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Small-Scale Sanitation Scaling-Up (4S) in South Asia: Findings and Recommendations from Two Years of Field Research

Small-Scale Sanitation Systems & Utility Model Learning Session
Bill & Melinda Gates Foundation, 17-18 July 2018

Lukas Ulrich and Manas Rath

Project Partners

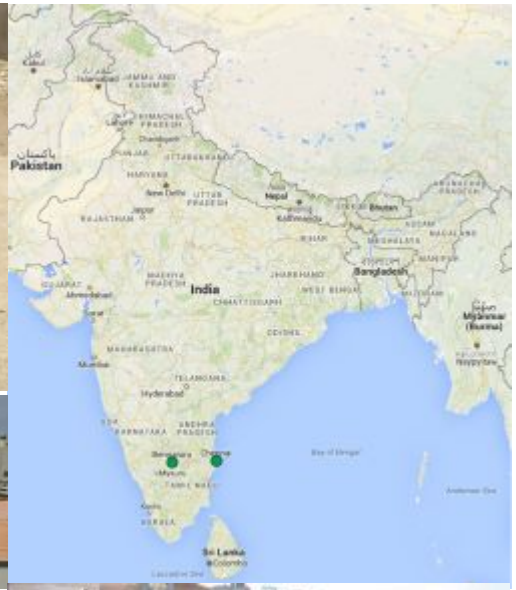
Funding

South Asia: A Sanitation Hotspot

Large population – rapid urbanisation – daunting water challenges

India

- Nearly 600 million practice open defecation
- Strict discharge standards, but only 37% urban WW treated
- Massive government initiatives
  - Swachh Bharat (ODF till 2 October 2019), AMRUT,[1] Smart Cities[2]
  - Andhra Pradesh & Telangana states: building 76 + 72 FSTPs
  - 2006 MoEF Policy: STP for construction projects >20'000 m^2
- BMGF working with 60+ partners in India, focus FSM, BCC, capacity building



https://www.indiatoday.in/mail-today/story/aap-delhi-drain-cleanup-yamuna-najafgarh-drain-israeli-firm-roped-in-959571-2017-02-08

Bangladesh

- 61% access to improved sanitation in 2015 (+28% since 2003)
- 99% ODF

[1] Atal Mission for Rejuvenation and Urban Transformation – includes urban sewerage and water supply
[2] Sustainable development of 100 cities – includes application of smart solutions to infrastructure and services, e.g. water recycling

Small-Scale (Decentralised) Sanitation…

India:
20'000+ Systems
300+ Companies

Nepal:
60+ Systems

Flexible Comple-me ntation of Large-Scale Systems

Targeted Pollution Abatement

Freshwater Saving Through Reuse

… requires a roadmap for scaling-up









Why this Project?

- Previous research focused mostly on technology, not management
- Continuously increasing numbers of small systems
- Sanitation as policy priority of South Asian governments
- Interest in viability of small-scale systems in comparison with conventional approaches

4S Objectives

Investigate technical, financial & management performance of existing small-scale sanitation systems

Develop a cause-impact framework for the success & failure of small-scale sanitation systems

Investigate the management & institutional schemes required for effectiveness, & how to include the private sector

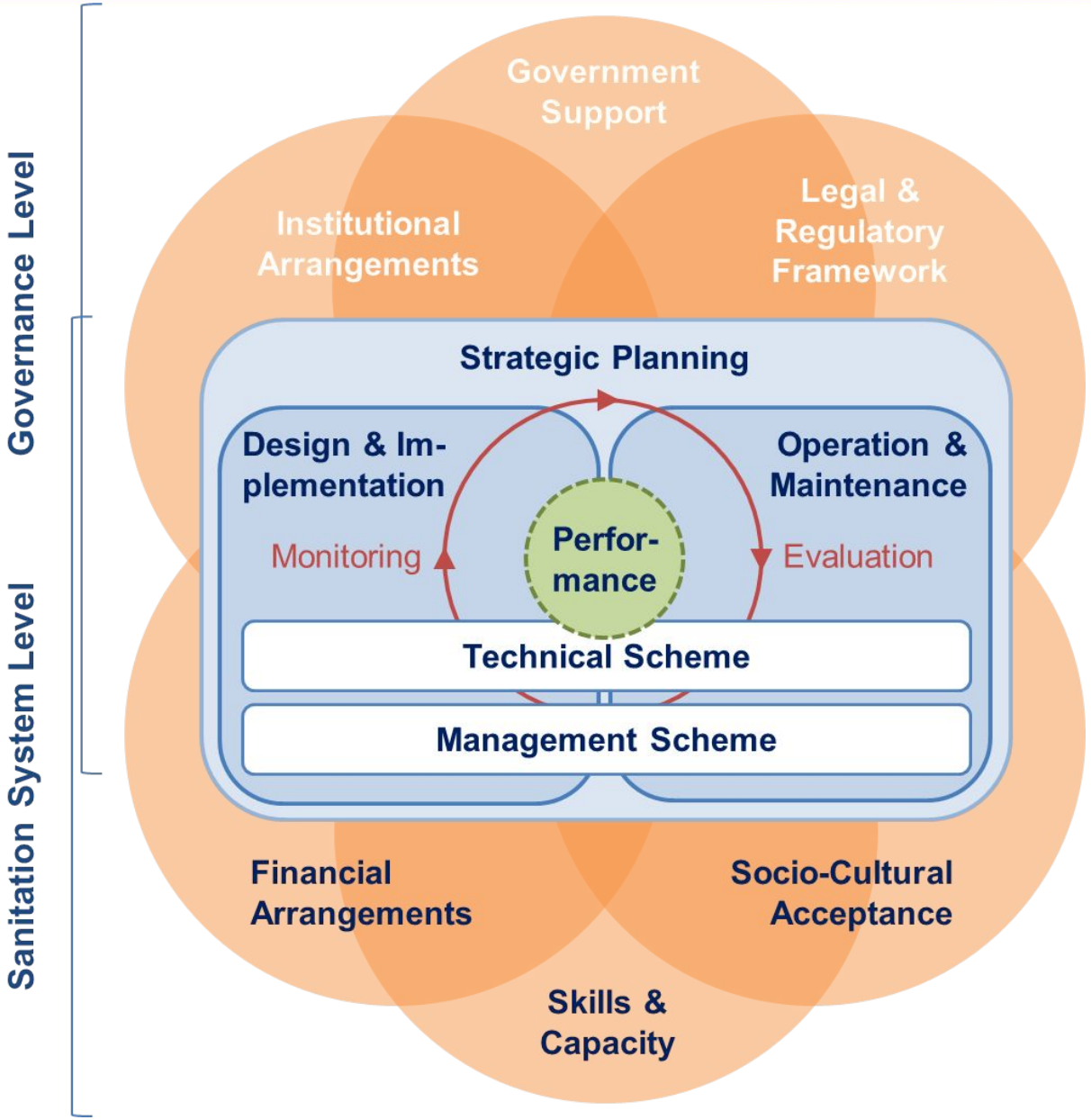
Carry out a simplified comparative cost-benefit analysis, incl. cap., op. & asset maint. requirements for varying scales

Determine in which contexts a small-scale approach is optimal & sustainable

Develop policy recommendations for scaling-up

Approach and Methods

1. Landscape Study
2. Basic Assessment of Systems
3. In-Depth Analysis of Performance
4. Policy, Institutional and Governance Analysis
5. Financial Analysis

