Theme 1

Waste & Water Management

How to get the most out of it

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Content

- What to do with poo & pee?
- Water usage and grey water treatment
- Transport of human waste

- Discussion sessions
  1. Transport of human waste
  2. Grey water treatment
  3. Capacity sanitation blocks

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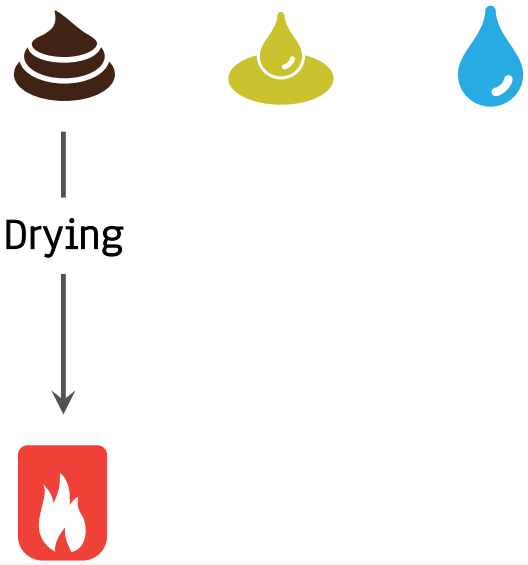
What to do with poo?



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Microwave Plasma Gasification

- Creates syngas for electricity generation
  > Potentially (beyond) self-sufficient
- Immediate elimination of pathogens
- Fast processing, limited storage
- Sterile P-rich ash for local use or export
- Modular & compact equipment

Required feed >2,000 people per day

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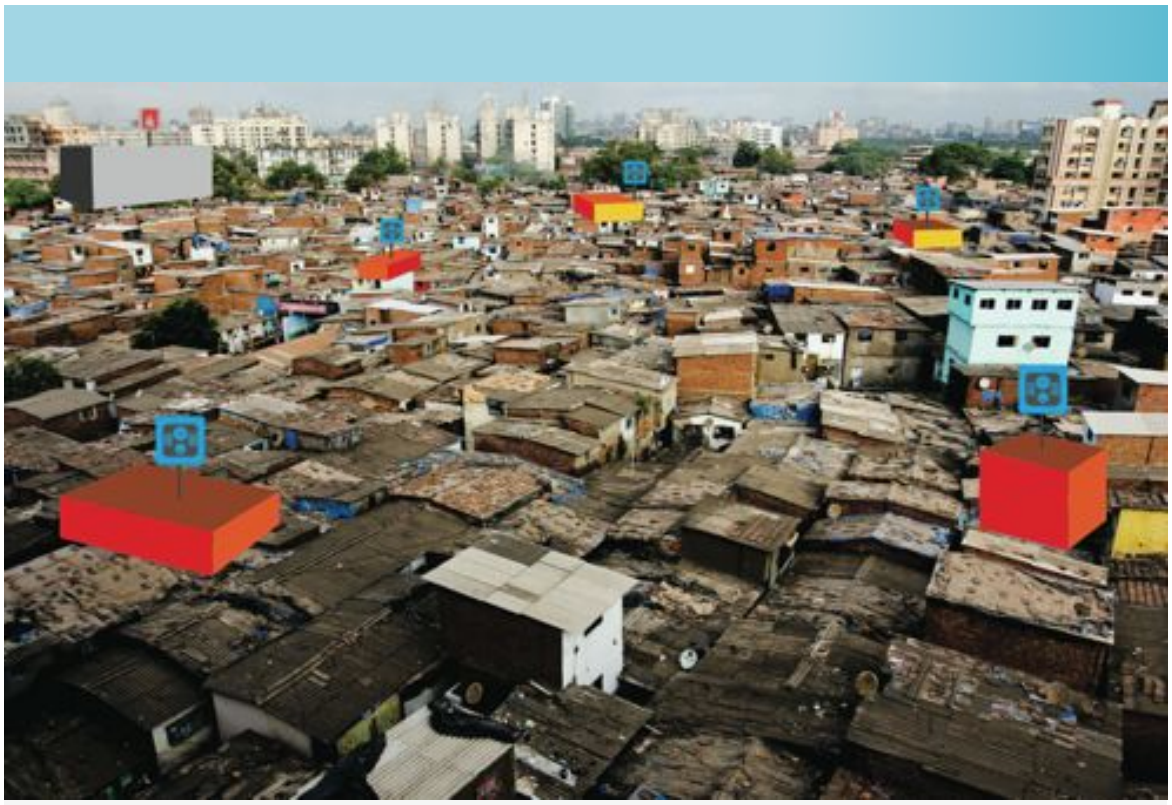

