



Lifecycle cost comparison of fecal-sludge and sewer based sanitation systems in India

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Acknowledgements

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Limited understanding of capital and operational costs of sanitation infrastructure in India

- What are the **range of costs** for fecal sludge (FS) and sewer-based (SB) sanitation service provision?
- What are the **key cost drivers** for FS and SB sanitation?
- At what **project stage** (capital vs operational) are costs incurred?
- Where along the **sanitation service chain** drives costs for FS and SB sanitation?





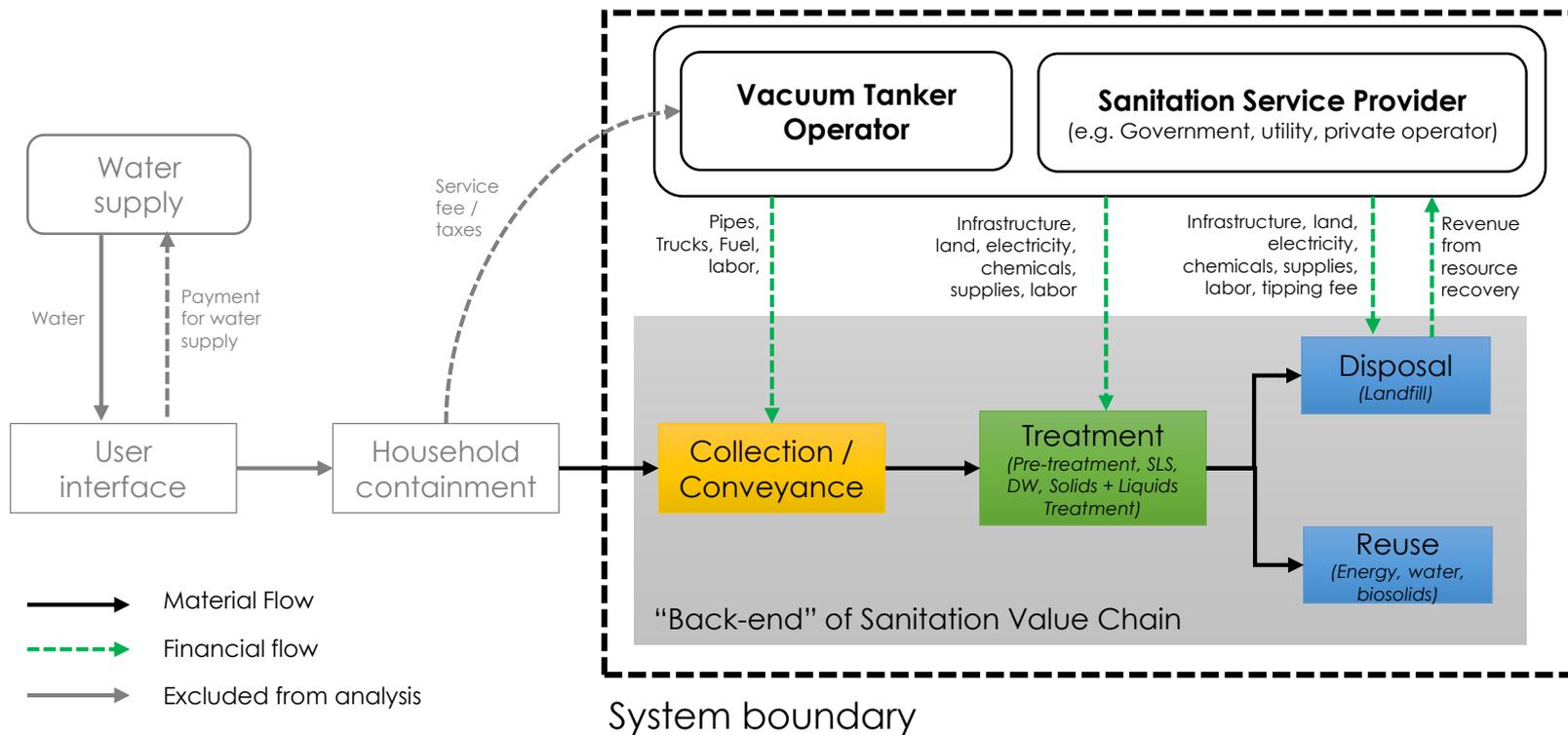
Methodology



- Defined eight sanitation 'model systems' relevant in India (4 FS, 3 SB, 1 CT)
- Developed an excel-based, dynamic cost tool to estimate annual per-capita costs based on conceptual level engineering designs
- Collected data from operational FS and SB sanitation systems in India to calibrate and validate the cost tool



