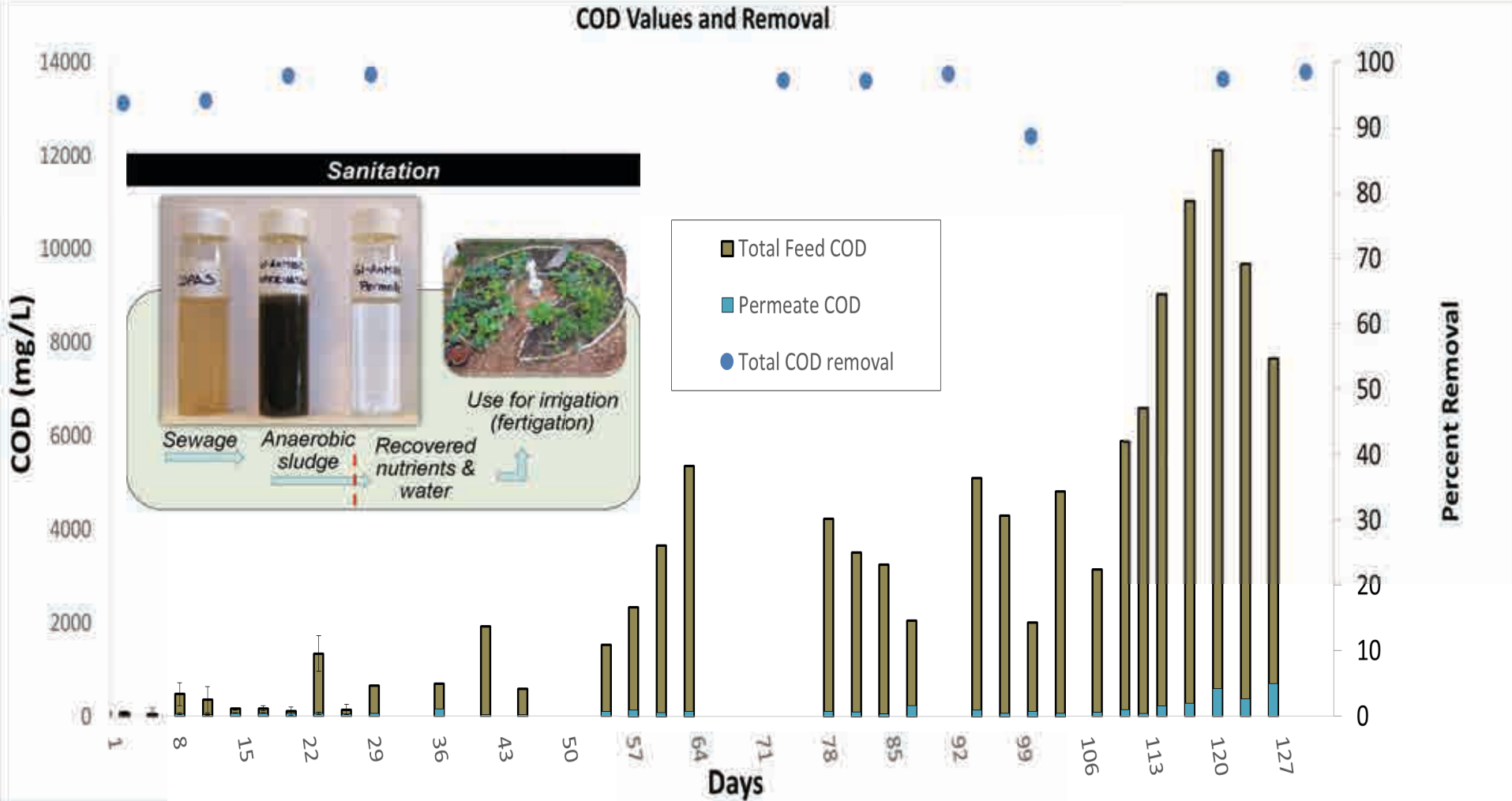


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# Pilot-scale system (TRL6)



# TRL6 System testing for baseline treatment efficiency at increasing feed concentrations (system in Florida on a septic tank).