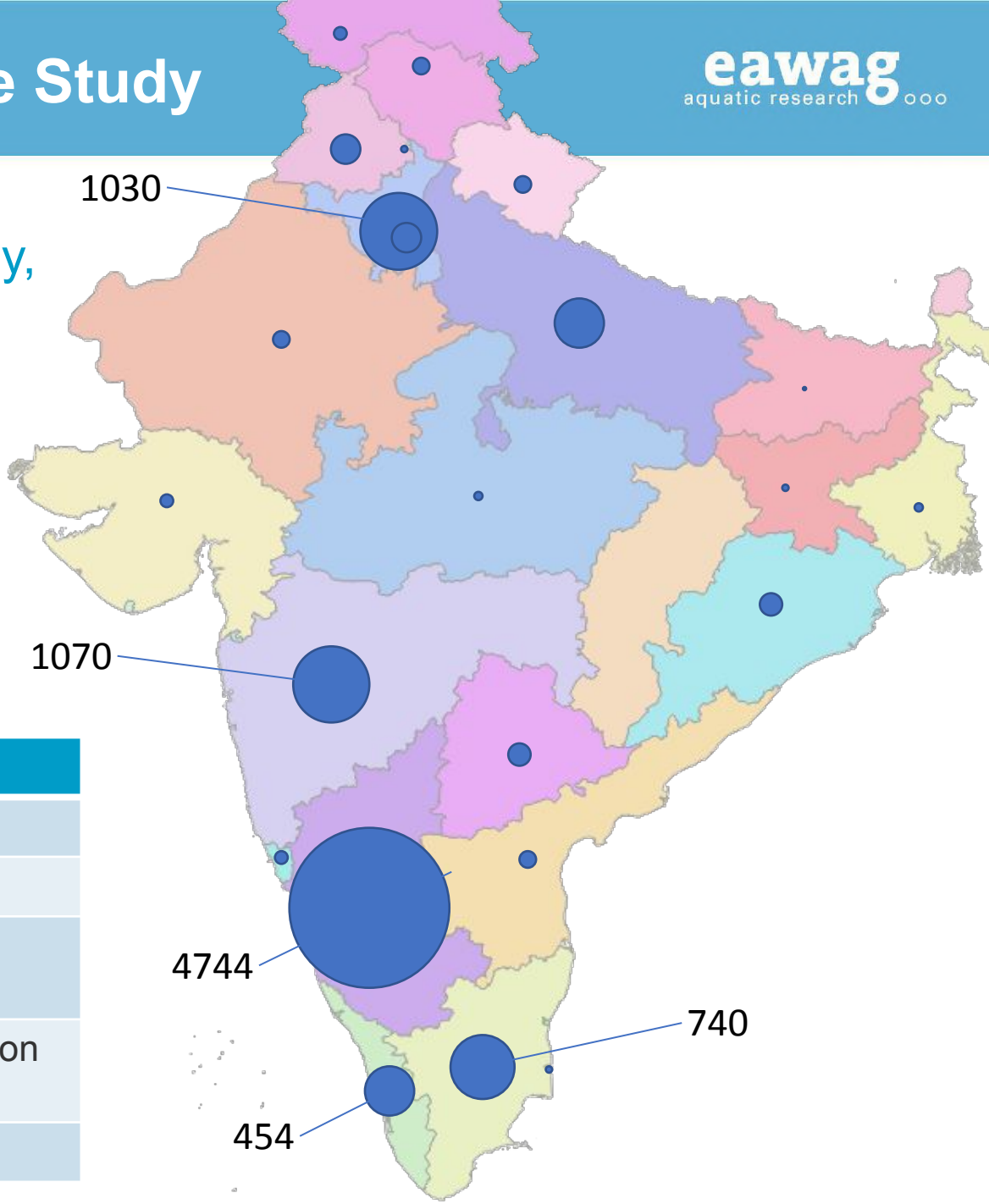


Results – Landscape Study

Small-scale sanitation systems in India: How many, where and why?

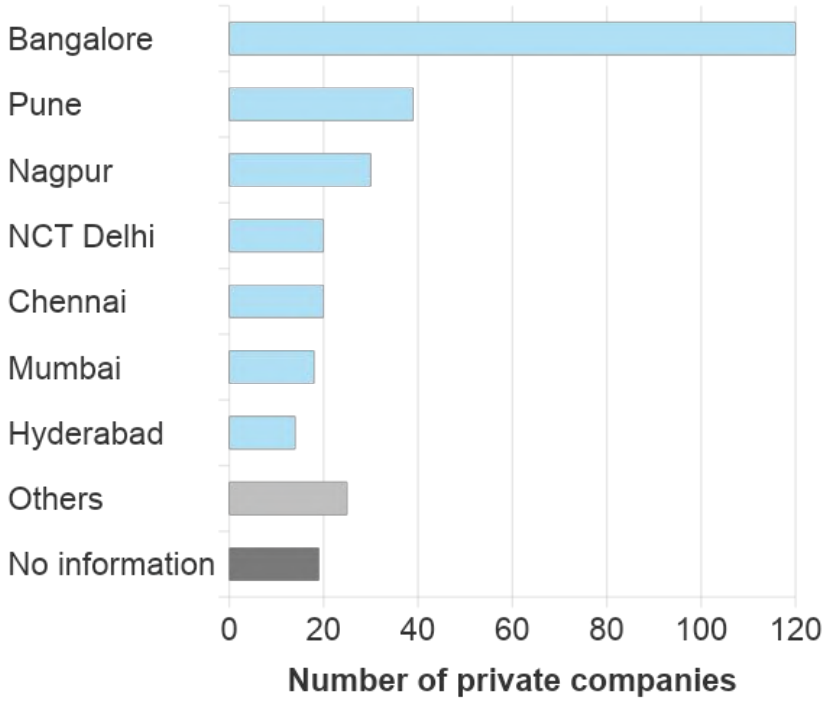
- Found: **9'442** >5/day
- Existing: **>20'000**?
- Poor documentation
- Private sector: **309** companies found

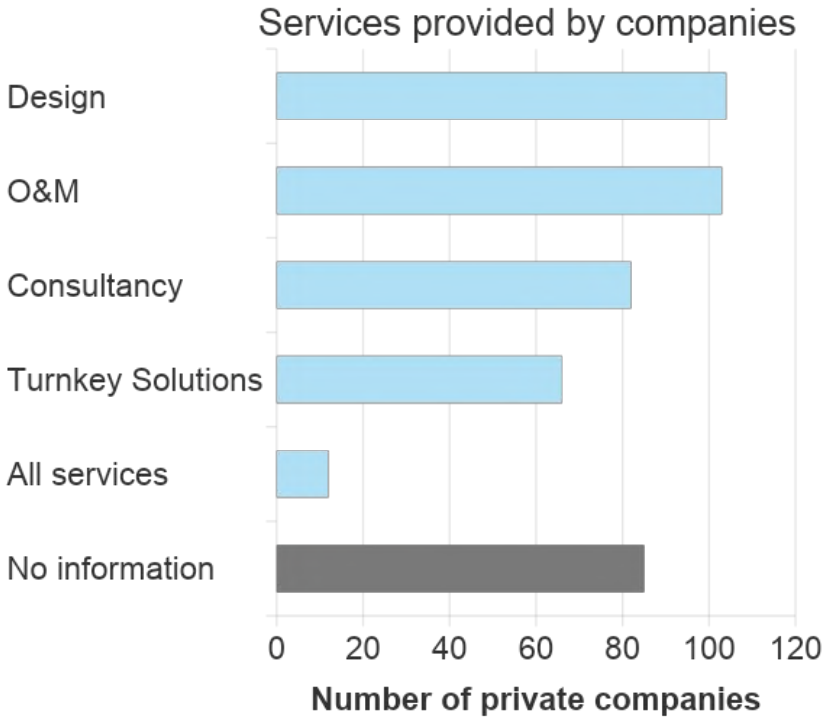
SSS Technology Families
Suspended Growth Processes
Attached Growth Processes
Anaerobic Baffled Reactor (ABR) Based Systems
Constructed Wetlands & Soil Filtration Systems
Other Systems



Results – Landscape Study

Private Sector Stakeholders in India (309 listed during the project)