System boundary includes costs incurred by service provider





Model system overview

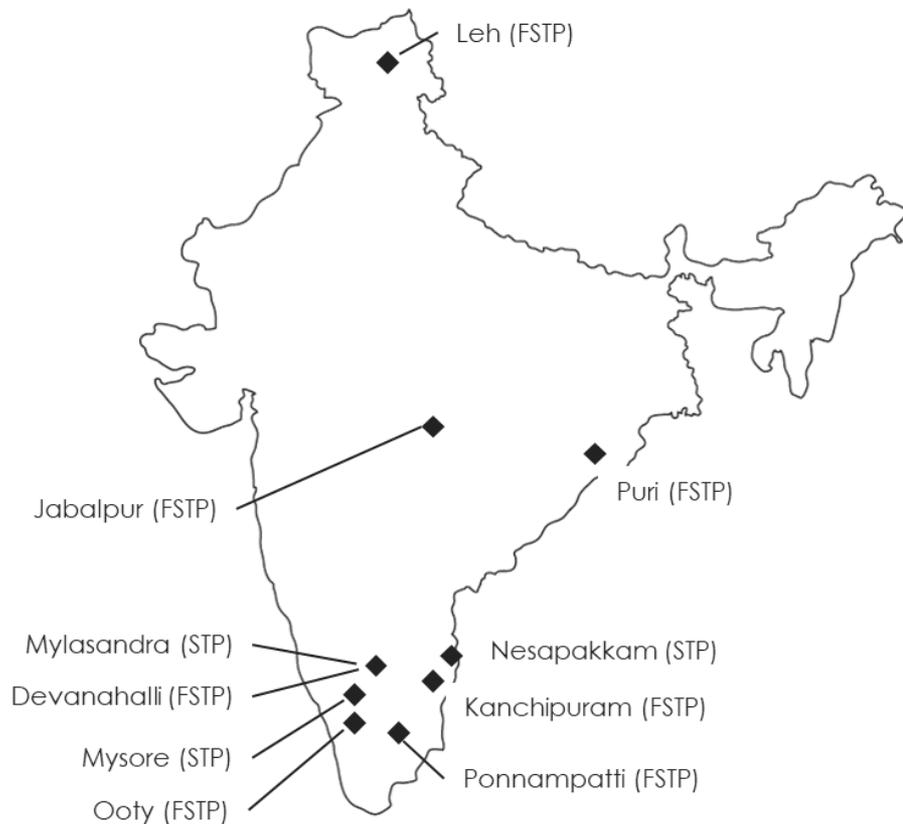
No.	Collection	Solids Treatment	Liquids Treatment	Disposal / End-Use	Population range
FS-1	Vacuum Truck	Sludge Drying Bed	Waste Stabilization Pond	Land apply	5K – 200K
FS-2	Vacuum Truck	Sludge Drying Bed + Composting	Waste Stabilization Pond	Compost	5K – 200K
FS-3	Vacuum Truck	Anaerobic Digestion + Sludge Drying Bed + Composting	Aerated Waste Stabilization Pond	Compost, Biogas	50K – 1M
FS-4	Vacuum Truck	Mechanized Dewatering	MBBR + Chlorination	Landfill	200K – 2M
SB-1	Sewer	--	Aerated Waste Stabilization Pond	Land apply	5K – 200K
SB-2	Sewer	Mechanized Dewatering	Activated Sludge WWTP	Landfill	200K – 2M
SB-3	Sewer	Mechanized Dewatering + Anaerobic digestion	Activated Sludge WWTP	Biogas, Landfill	200K – 2M
CT-1	Vacuum Truck + Sewer	Mechanized Dewatering	Activated Sludge WWTP	Landfill	200K – 2M

Complexity ↓

Footprint (land) ↑



Financial data collected from 7 FSTPs, 3 STPs and 1 CT system in India



Operational system	Type and design capacity
Kanchipuram, Tamil Nadu	FSTP (23 KLD)
Ooty, Tamil Nadu	FSTP (36 KLD)
Ponnampatti, Tamil Nadu	FSTP (2 KLD)
Leh, Ladakh	FSTP (12 KLD)
Puri, Orissa	FSTP (50 KLD)
Devanahalli, Karnataka	FSTP (6 KLD)
Jabalpur, Madhya Pradesh	FSTP (50 KLD)
Mysore, Karnataka	CT (68 MLD)
Nesapakkam, Chennai	STP (40 MLD & 54 MLD)
Mylasandra, Bangalore	STP (70 MLD)

FSTP: Fecal sludge treatment plant; STP: Sewage treatment plant; CT: Co-treatment



Results – dynamic tool allows for varying assumptions

Model results presented are based on a particular set of “baseline” assumptions, including:

- Defined fecal sludge and sewage characteristics
- No cost for land
- No cost for solids disposal
- System lifespan = 30 years