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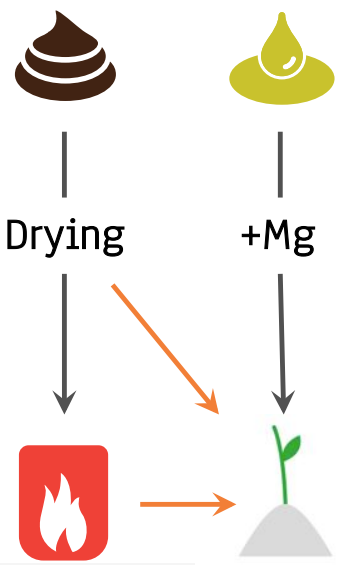
What to do with pee?



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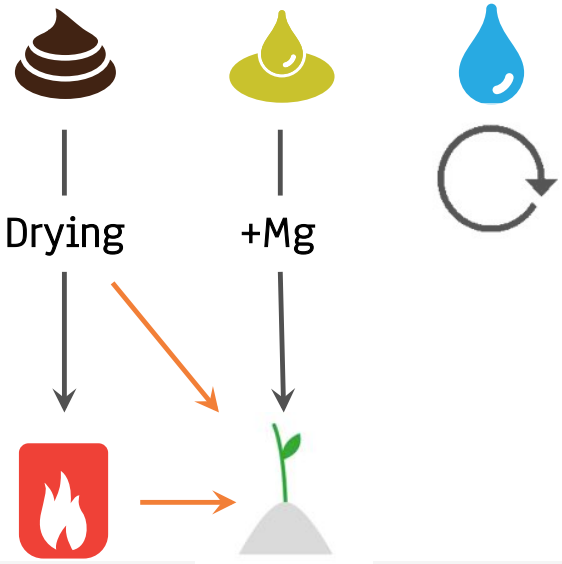
What to do with water?



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Water consumption

- Excessive use of water as part of toilet ritual India (~4 liter/person)
  - Hand washing
  - Anal cleansing
  - Maintenance
  - Other activities
- Retain & recycle, because:
  - Transport of water is not desirable
  - Reliable water supply at facilities

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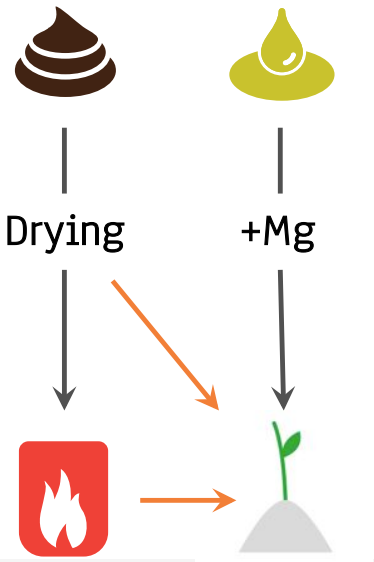
Urine diversion?



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Urine diversion?

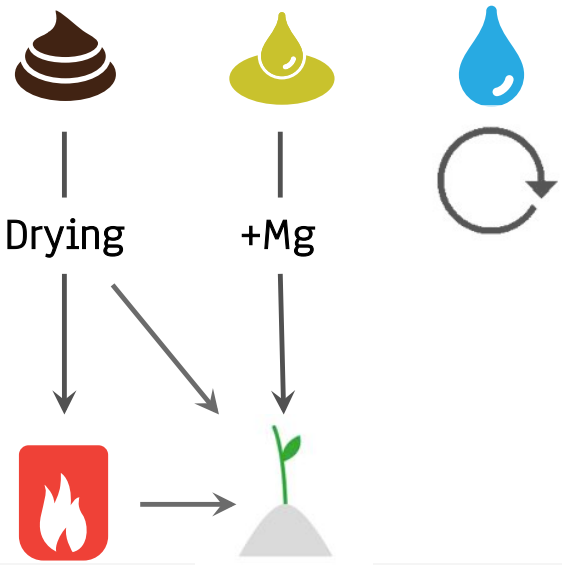
Barriers:

- Physical (gender differences)
- Technical (cross-contamination, clogging due to misuse, not easy to convey isolated feces)
- Social (user acceptance, conservative attitude others)
- Economic barriers (low market value struvite)
- Operational barriers (cleaning difficulty, additional infrastructure and transport line)

Urine diversion?