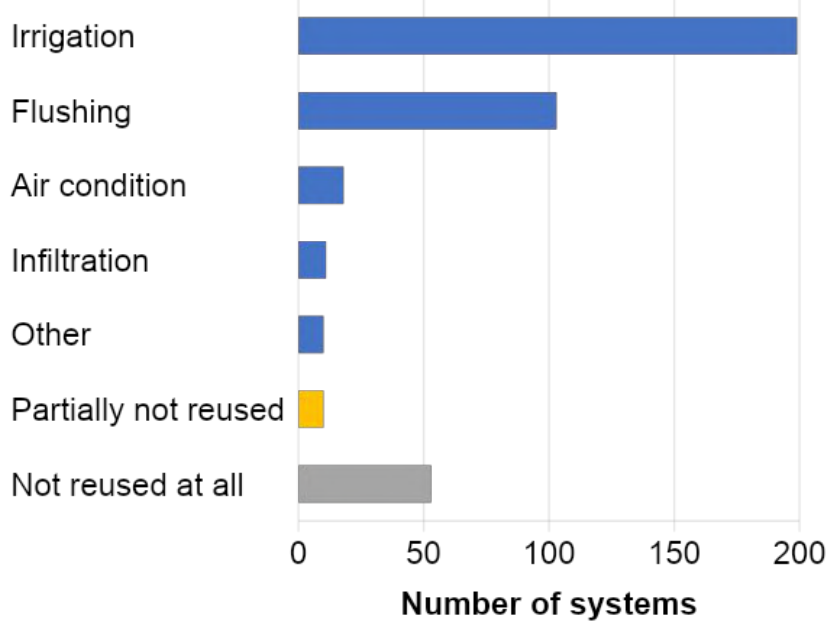


Results – Basic Assessment

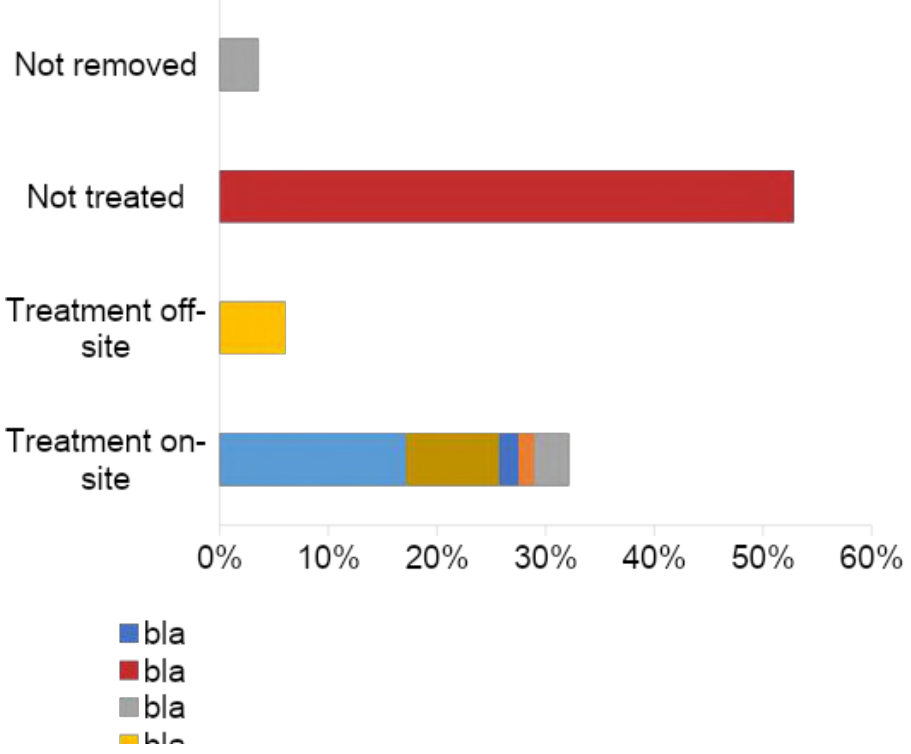
Qualitative assessment of systems through interviews and site inspection

- 309 sites assessed in 8 states of India, 30 sites in Nepal, 10 in Pakistan
- 5-700 m^3/day
- Residential, commercial, institutional, public/community toilets

Water reuse practices



Sludge management practices

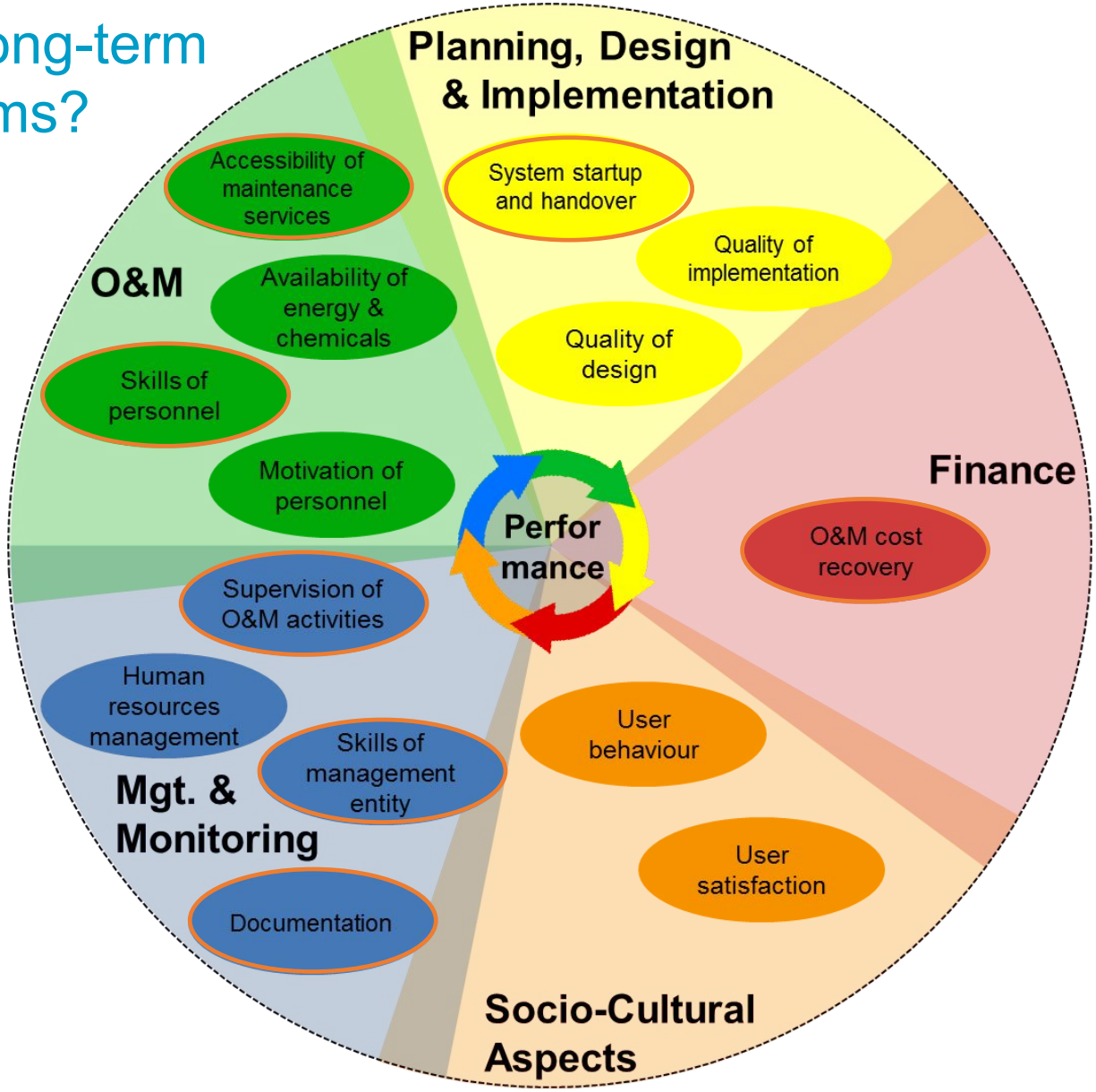


Results – Basic Assessment

What influences the long-term performance of systems?