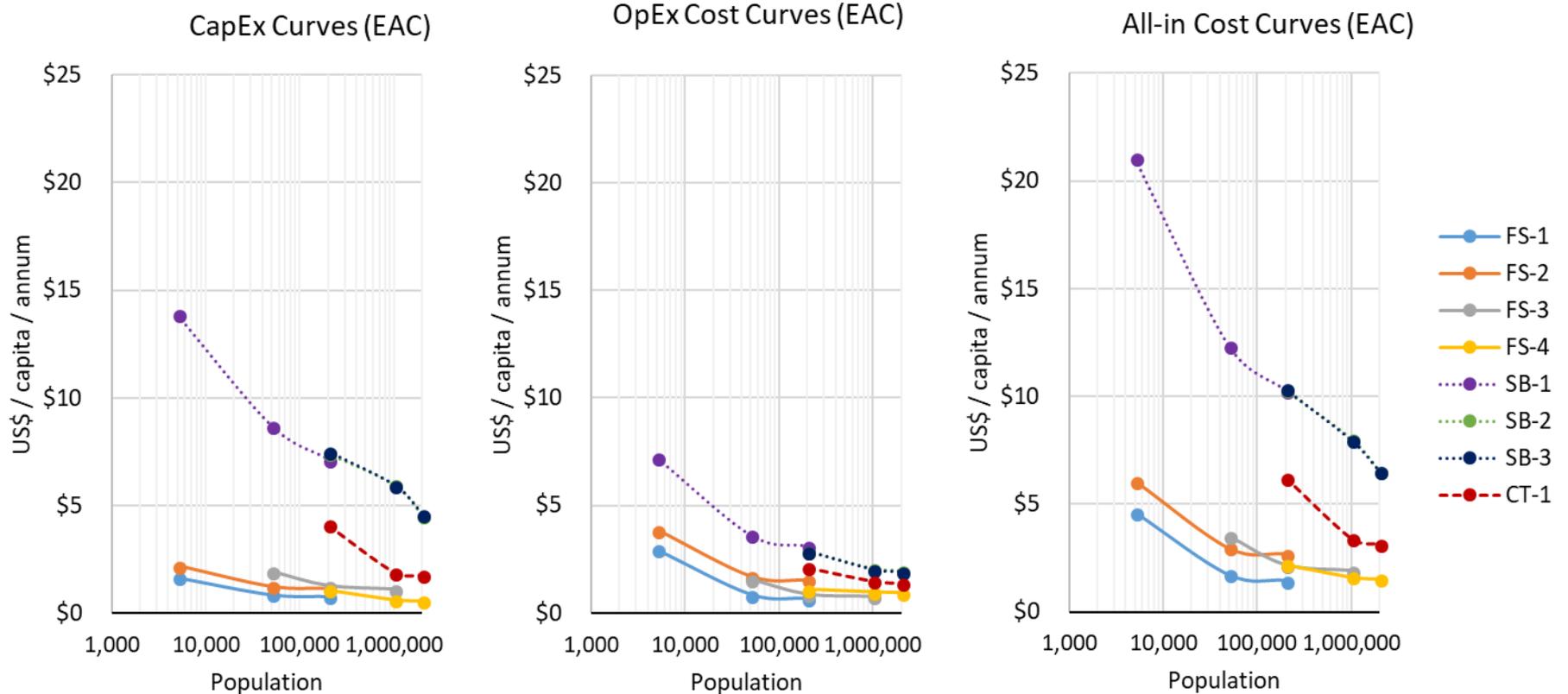
The static results shown in the following slides should only be interpreted as one possible outcome.



Cost Framework Screenshot

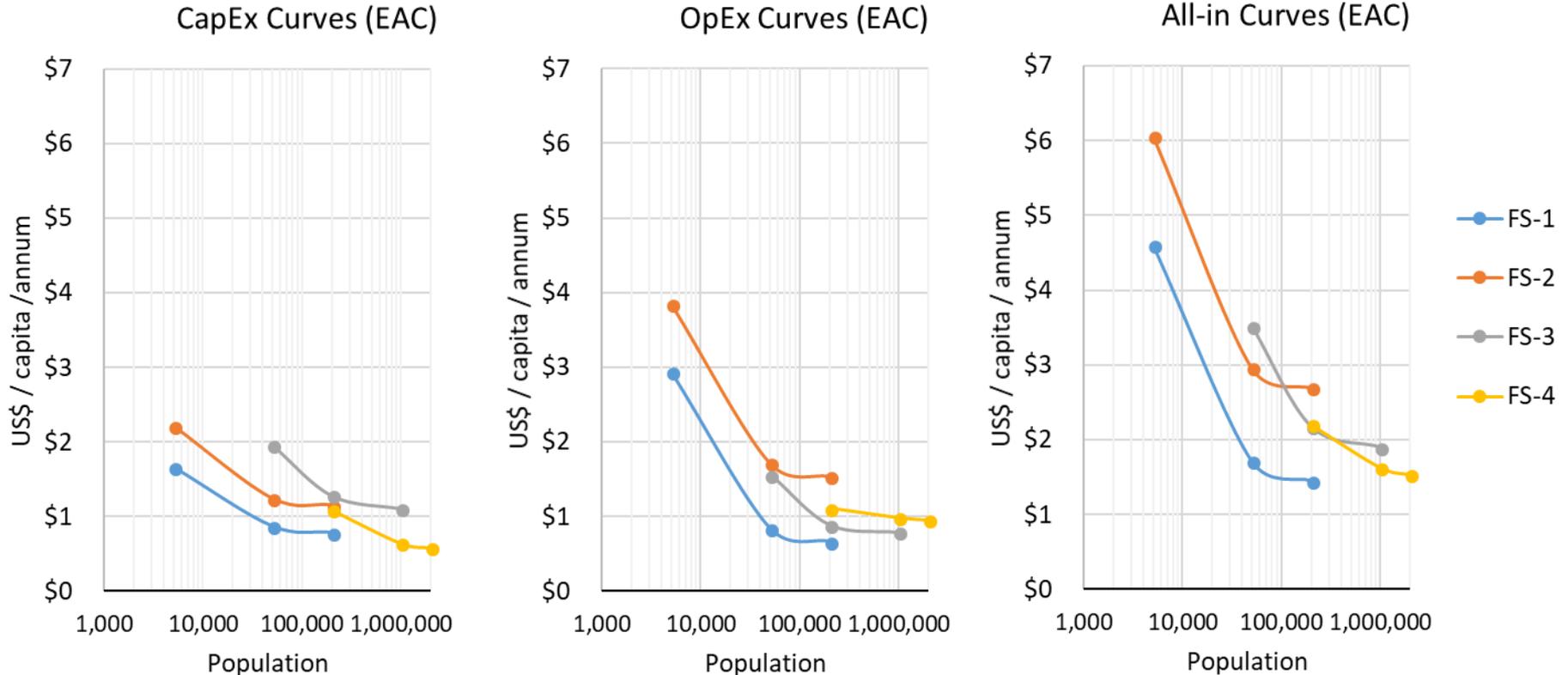


Higher per-capita CapEx, OpEx, and All-In costs for SB models compared to FS models