Perceived stigmatization

Urine diversion?



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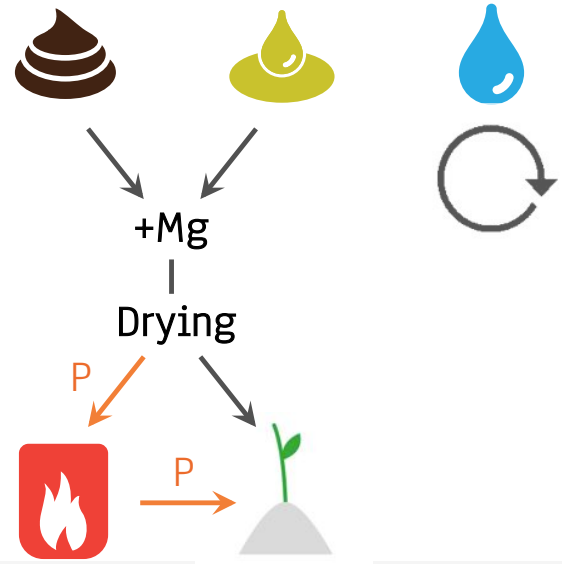
Our proposal



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Quantifying waste & water

How to determine capacity of sanitation blocks?

- Proximity
- Sharing (sense of ownership/accountability)
- Costs
- Space occupation
- Presence of caretaker & shop
- …

Quantifying waste & water

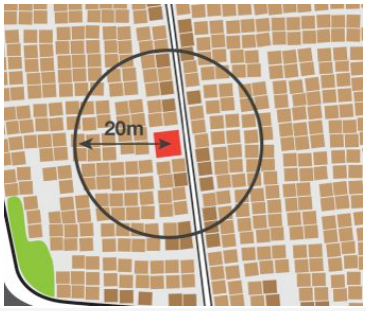
Target area: 20m radius, >400 people

Users: 70% = 300 people

Toilets: 7 (Indian governmental norm 1:50)

» 3 for men plus additional urinals

» 4 for women



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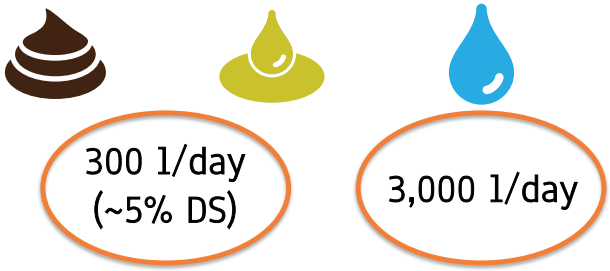
Quantifying waste & water



Visits per user: 2,5 times per day (once defecation)
Feces: 250 gram (100-300 gram)
Urine: 300 ml (100-600 ml)
Water: 2 liter (cleansing) + 2 liter (hand wash) + maintenance

Quantifying waste & water

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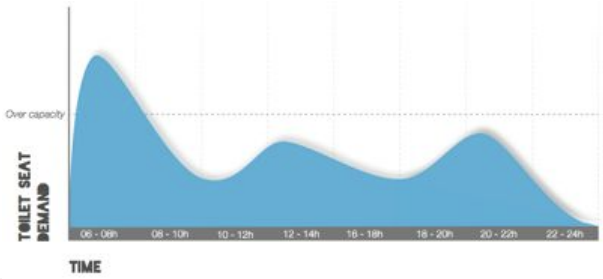
Quantifying waste & water

Peak hours (6.00am-9.00am):

- 80% of community (250p) shows up, 90% defecate
- >100 liter waste collected (~50% of daily amount)
- >300 liter/hr water consumed (~33% of daily amount)



What more can we expect?