Key challenges:

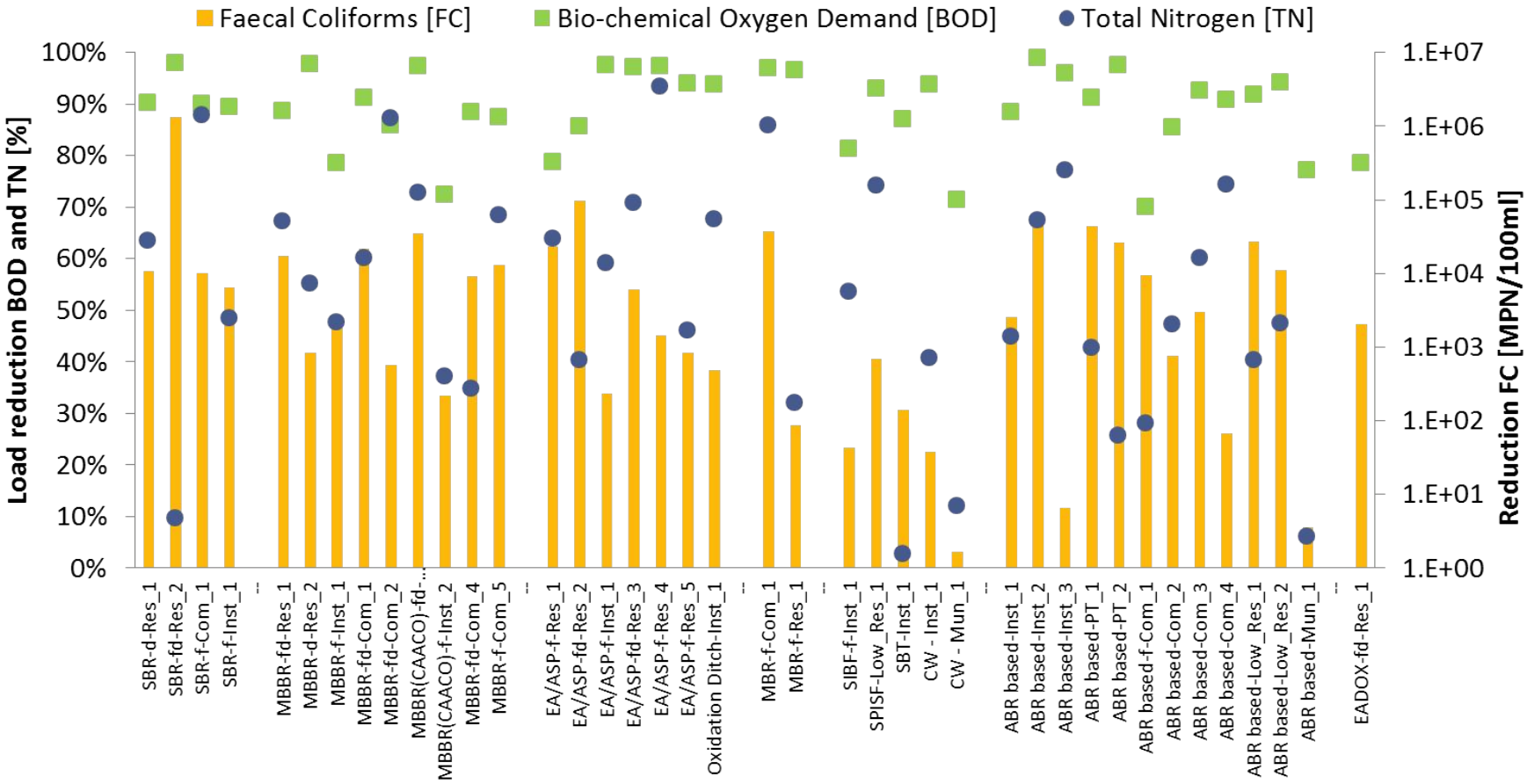
- System start-up and hand-over
- Skills and knowledge of operation & maintenance (O&M) personnel and management entities
- Supervision of O&M activities
- Documentation of O&M activities and financial flows
- Anticipation of maintenance works



Results – In-Depth Assessment

Quantitative assessment of systems through sampling campaigns

- 35 sites in India, 5 in Nepal
- 3 rounds of 24h composite sampling (inlet / outlet) & grab samples (all reactors)
- DO, pH, Turbidity, T (on-site); BOD, COD, TSS, TN, NH4-N, TP, O&G (lab)



Results – Governance Analysis

Mixed-method analysis of the policy and institutional framework and impact on the ground (policy review, interviews, stakeholder analysis, SNA)

- SSS as requirement for building projects. Bangalore: >7% of WW treated by sSTPs, but **currently not on the sanitation map**
- **Lack of a clear policy framework** for SSS, incl. **technical specifications**
  - **«Trial and error»** process, reuse policies not always pragmatic
- **Responsibilities scattered** between pollution control boards (PCBs), urban local bodies (ULBs) and water supply and sewerage boards (WSSBs)
- **Responsibility for long-term monitoring** is often not allocated
- **Lack of capacities and ownership** by WSSBs and ULBs
- Lack of comprehensive and unified **SSS database**
- **Loopholes** in the technology selection, design, implementation and O&M and monitoring of SSS systems

Results – Governance Analysis

Effluent and reuse standards

- **No dedicated standards specific to SSS**
  - Some standards more stringent than in the EU or Japan!
- **No reuse specific standards**
  - Adapt to different reuse/disposal?

    Quality of the receiving water bodies; discharge to sewer network; stormwater drain; greywater recycling for toilet flushing; construction site; gardening; agriculture
  - The **practical implications for implementation** by building owners should be thoroughly studied
  - The advantages and limitations of SSS systems need to be well balanced **before** imposing new standards

National Workshop on Small-Scale Sanitation Systems

A Roadmap for Small-Scale STPs in India:
Fulfilling their Potential for Healthy and Water-Secure Cities

Implementing Small-Scale STPs at Scale

Understanding and Addressing Causes of Failure

5th April 2018, New Delhi

Purpose of this Financial Study

1. Lack of detailed cost information on small-scale STPs
   – Understand lifecycle cost of owning a STP

2. Identify financially-driven reasons for why STPs fail

3. Options for de-centralized STPs at city-scale

Domains for Deployment

1. **Buildings and Campuses :** Closed, “single” owner

2. **Neighbourhoods :** Open, public spaces with small-scale sewage networks (3-5 sq.km.)