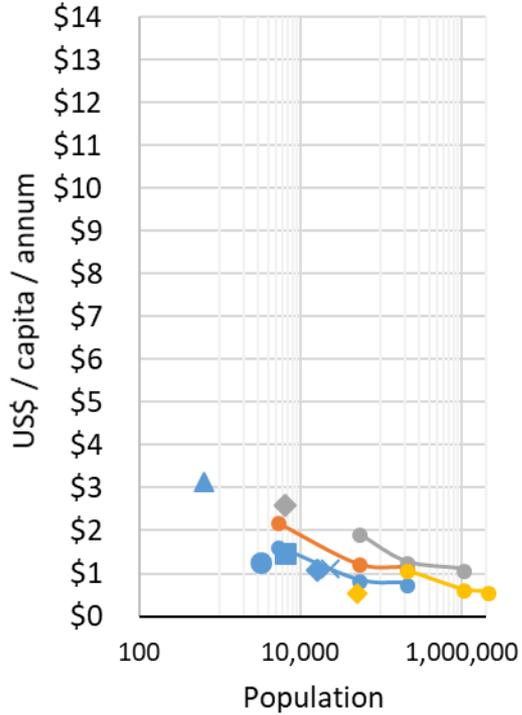
FS-1 (most basic model) is lowest cost option, however land cost not included



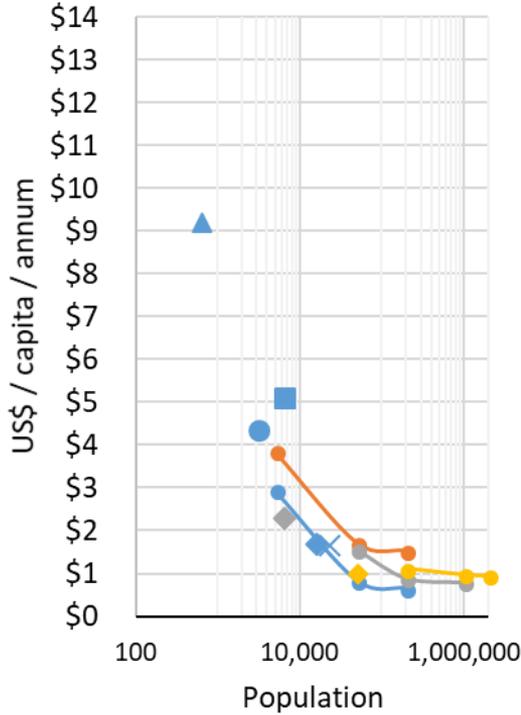


Modeled curves generally align with data collected; Model FS-1 most commonly observed

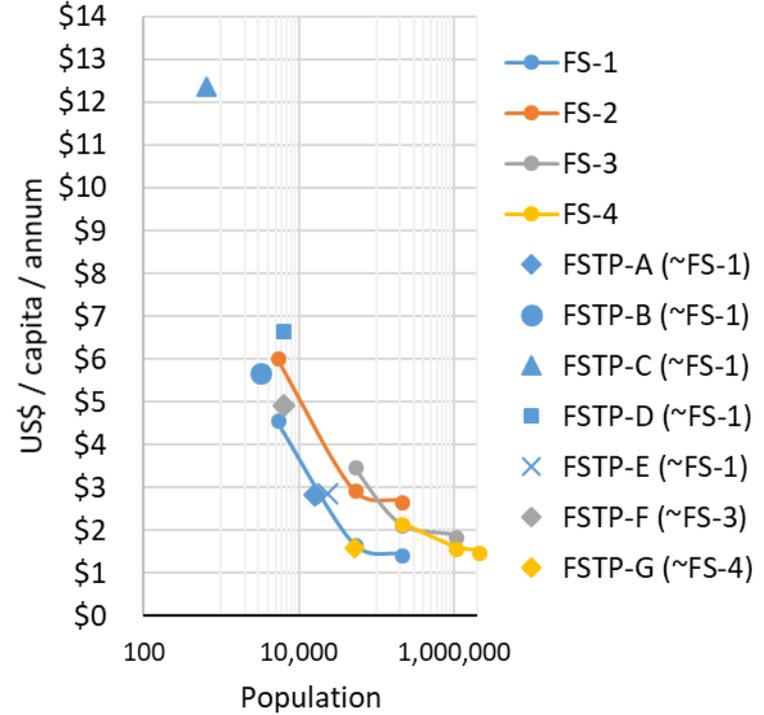
CapEx Curves (EAC)



OpEx Curves (EAC)



All-in Curves (EAC)