# TRL7 **NEWGENERATOR™**

Technology for the global sanitation challenge



Patent-pending

**Decentralized, onsite**  
**Safely processes wastes**  
**Modular & Off-Grid**  
**(renewable energy)**

**Compact design**

**Water recycling**  
**Energy harvesting**  
**Fertilizer recovery**

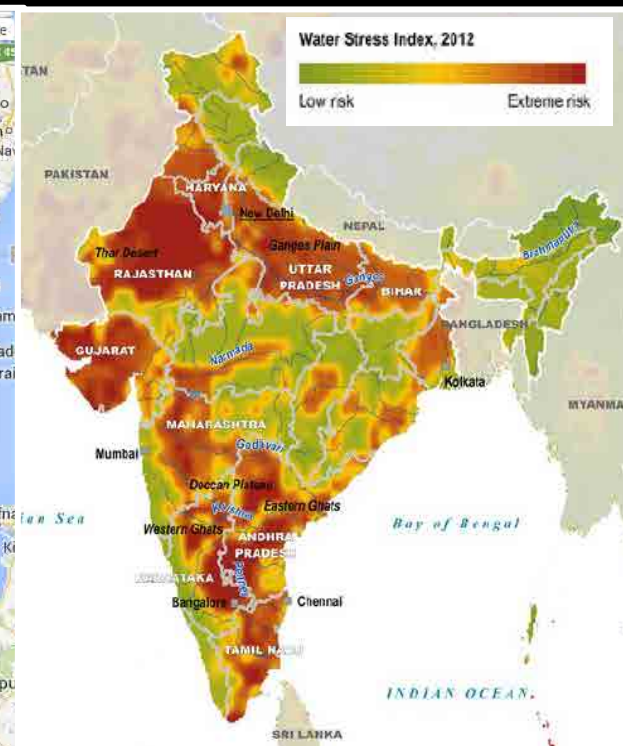
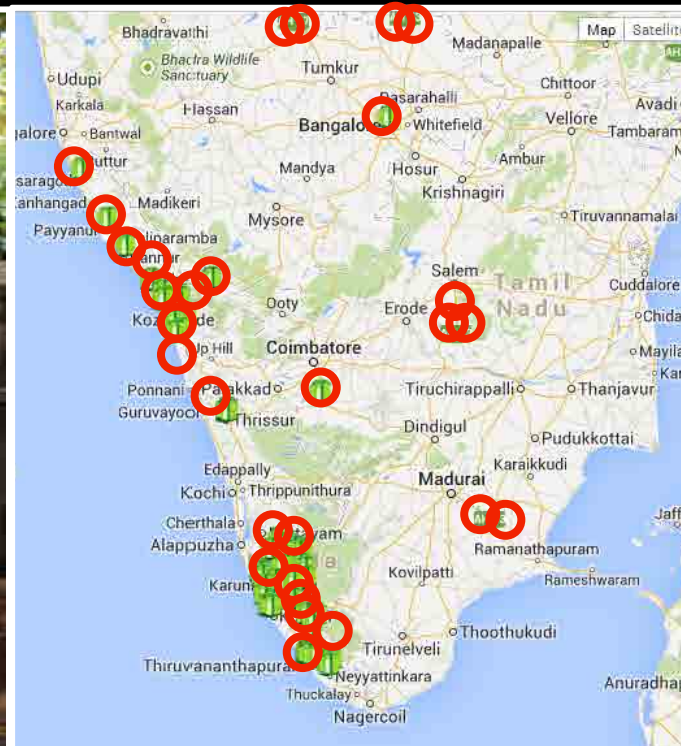
**Turning waste into profit**