Differences : Ownership, responsibility, public safety

Technologies Studied

1.	MBR	Membrane Bio-Reactor
2.	SBR	Sequencing Batch Reactor
3.	MBBR	Moving Bed Biofilm Reactor
4.	ASP	Activated Sludge Process
5.	EA	Extended Aeration
6.	P-MBBR	Packaged MBBR
7.	DEWATS	Decentralized Wastewater Treatment Sys.
8.	SBT-CAMUS	Soil Bio-Technology

Many factors determine cost of a STP

1. Quality of components
2. Design Specifications: Capacity, component ratings etc
3. Climatic conditions
4. Soil type
5. Automation
6. Geographic location
7. Location within a site (underground/basement etc)
8. Profit margins of designer

1. **Lifecycle Cost of STPs**
2. Failure and Management
3. City-scale De-centralization
4. Conclusions and Testing

Cost Headers

A. Capital Costs

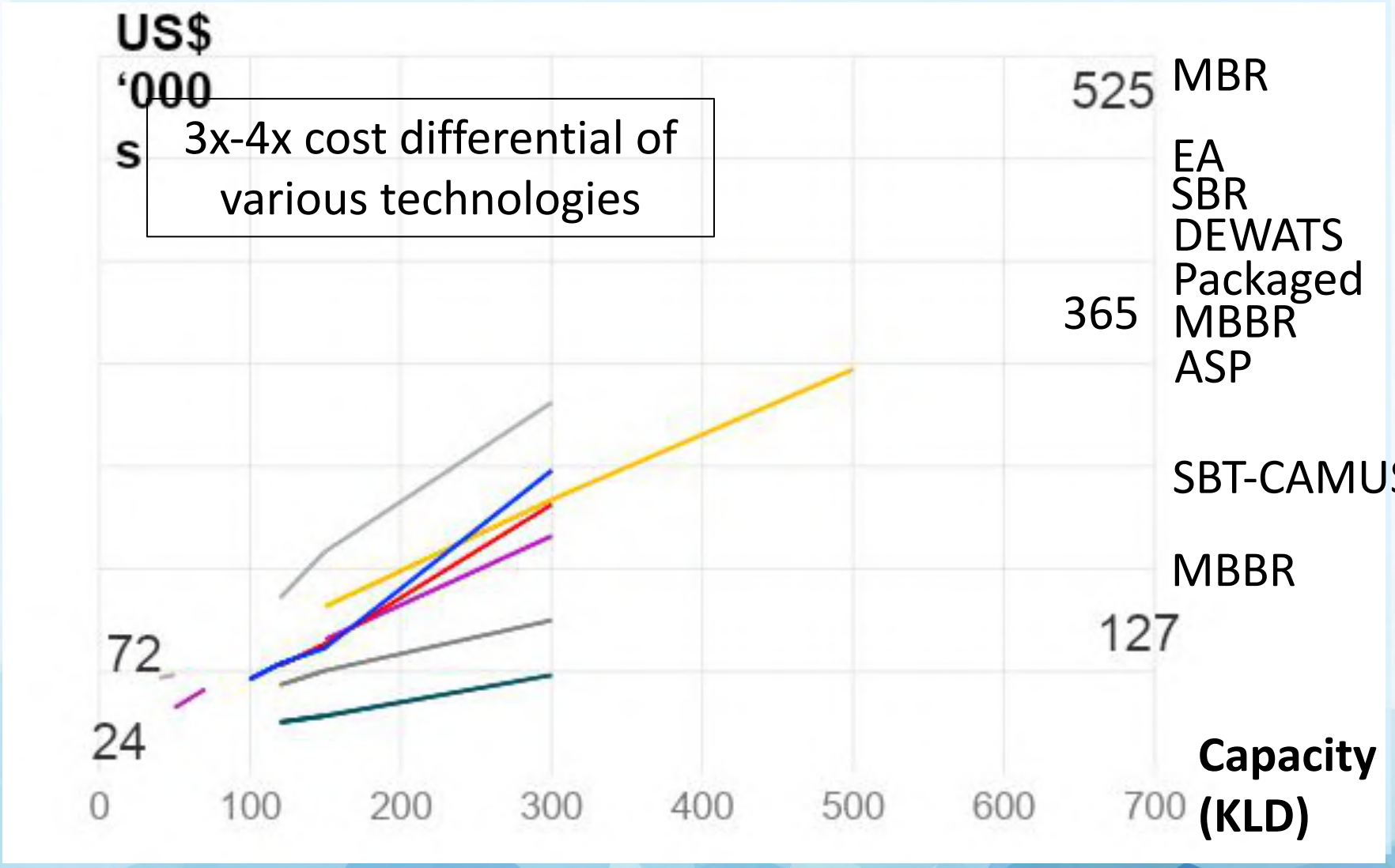
- Civil Construction and Tanks
- Electro-mechanical components: Pumps, Blower etc.

B. O&M Costs

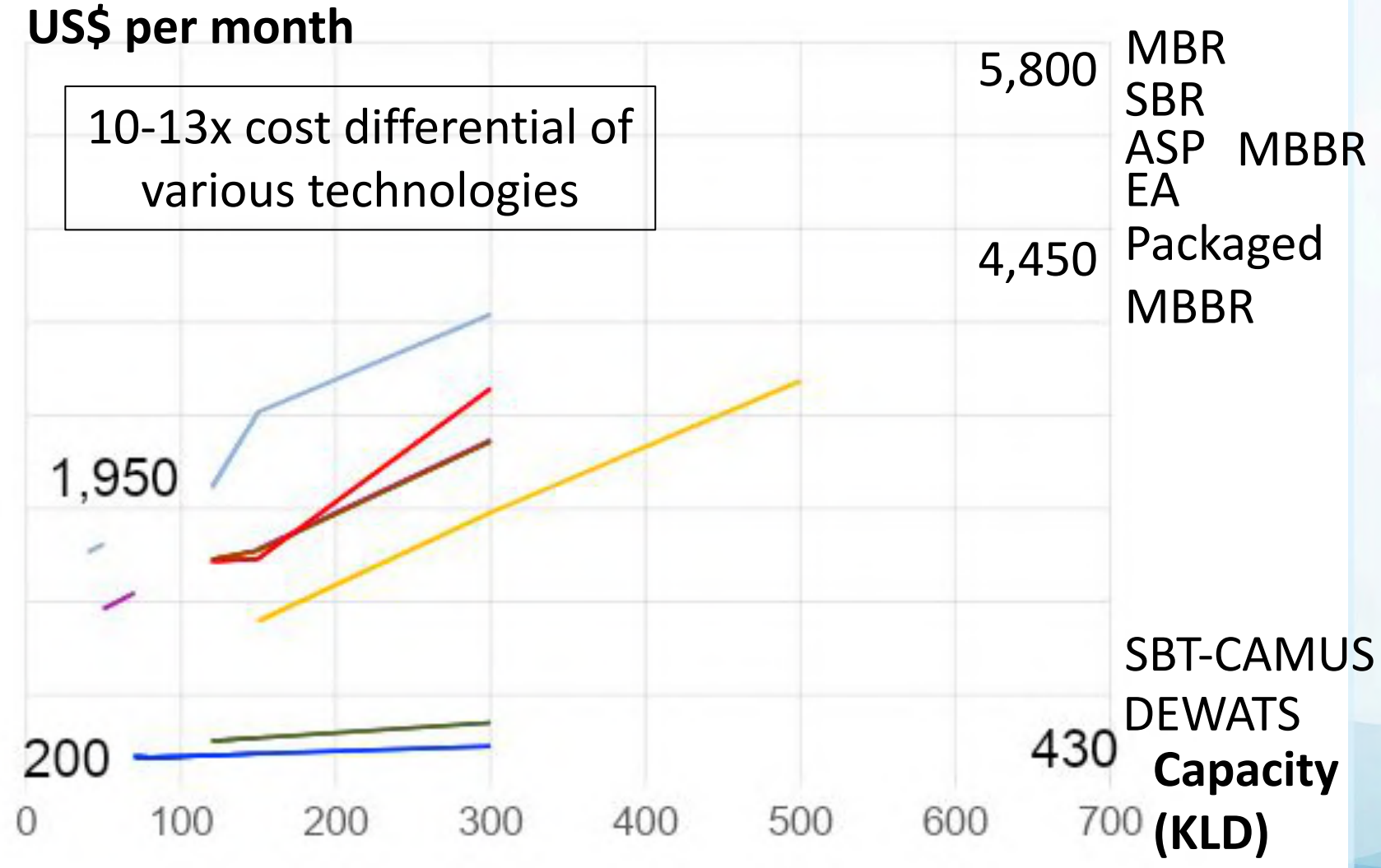
- Labor
- Electricity
- Consumables
- Minor maintenance