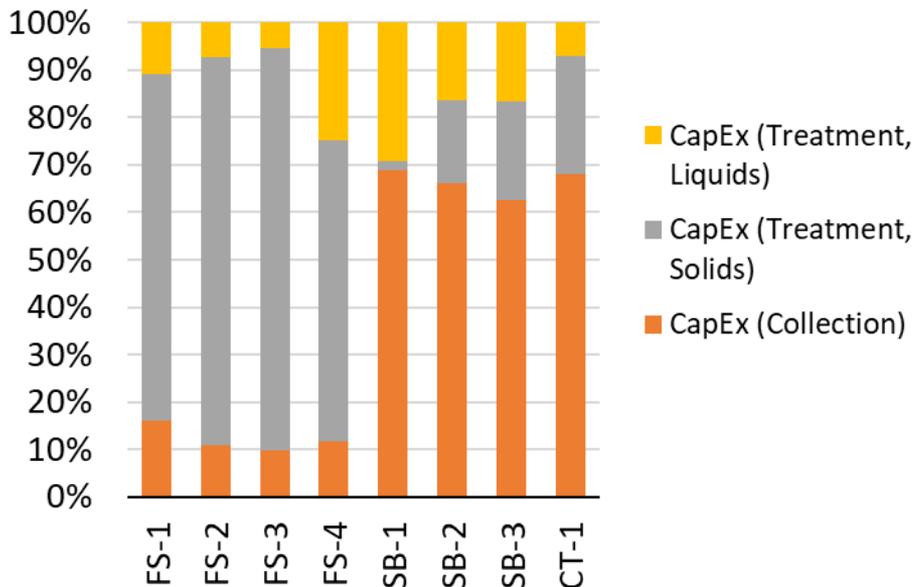




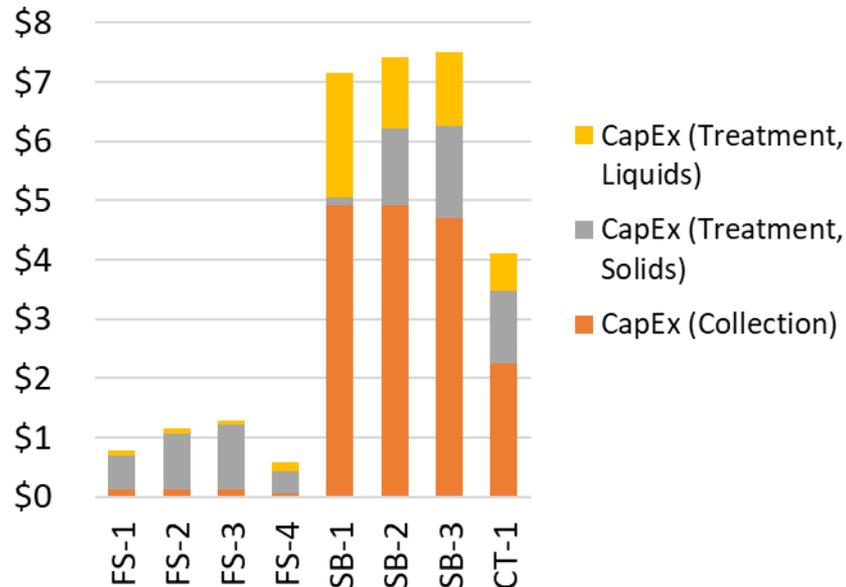
Differing CapEx drivers for FS & SB systems

- **FS models: solids treatment** (~75% of CapEx)
- **SB models: collection** (~65% of CapEx)

CapEx – Proportional costs (Pop. 200K)



CapEx – Absolute costs (Pop. 200K)