# Business Model (India Case)

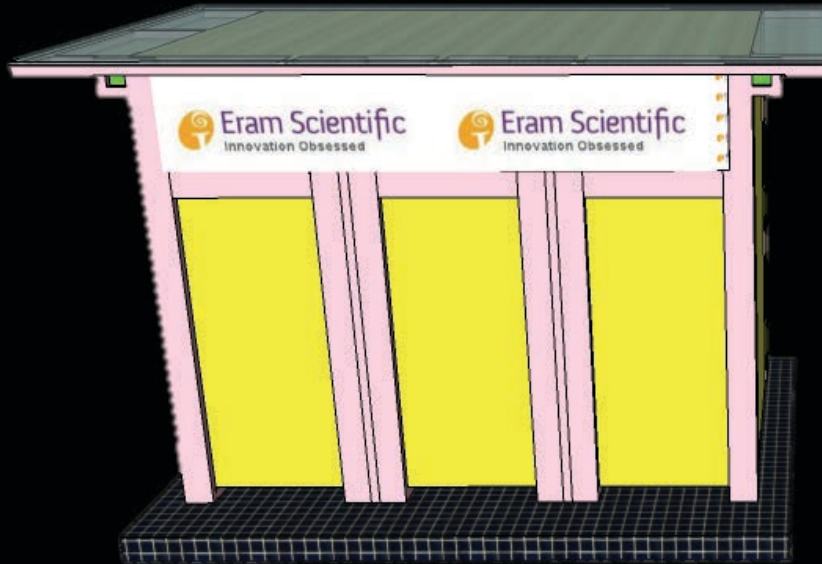
## ERAM Scientific Solutions

- Over 600 units of eToilet installed in just 3 years → public sanitation coverage
- Expansion to additional regions in India not possible due to water and energy scarcity
- Coupling with NEWgenerator will enable expansion in India and elsewhere