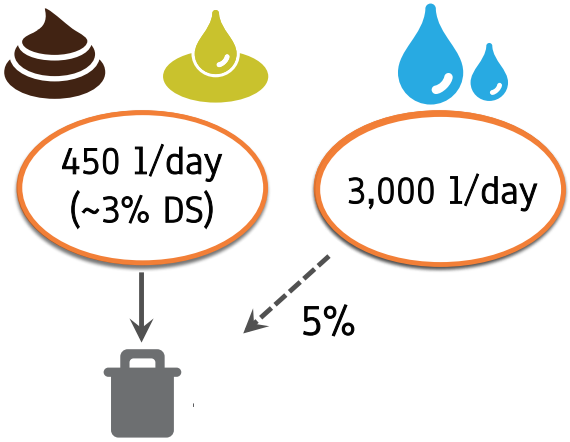
Incidental & accidental waste

Design of water diverting toilet

Why?

- Reduce transport volume
- Less dewatering
- Recycle water

Diversion efficiency is critical!



Design of water diverting toilet

How?

- Low-(or no)-tech
- Do not rely on user
- Rather, connect to beneficial activity for user

Design of water diverting toilet

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Design of water diverting toilet

Hand shower:

- Climb sanitation ladder
- Positive (new) experience
- Control water consumption

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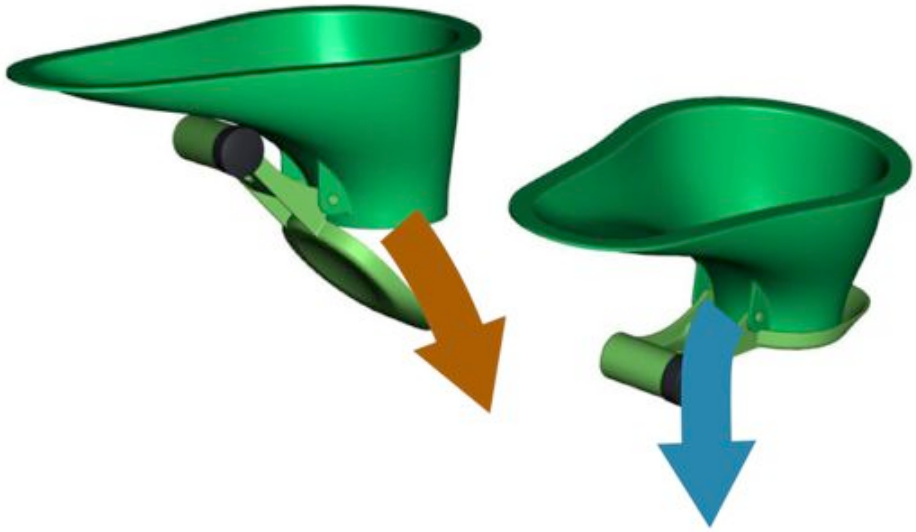
Design of water diverting toilet



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Grey water treatment

What?

Around 3,000 liter per day (toilet + taps + maintenance)

Contains: feces/urine, pathogens, blood, soaps, hormones, medicines, etc.

How?

Filtration:	Septic tank Sand filtration
Disinfection:	Passive solar (UV) disinfection

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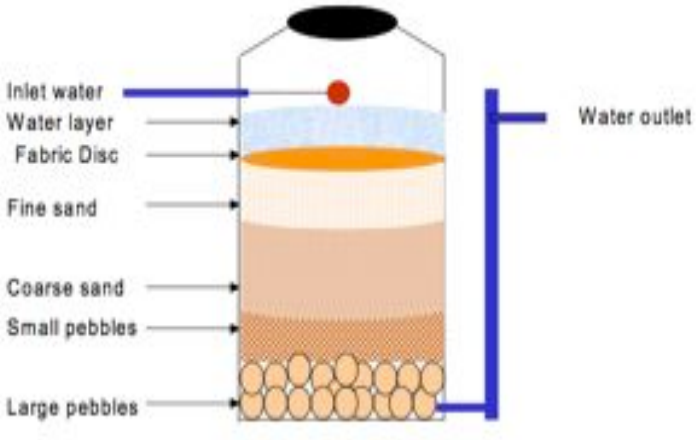
Sand filtration



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Solar disinfection

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Solar disinfection

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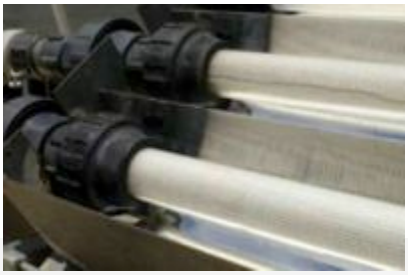
Solar disinfection + TiO2