C. Capital Maintenance Costs

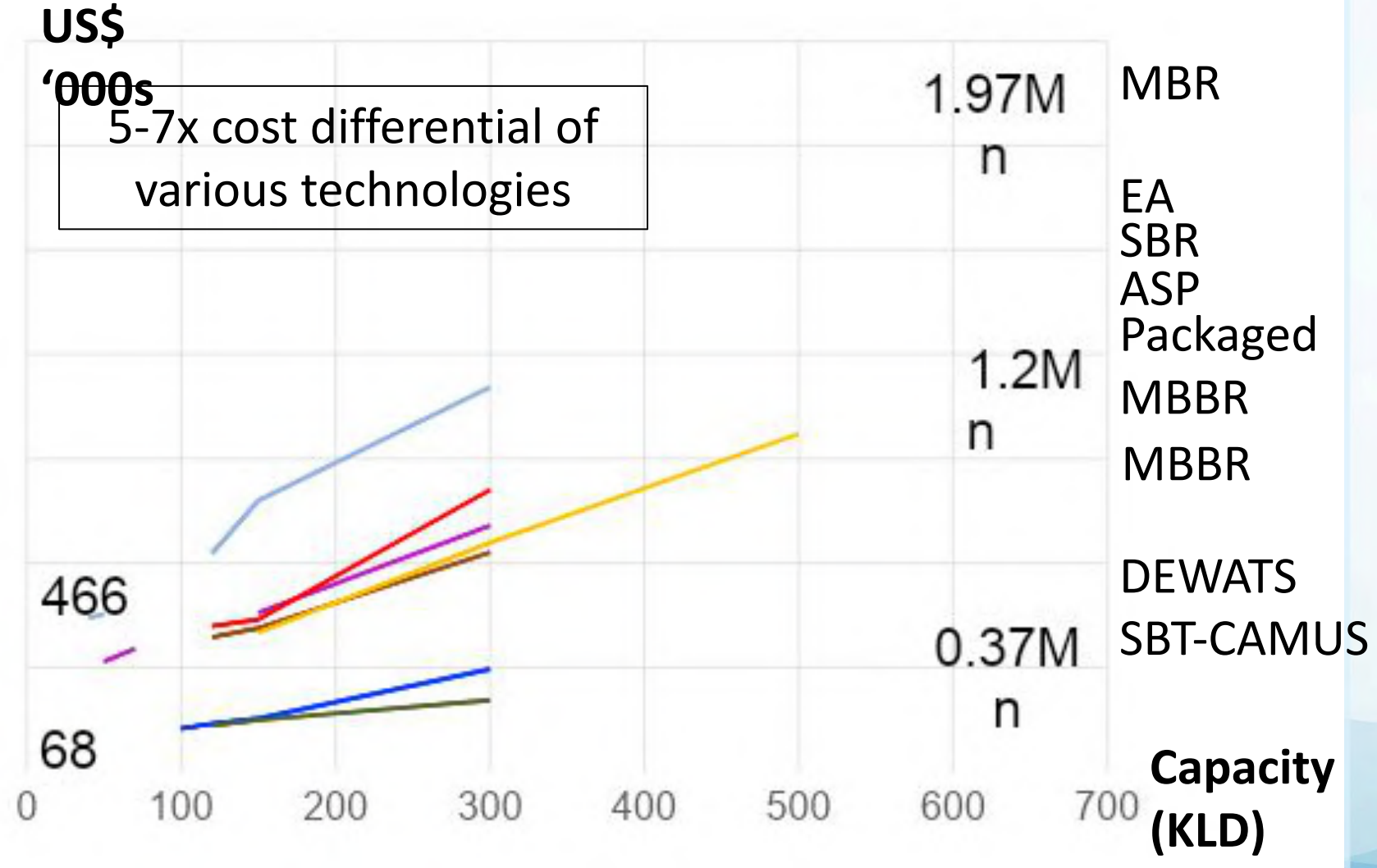
Capital Costs



Operation and Maintenance Costs

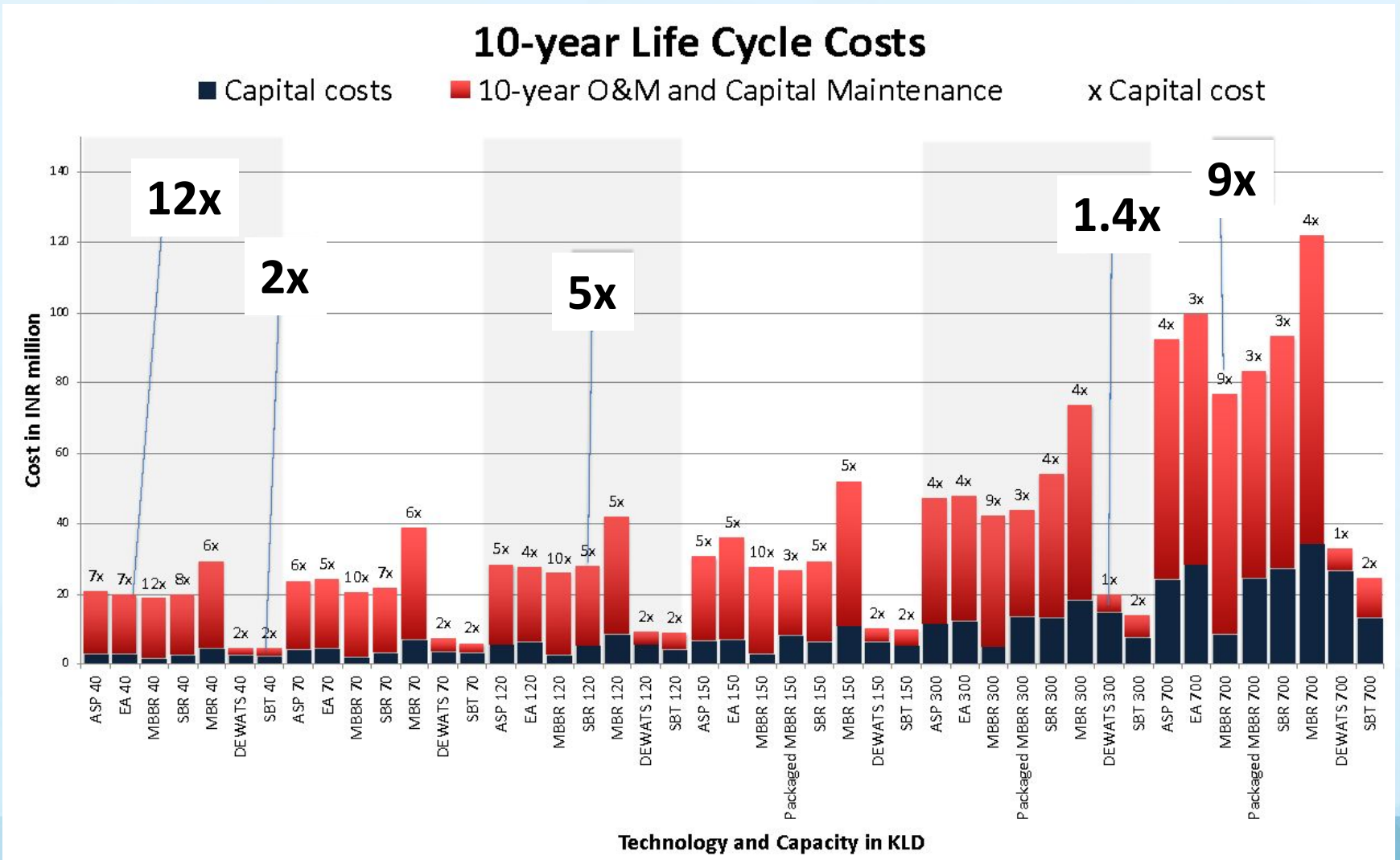


Life Cycle Costs (LCC) (10 years)