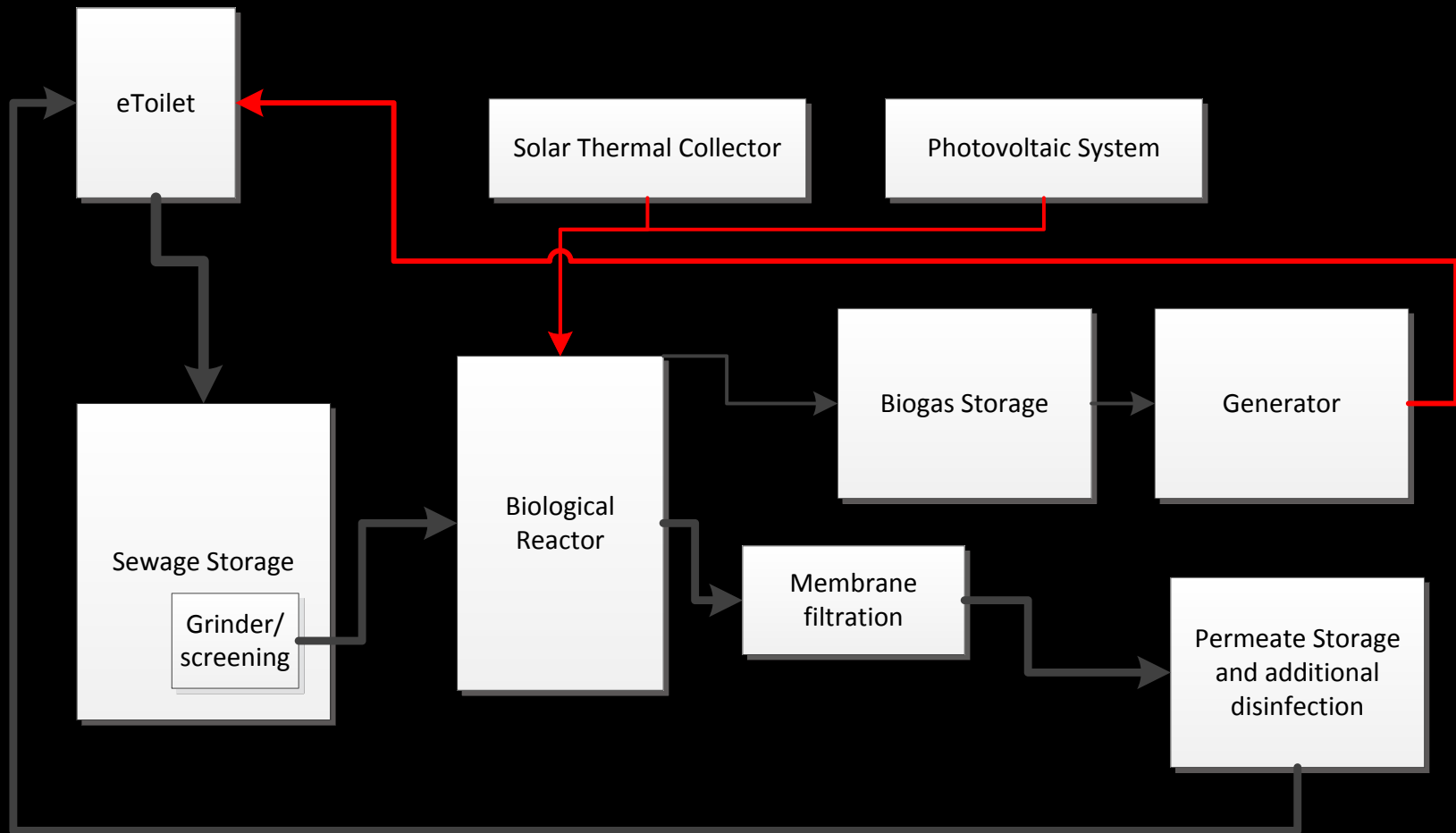


# Integration of eToilet with NEWgenerator



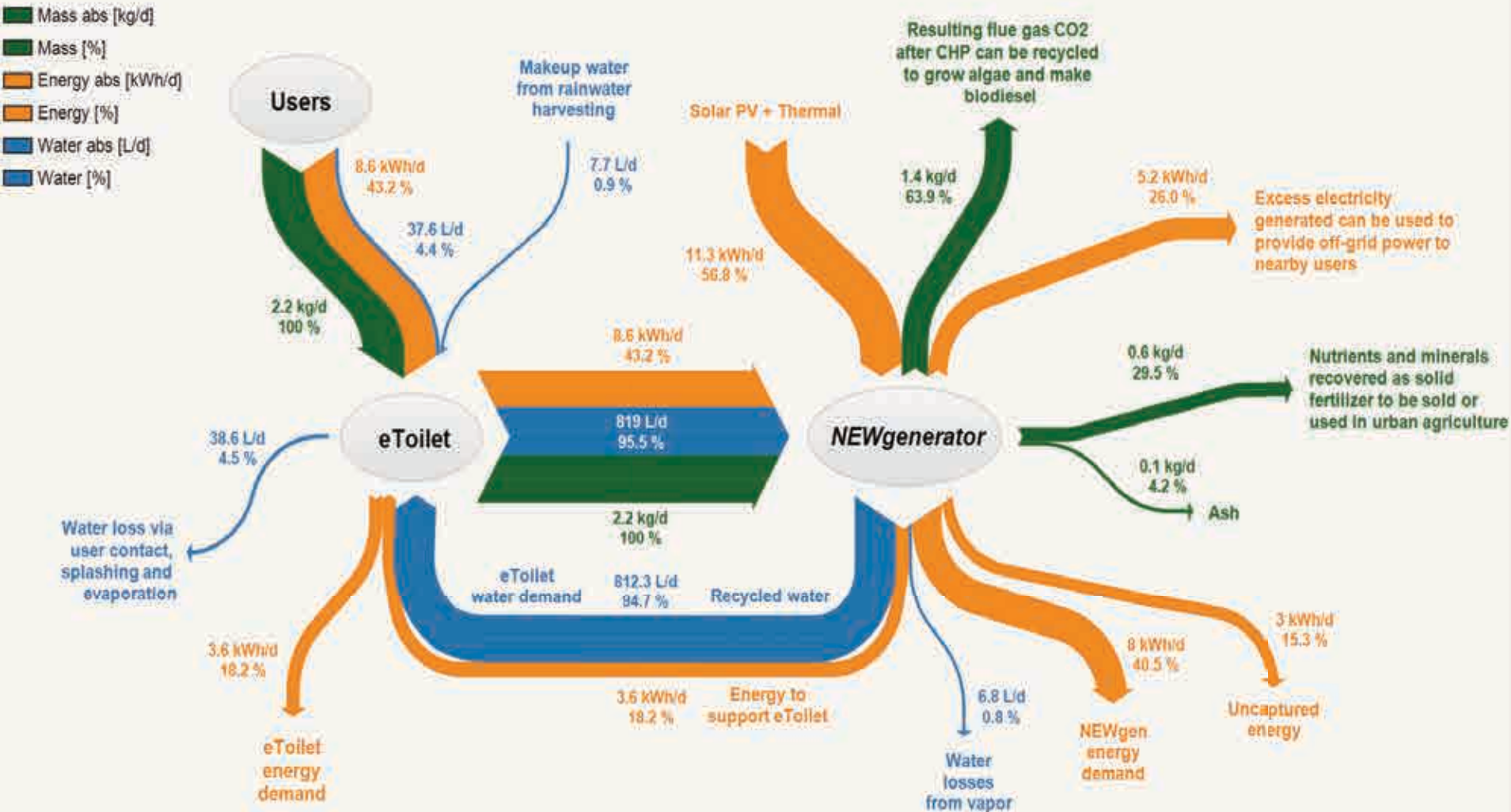
- Fully off-grid
- Biogas generation + Solar thermal to boost biogas production
- Photovoltaic to assist biological start up
- for night time and cloudy conditions
  - Battery backup – 4 days worth of storage
  - Biogas Combustion