Benefits TiO2 catalysation:

- Smaller surface area, higher flow rate
- Deactivate micro organisms



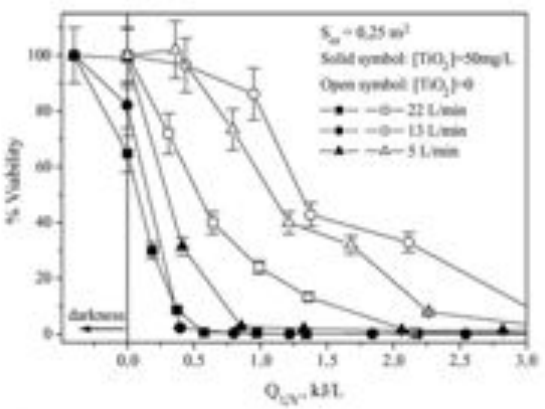


Fig. 7. Inactivation of *Escherichia coli* under solar photocatalysis $[TiO_2] = 50$ mg/L, 0.25 m^2 of irradiated surface and three flow rates: 22.5, 13.0 and 5.0 L/min (solid symbols) and for experiments made without catalyst under solar radiation (open symbols).

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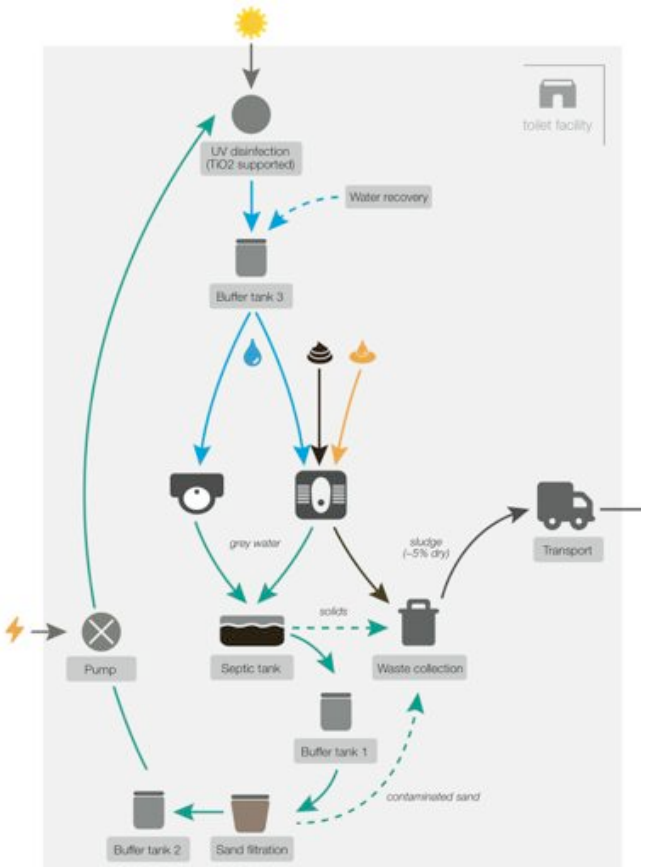
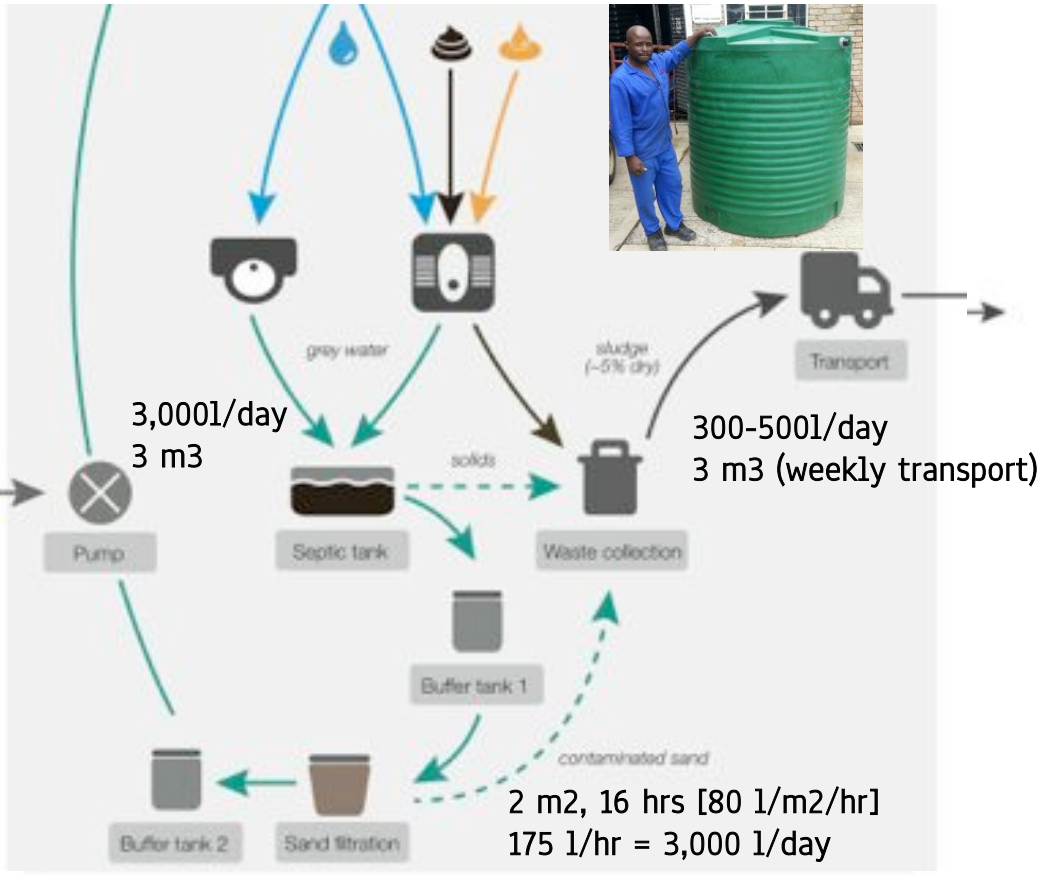
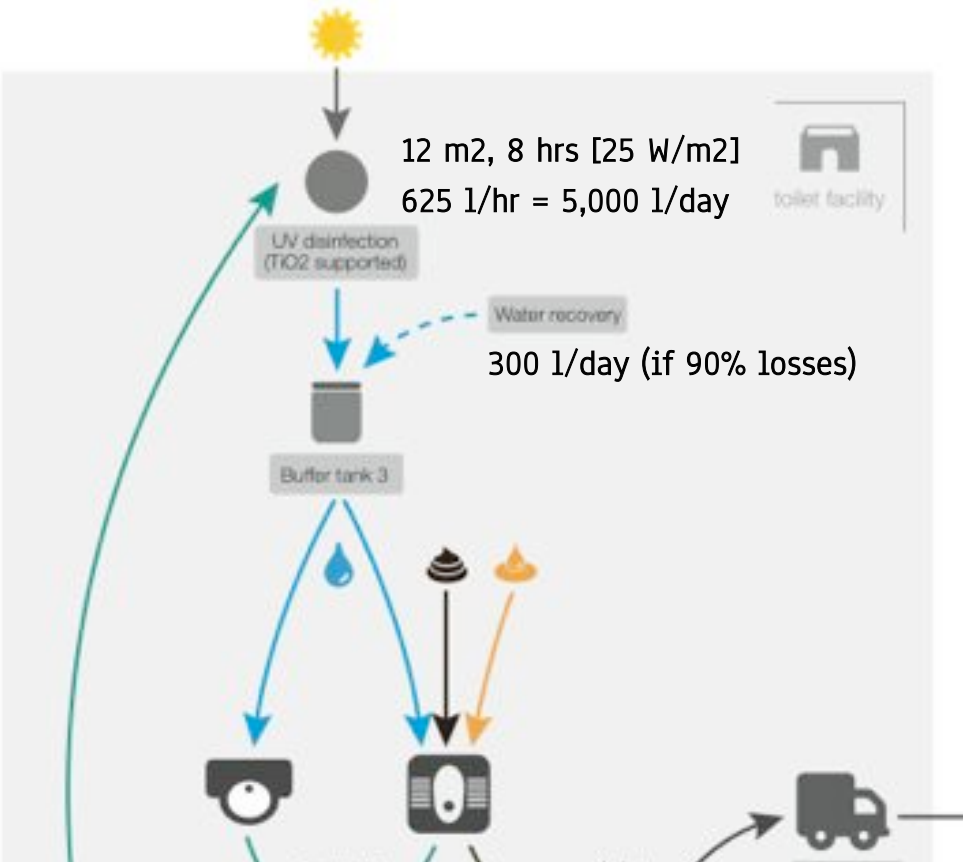
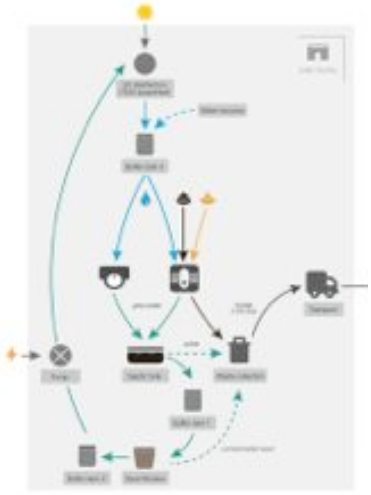
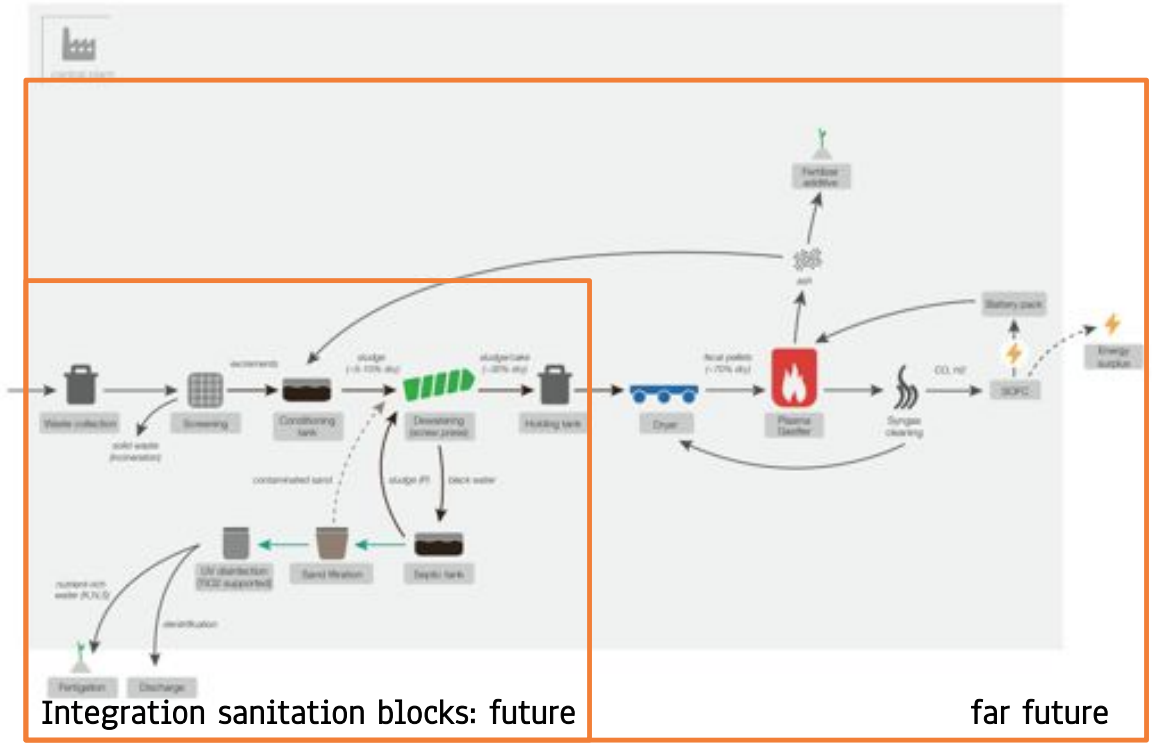