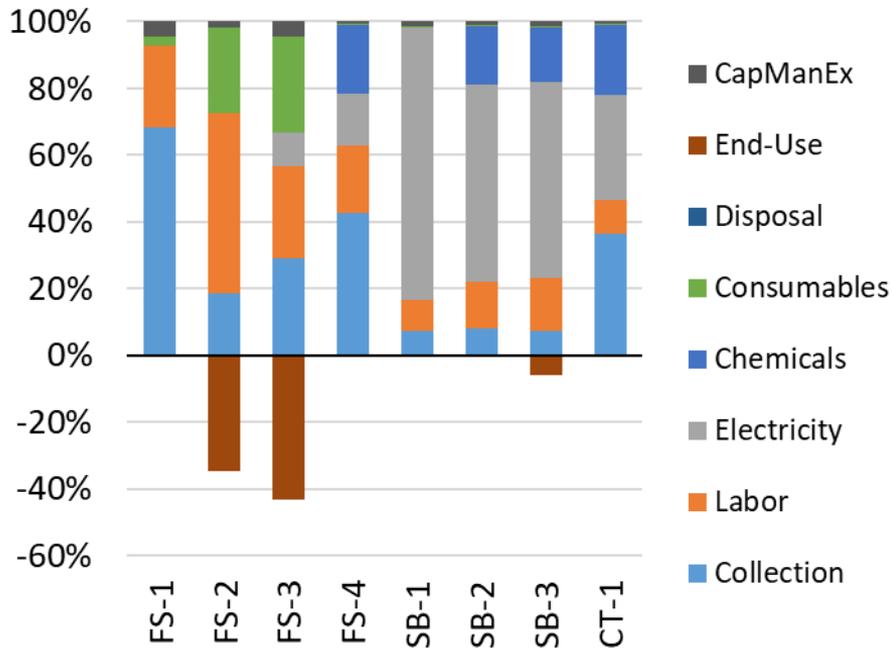




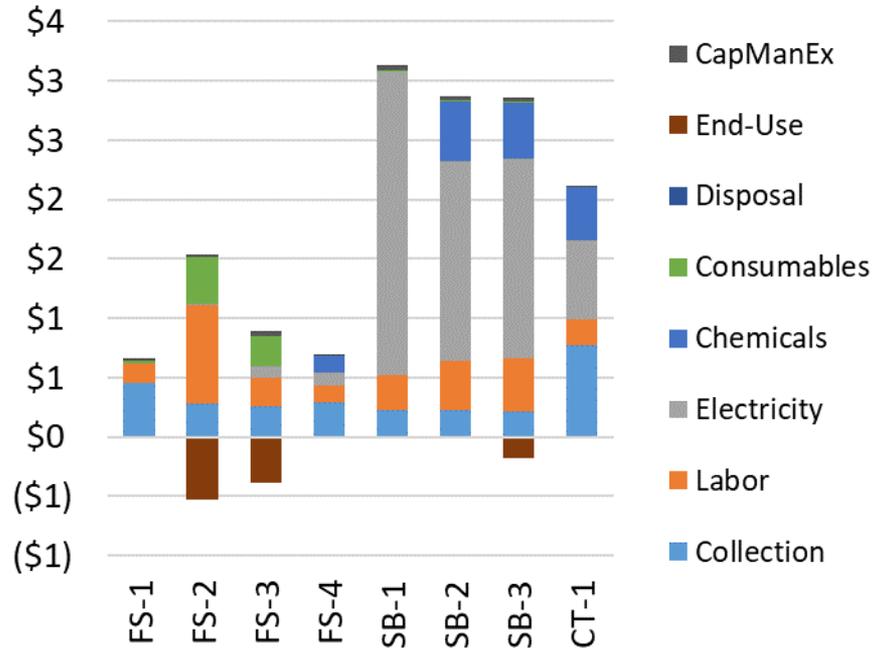
Differing OpEx drivers for FS & SB systems

- **FS models**: **collection & labor** (~60% to 90% of OpEx)
- **SB models**: **treatment** (electricity) (~65% of OpEx)

OpEx – Proportional Costs (Pop. 200K)



OpEx - Absolute costs (Pop. 200K)

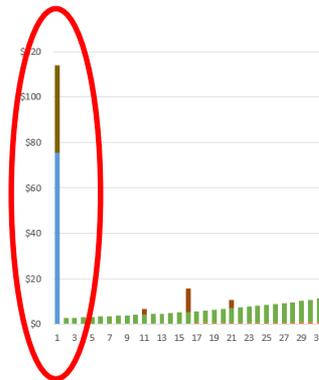




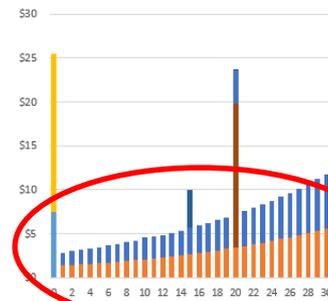
Points to remember

- Absolute per-capita CapEx, OpEx and All-In costs generally higher for SB vs FS models
- Costs are incurred at different infrastructure stages (capital investment vs operations) for SB vs FS models
- Sanitation service chain cost drivers differ for SB vs FS models and are also dependent on infrastructure stage

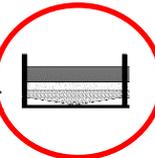
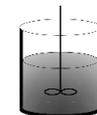
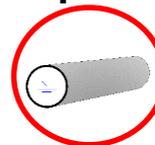
Sewer-Based



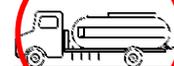
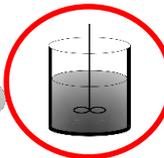
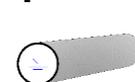
Fecal Sludge



CapEx



OpEx





Limitations & future work

- Cost model and results applicable in the Indian context only
- Cost model includes a finite number of sanitation models and resource recovery options.
- Containment at the household level is not included in the model. This cost is typically borne by the household, and is important to understand overall costs of sanitation provision.





Full Report & Cost Framework Tool available

<http://stepsforsanitation.org/resource-center/omni-processor-technology/all-resources/#techno-assessment>



TEA Report

Download Resource



Cost Framework Tool

Download Resource



Thank you!



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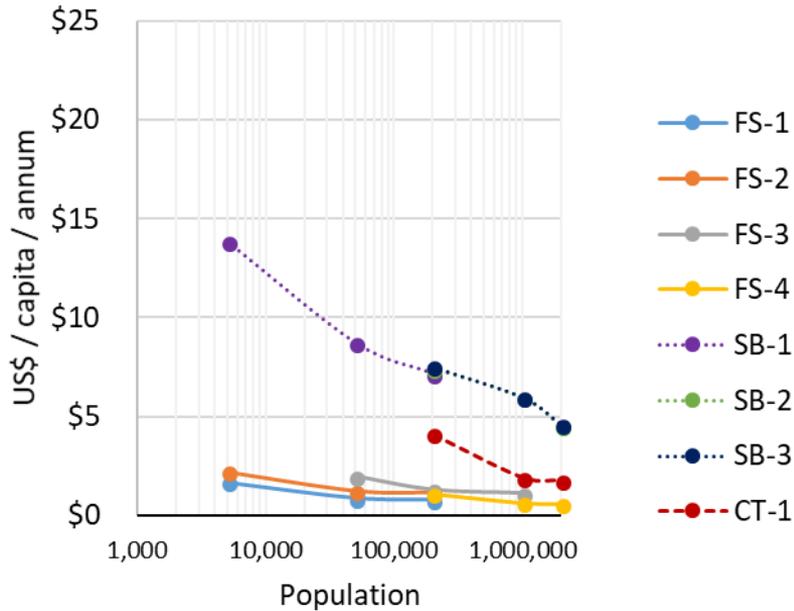