# Integration of eToilet with NEWgenerator



# Water, Energy & Mass Balance Modeling

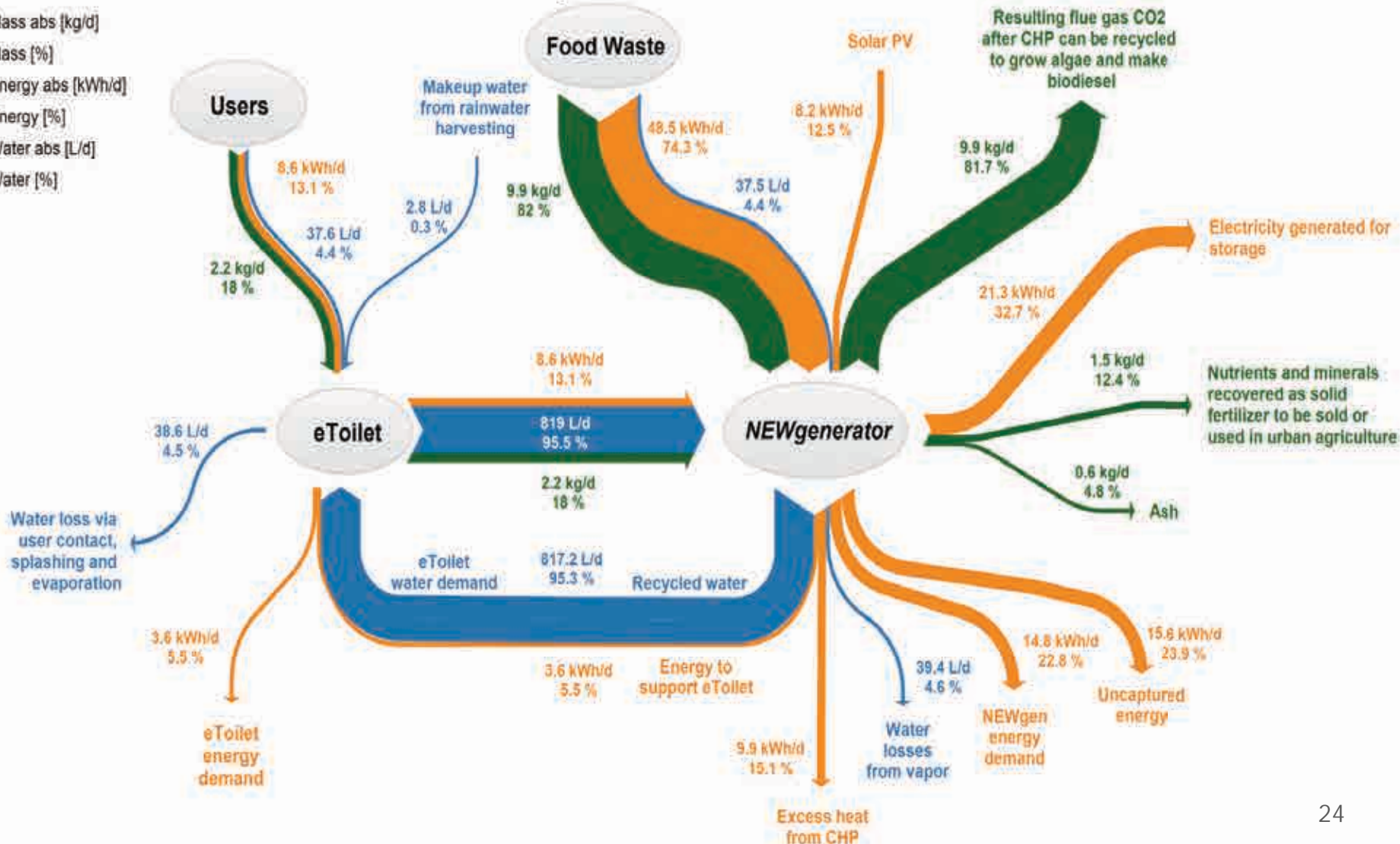
## Water-Energy-Mass Balance (NEWgen 100 + 2 eToilet Units)



\* Solar energy input is based on a 9.3 m<sup>2</sup> roof area deploying both solar thermal and PV.

# Co-digestion with food waste

Food Waste Co-Digestion Scenario



# What does this mean?

- Let's imagine if everyone in India (1.2 b) is served by NEWgenerator (quick back of envelope calculations)...
- $8.6 \text{ kWh/d (100 users)} \times \text{d}/24\text{h} = 0.36 \text{ kW (100 users)}$
- $86\text{Wh/d (per user)} \times 1,200,000,000 = 103,200 \text{ MWh/d} \times \text{d}/24\text{h} = 4300 \text{ MW}$
- Divided by 440 MW (medium-size power plant)  
= almost **10 power plants**
- Divide by 1MW landfill biogas power generator  
= 4300 landfill generators.
- If adding **Food waste**:  $48.5 \text{ kWh/d}$  (about 6X)  
→ **60 power plants**, or 13,000 landfill generators
- This is a previously untapped distributed power production from waste biomass !



# Large Scale Impact

The **eToilet** provides the users with a clean and convenient sanitation user interface. The **NEWgenerator** harvests and safely treats waste contents from the eToilet to remove pathogens, recycle clean water for reuse, generate renewable energy, and recover valuable fertilizer.

Fully off-grid system can be applied in remote and water scarce areas.

## Slum sanitation:

- Usage patterns will be different from other users
- Opportunities for educational/awareness activities

## Progression of technology uptake

- Slums offer technology entry point for other high density and more challenging urban areas