toilet facility
UV disinfection (TiO2 supported)
Water recovery
Buffer tank 3
grey water
sludge (~5% dry)
Transport
solids
Pump
Septic tank
Waste collection
Buffer tank 1
contaminated sand
Buffer tank 2
Sand filtration


grey water
sludge (~5% dry)
Transport
3,000l/day
3 m3
300-500l/day
3 m3 (weekly transport)
solids
Pump
Septic tank
Waste collection
Buffer tank 1
contaminated sand
2 m2, 16 hrs [80 l/m2/hr]
175 l/hr = 3,000 l/day
Buffer tank 2
Sand filtration


12 m2, 8 hrs [25 W/m2]
625 l/hr = 5,000 l/day
toilet facility
UV disinfection
(TiO2 supported)
Water recovery
300 l/day (if 90% losses)
Buffer tank 3





Input-output model overall system

Demand - sanitation blocks:
- Water pump(s), lights, etc.
- Water replenishment

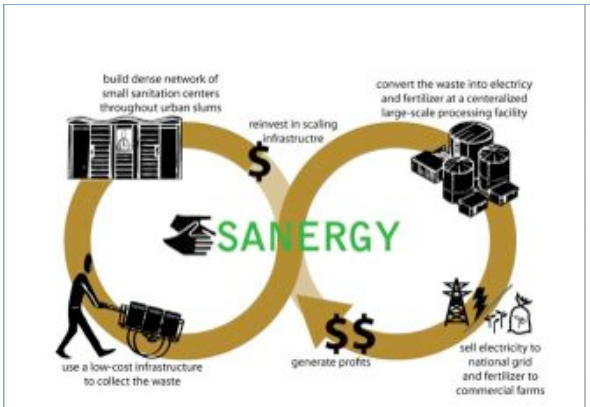
Supply - sanitation blocks:
- Human waste (poo+pee)

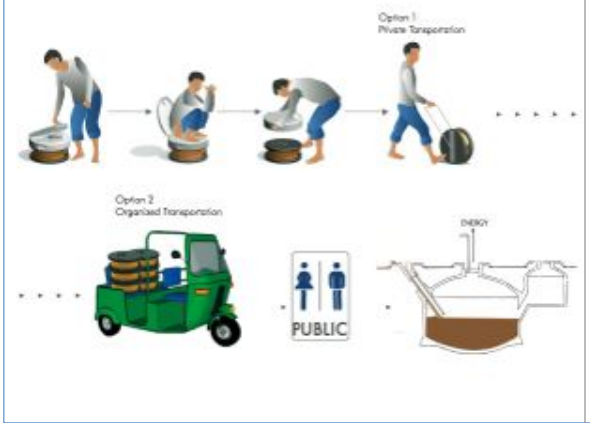
Demand - central plant:
- Plasma gasifier
- Drier
- Conditioner, screw press

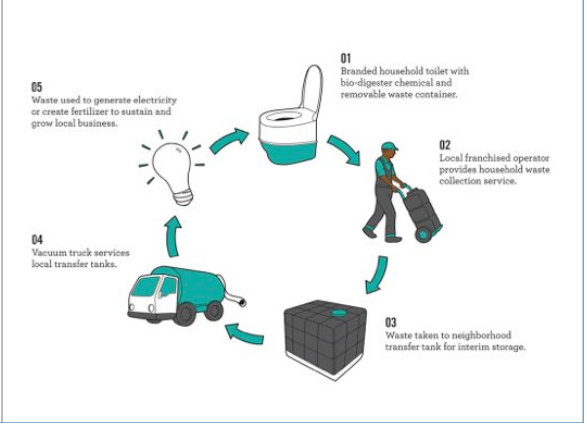
Supply - central plant:
- Electricity
- Surplus (heat, gas, electr.)
- P-rich ash
- K,N,S-rich water

Demand - plant/external:
- Agriculture
- MFC?

Transport of human waste







What reality looks like

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What reality looks like

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Considerations

What?

~300-500 l/day (~5% DS) for a 7-toilet sanitation block

How?

- Feasible within the narrow streets of urban slums
- Safe for workers and community
- Non-stigmatizing (looks, smell, etc.)
- Profitable:
  - Who is in charge?
  - Frequency of collection?
- …

Discussion #1

Transport of human waste

1. What are important considerations when transporting human waste in urban slums in India?
2. Given these considerations, what are best practices or new practices?
3. How to make a business out of transport of human waste when there is little money available?

Discussion #2

Grey water treatment

1. What is the technical feasibility of sand filter, UV as well as fully integrated system? (O&M)
2. What is the economic viability of this system?
3. Will people accept water that is recycled?

Discussion #3

Capacity sanitation blocks

1. How many users and visits per user can be expected, how many toilets are needed? (consider genders)
2. How to anticipate to the uncertainty of waste & water quantities?
3. Can water consumption (cleansing, flushing, hand washing) be reduced in “washer” cultures like India?