LCC (10yrs) = 2x-12x of Capital Costs

…yet purchasing decisions are based on Capital Cost

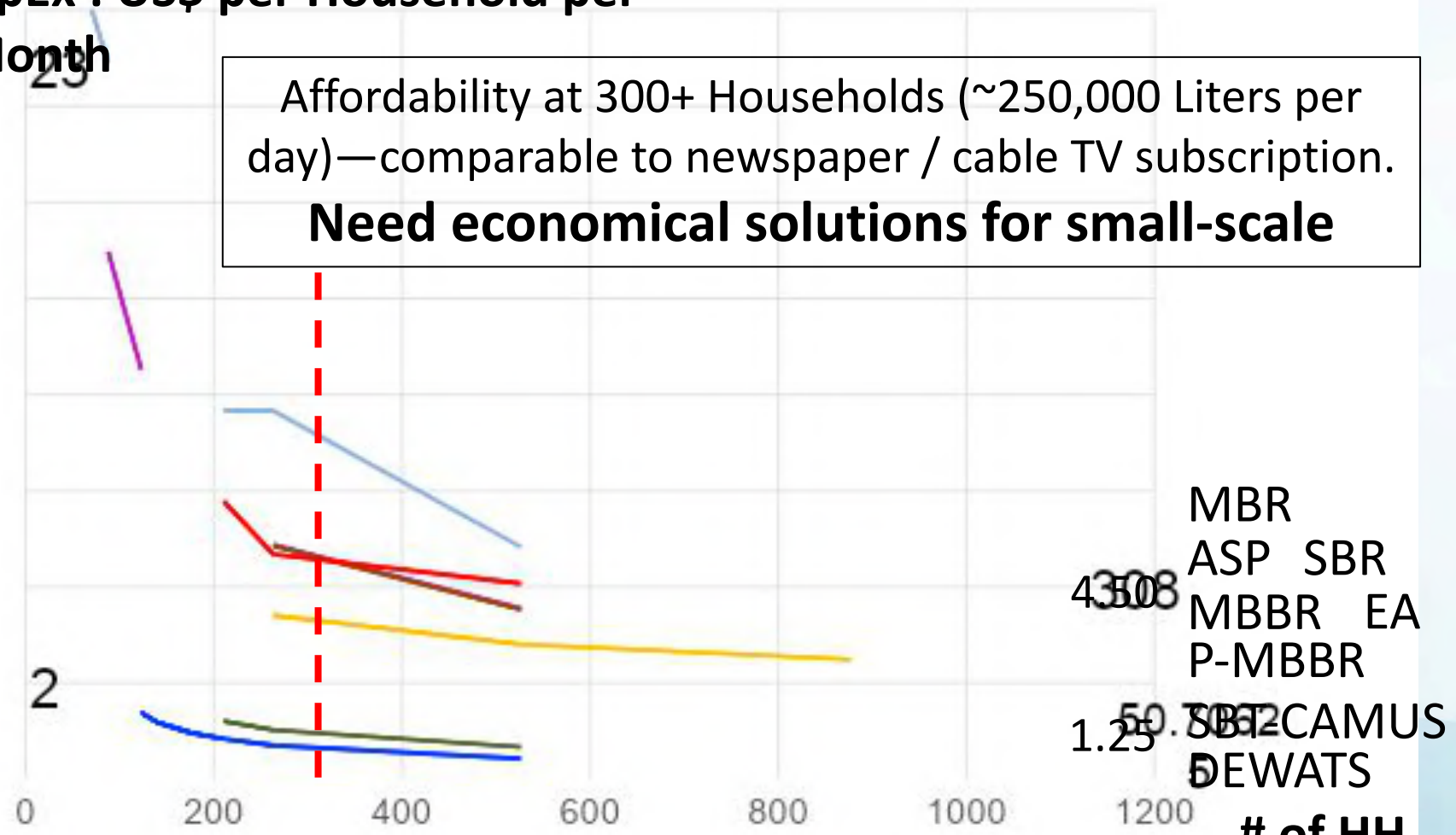


Scale makes STP OpEx more affordable

OpEx : US$ per Household per Month

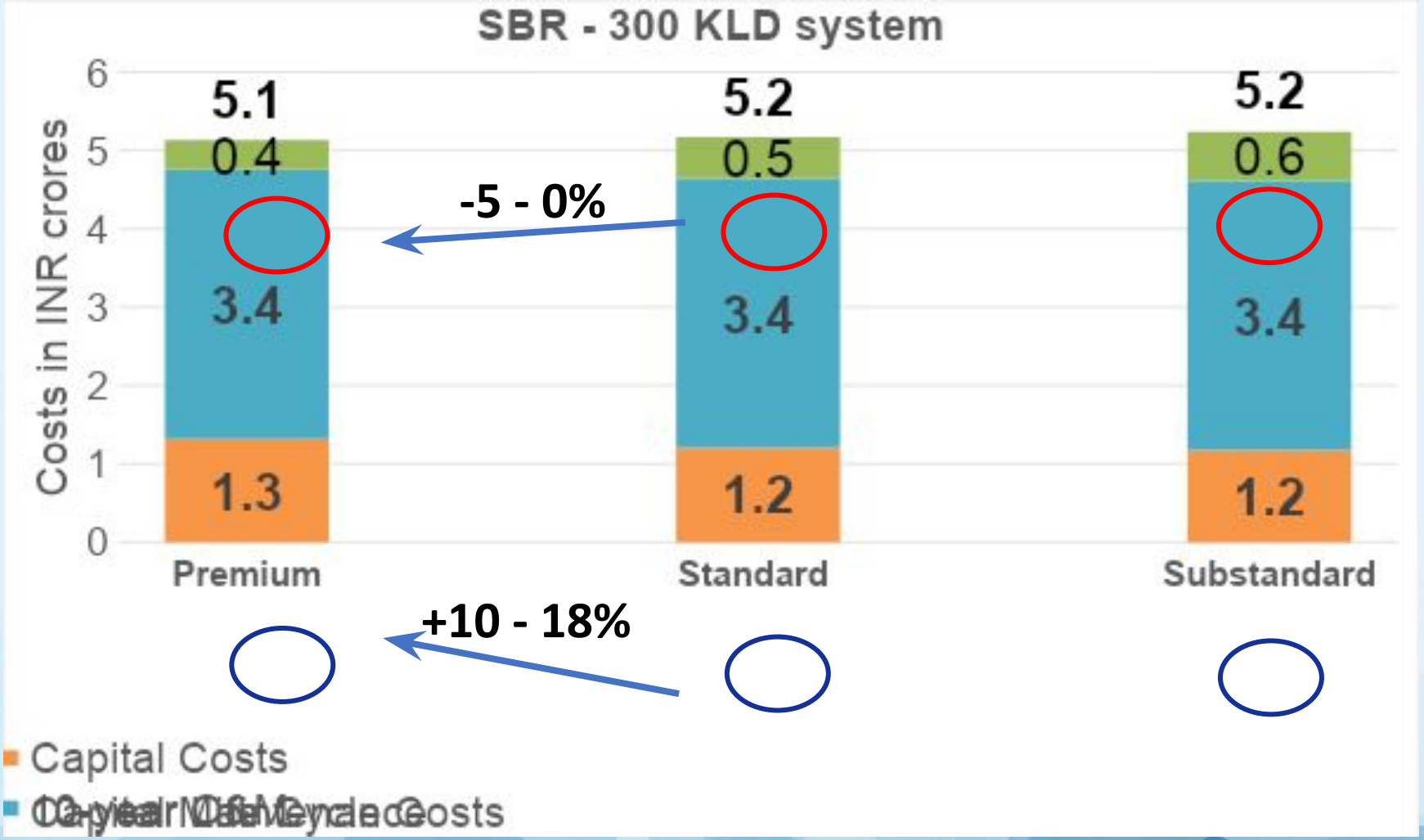
Affordability at 300+ Households (~250,000 Liters per day)—comparable to newspaper / cable TV subscription.