# Market Segments

BMGF  
USAID  
NGOs  
Gov't



Urban Communities



Rural America

USEPA  
USDA  
BIA  
State  
agencies

DoD  
DoE  
FEMA

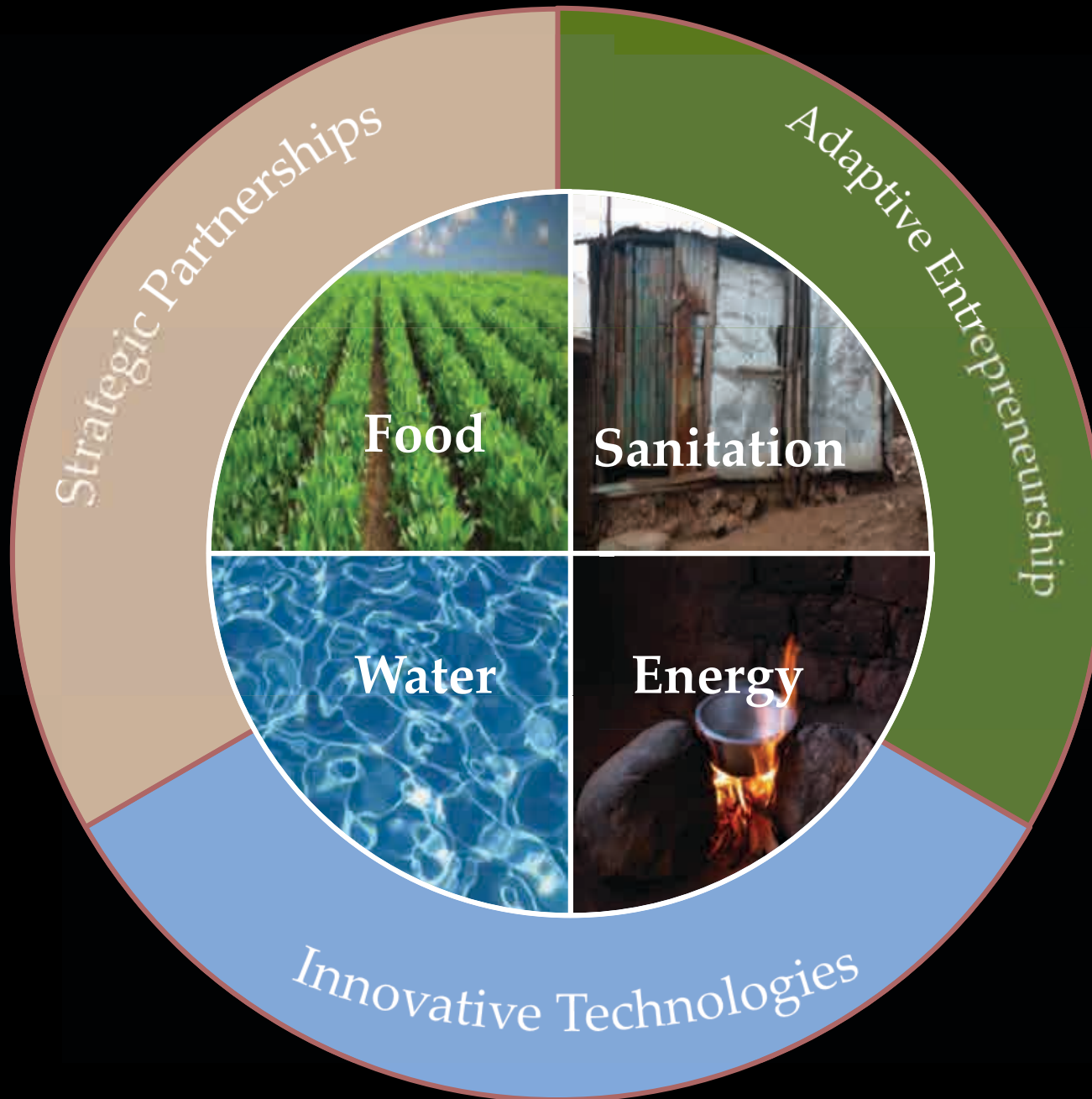


Military & Emergency



Green Building & Space

USGBC  
DoE  
Developers  
NASA



# Strategic Partnerships

Private, foundation, governmental, NGO, educational

Existing

Under development



National Science Foundation  
WHERE DISCOVERIES BEGIN



# For more information

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