Additional slides

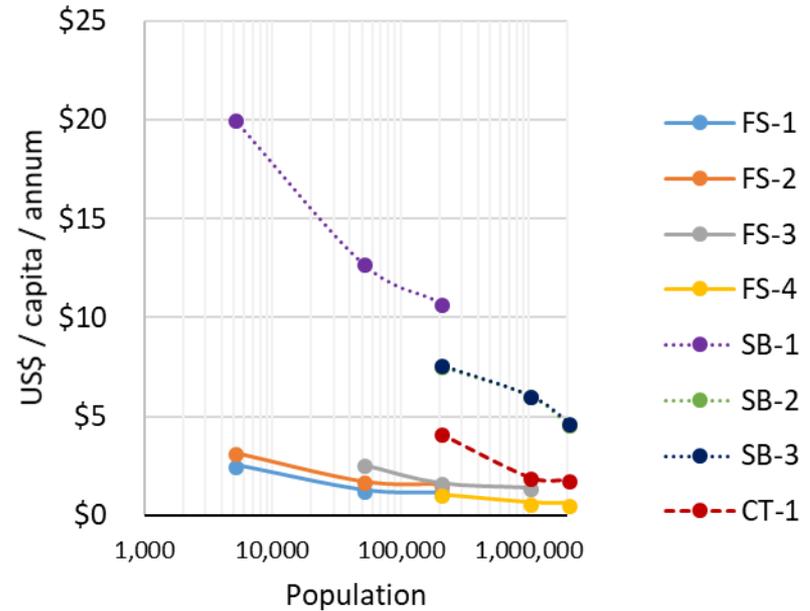


Land cost can significantly increase CapEx for extensive treatment systems

CapEx + Land Cost Curves (EAC)
Land Cost = \$0 USD/m²

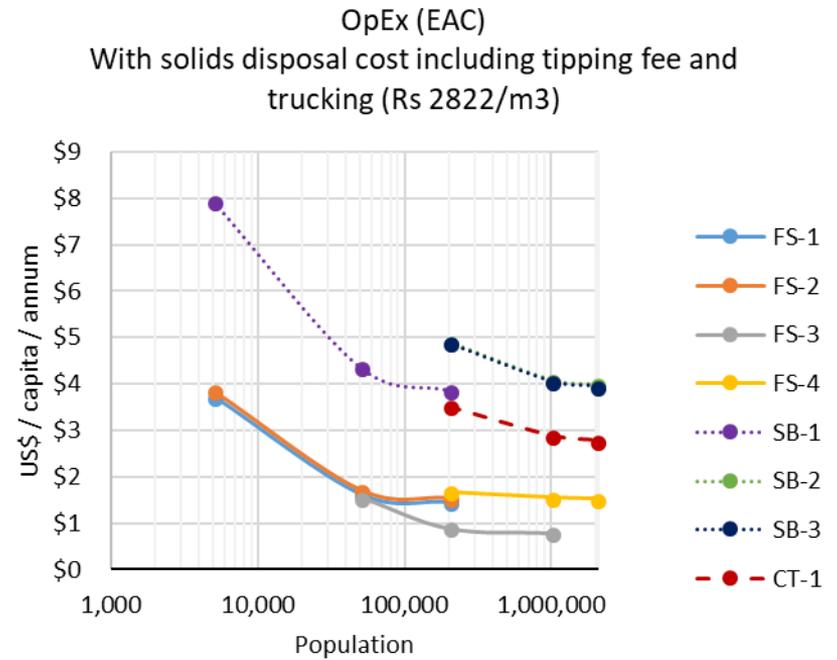
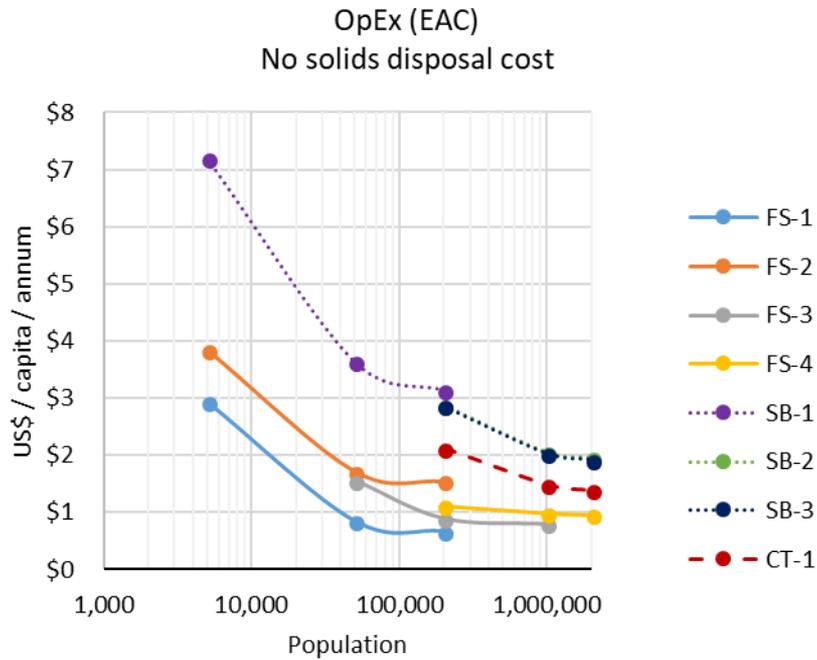