Need economical solutions for small-scale



Premium Components can be lowest LCC

Premium components require least maintenance / replacement



1. Lifecycle Cost of STPs
2. **Failure and Management**
3. City-scale De-centralization
4. Conclusions and Testing

Key stakeholders

Planning, Design, Implementation

- Real estate developer
- Architect, MEP Consultant, EPC Contractor etc
- STP designer and installer

Operations and Maintenance

- Owner / RWA
- O&M Service Provider
- O&M Staff

Regulations and Permits

- State Pollution Control Board
- Municipality: Building Permits
- Water and Sewerage Board

- **Financial factors determine management choices**
- **Buyers and long-term owners are often different parties**
- **Conflicting incentives among Stakeholders**

Key reasons why systems fail?

1. Lifecycle Cost of STPs
2. Failure and Management
3. **City-scale De-centralization**
4. Conclusions and Testing

De-centralizing Sewerage Networks

- Sewerage systems take 6-12 years to build
- Often connect only 30-50% of the population
- Failure of large STP is catastrophic (60% don’t meet stds.)
- Pipelines choke, break—contamination, scavenging etc.
- De-centralized options—neighbourhood-scale sewerage network with many small STPs in the city—are viable
- Requires a different approach by authorities
  - Different technologies and construction norms
  - New management processes

Cost Comparison

- Network is 80% of cost, depends on local conditions:
  - Soil, water table, land gradient, materials, flow etc

Component	Cost Comparison
1. Feeder Networks	***Similar***
2. Trunk Networks	Smaller Pipes—Cheaper
3. Pumping Stations	Not required
4. STP	Many more—higher Capital Cost

- Overall Cost: Similar
- But can do by locality, based on budget / sensitivity
- *Can reduce if norms for pipelines are changed*

It's a New Way : Benefits and Challenges

- **Cap. Cost** Similar to centralized, but can do locality-wise
- **Time** Can operationalize segments quickly (2-3 yrs)
- **Tech** More choice—select ideal tech for each area
- **Land** Need many smaller plots
- **Re-use** Easier at local level
- **Expansion** Easier over time (save $$ today)
- **Op. Cost** Depends on STP tech
- **Mgmt.** Many locations—new systems and processes

Speed, Flexibility and Re-use are key advantages

1. Lifecycle Cost of STPs
2. Failure and Management
3. City-scale De-centralization
4. **Conclusions and Testing**

Conclusions and Key Lessons

- STPs cost < 0.2% of building project cost—**AFFORDABLE!!**
- Lifecycle cost is 2-12x Capital Cost
- Alignment of interest is needed for proper O&M
  - Better regulations / enforcement, training
  - Financial investment, fines and incentives
- De-centralized STPs viable and beneficial for cities
- Wastewater re-use—cut water supply capital / O&M costs and improve water security, health etc

Main Conclusions (1/2)

- SSS sector much more developed in India than the rest of South Asia due to 2006 **policy**
- SSS systems have a **crucial role** to play for water-secure South Asian cities and are **affordable**
- **Proper O&M with skilled operators** is decisive for performance of systems, **irrespective of the technology**
- **Unmanaged** scale-up process, weak regulation
- **Challenges during planning, design and implementation**
  - Intransparent technology decision-making and design processes
  - Skills and reliability of some private players
  - Only few technologies able to fulfil nutrient standards (SBR, MBR)

Main Conclusions (2/2)

- **Challenges during O&M**
  - Poor O&M due to high cost, low awareness and skills, and weak enforcement
  - Sludge management
  - System start-up and hand-over
  - Supervision and documentation of O&M and financial flows
  - Anticipation of maintenance works/costs
  - Disinfection step
- **Challenges at governance level**
  - Mismatch between supply and demand for off-site water reuse
  - Impractical discharge standards
  - Unclear policies, responsibilities, low accountability and loopholes in monitoring framework

Key Recommendations (1/3)

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Sustainable small-scale sanitation in South Asia

- **Recognise** role of SSS and **clarify** policy and institutional frameworks
- Develop a centralised online **database** for planning, coordination, monitoring
- Develop robust **monitoring** framework
  - Inclusion of soft parameters (e.g. observations, operational, financial documentation)
  - Significant penalties
- Reuse-centred **discharge standards** specific to SSS
- **Certification** of firms
- Integrated **contracts** for build + O&M
- Provide **incentives**/subsidies (e.g. credit for good STPs)
- **Earmark** financial resources for O&M
- Standardize and strengthen system **start-up and hand-over**
- Systematic **training and licencing** for operators
- Promotion of training for plant manager
- **Sludge management** to be addressed strategically (onsite/offsite)

Key Recommendations (2/3)

Sustainable small-scale sanitation in India

- State Sanitation Strategies and City Sanitation **Plans need to include role of SSS**
- Water Supply and Sewerage Boards / Urban Local Bodies should have a **prominent role**
- Ministry of Housing and Urban Affairs or Central Pollution Control Board should **oversee database development**
- Create **used water markets** - linking supply and demand for treated wastewater
- Encourage **shared STPs**
- Discuss **Price** of municipal water
- Develop **guidelines and technical specifications** specific to SSS systems

Key Recommendations (3/3)

Problem	Recommendation
No earmarked funds for O&M (where Developer sells and exits)	- Developer to create Fund so interest covers O&M costs - Fund = 12-15x annual O&M cost)
Low quality players with no accountability	- Installer must operate for 5 years - Operator + owner have joint liability
Lack of skilled operators and Job Perception	- Every STP must have a professional O&M service provider - All operators trained and licensed
Seen as a cost center, little benefit	- Allow sale of treated water to licensed customers - Property tax benefits - Rebate after 5-8 years of good O&M

Conclusion and Way Forward

- Adequate **dissemination** is crucial
- A lot of **scope for research** remaining
- Eawag's continued involvement in this field
  - **WINGS programme**: long-term strategic research initiative to develop innovations for non-grid water and sanitation systems (www.eawag.ch/wings)
  - **BARRIERS project** (3 years starting 2019): Overcoming institutional barriers, comparing lighthouse cities for on-site water reuse
  - **On-going PhD** on City-Wide Inclusive Sanitation in India
- Potential follow-up:
  - **Piloting 4S recommendations** in one state / city / neighbourhood?

Conclusion and Way Forward

How to Implement?

- **Stage 1:** Proper implementation of SSS in Buildings / Campus
- **Stage 2:** Implement at neighbourhood scale

1. SPCB / CPCB, Municipality, DMA need special team for ssSTP
2. Licensing of STP designer and operators
3. Clear, stringent process for Consent to Establish / Operate:
   - Norms for automation, component, inline testing (by size)
   - Private players do work, monitored by trained Govt. team
4. Required training for operators
5. Norms for accountability of builder, owner and operator
6. Licensing test labs. Develop SPCB database, equipment R&D
7. Refine norms for neighbourhood-scale sewage networks

Thank you

Coming soon:

- **Project report** summarizing the main findings (technical, financial and institutional)
- **Factsheets** such as technology factsheets with key information
- **Policy brief** with recommendations for sustainable scaling-up of SSS sector

Draft Policy Brief
Comments Welcome!

www.sandec.ch/4S

5 Common O&M Models

Model	Cost	Risks and Challenges
1. In-house staff (Part time)	$	• Training, Quality, Absenteeism • Risk of poor asset maintenance • Supervision likely will be weak • Automation can reduce risks
2. In-house staff (Full-time)	$$	
3. O&M by System Designer	$$$$	• Operator may not report system problems
4. Independent Service Provider	$$$$	• Can blame designer for problems
5. Facility Management Company	$$$	• Lack of specialization • Can blame designer for problems