CapEx + Land (EAC)
Land Cost = \$50 USD/m²





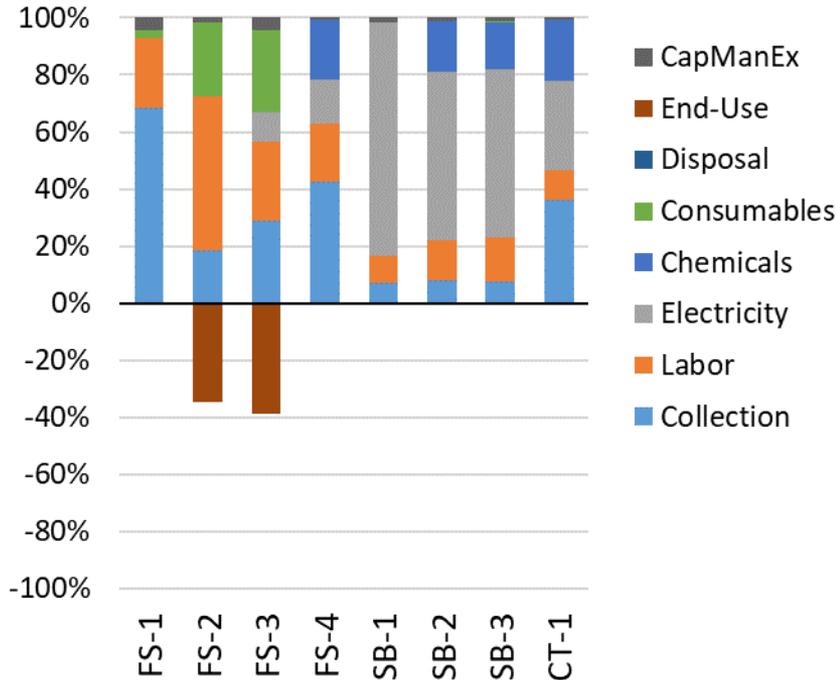
Solids disposal cost can significantly increase OpEx, particularly for SB systems



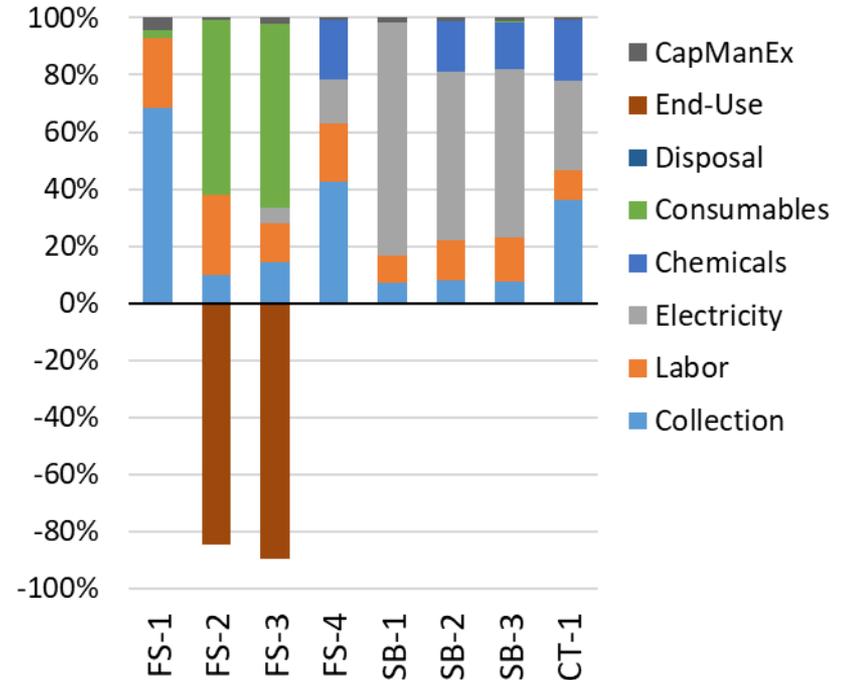


Compost value significantly impacts treatment OpEx

OpEx Breakdown (200K Pop.)
Compost Value = 1.5 Rs/kg



OpEx Breakdown (200K Pop.)
Compost Value = 7 Rs/kg

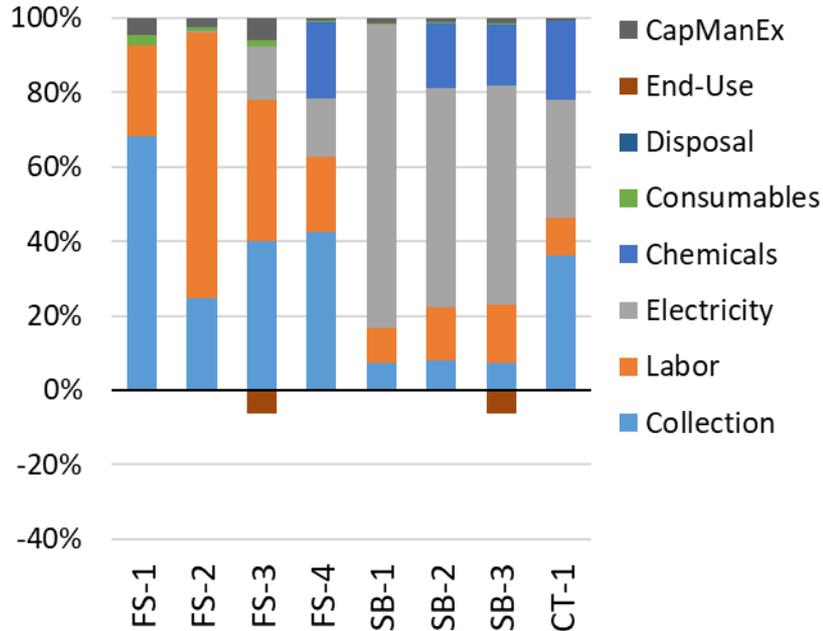




Biogas recovery value only moderately impacts treatment OpEx

OpEx Breakdown (200K Pop.)

Biogas value = 200Rs/mmBtu, based on the price of raw natural gas



OpEx Breakdown (200K Pop.)

Biogas value = 825Rs/mmBtu, based on price of electricity, 40% eff.

