

Innovations on Sanitation for Urban Habitat

Habitat Innovation Conclave 2023

March 17, 2023

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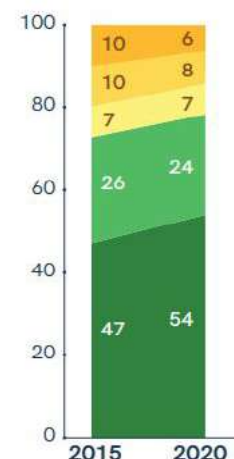
3.6B

people globally lack access to safely managed sanitation

7%

Increase in proportion of global population using safely managed services since 2015

Nearly half the world's population lacked safely managed sanitation services in 2020



Global sanitation coverage, 2015-2020 (%)

Safely Managed

Improved and not shared - excreta safely disposed in situ or off-site¹

Basic

Improved and not shared - excreta not safely disposed

Limited

Improved (e.g. sewer, septic, VIP latrines) and shared facilities

Unimproved

Use of pit latrines without a slab or platform, hanging and bucket latrines

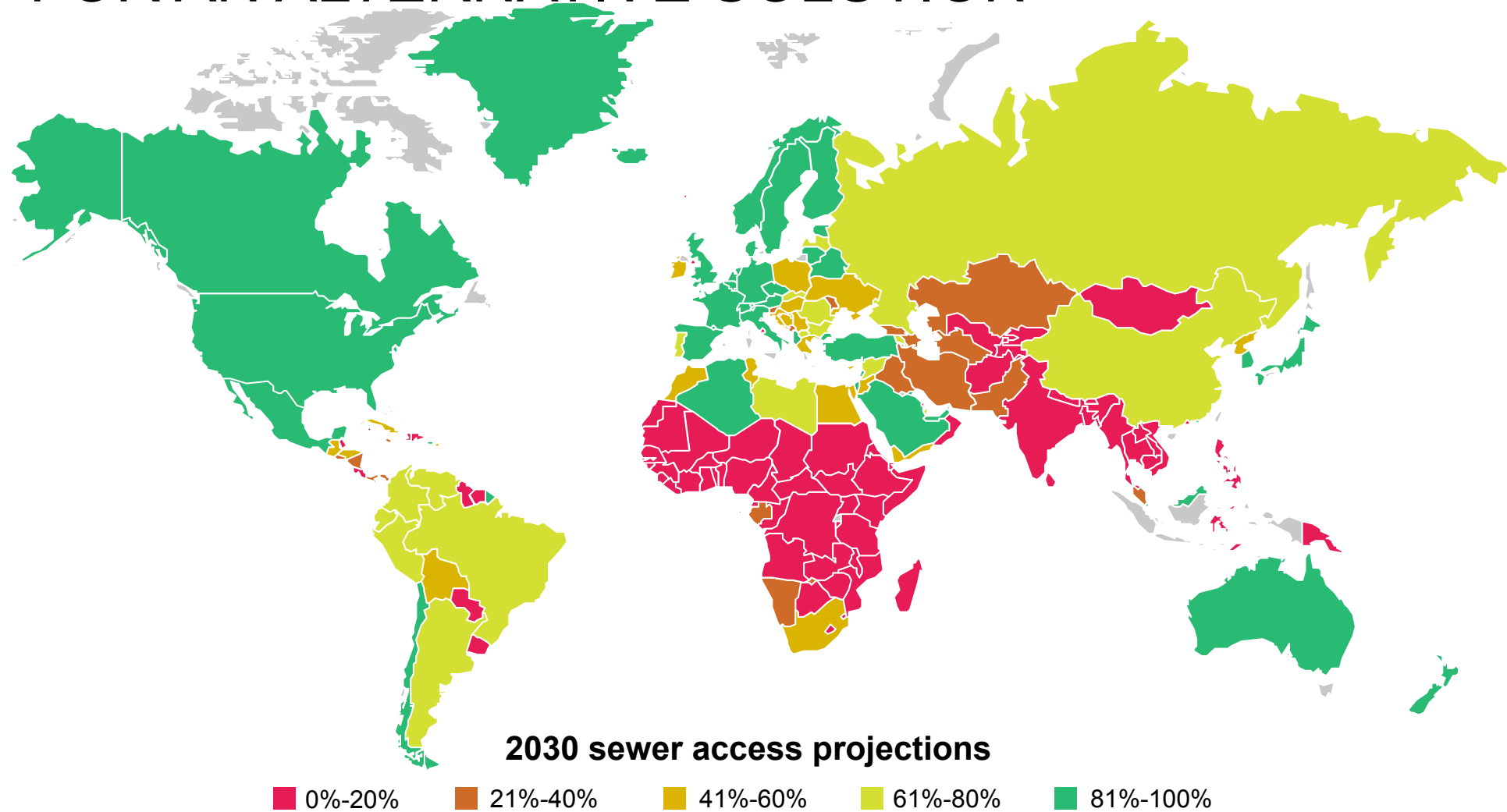
Open Defecation

Disposal of human faeces in fields, or other open spaces or with solid waste

Much faster progress is required to achieve the SDG goal of safely managed sanitation by 2030

1. Transported and treated offsite

SEWERS WILL REACH FEW IN MANY CITIES, INDICATING NEED FOR AN ALTERNATIVE SOLUTION



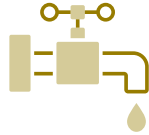
MACRO TRENDS MAKE TRANSFORMATIVE SANITATION TECHNOLOGIES INCREASINGLY NECESSARY



Growing population with urbanization

Population growth frequently outpacing infrastructure growth

68% of global population projected to be urban in 2050



Aging infrastructure

Centralized wastewater treatment systems often at/near capacity

Infrastructure repairs costly and disruptive



Water scarcity and stress

By 2030, 1/2 of world facing recurring water shortages, > 1/3 living full-time in water scarce areas

Demand could outstrip supply by 40%



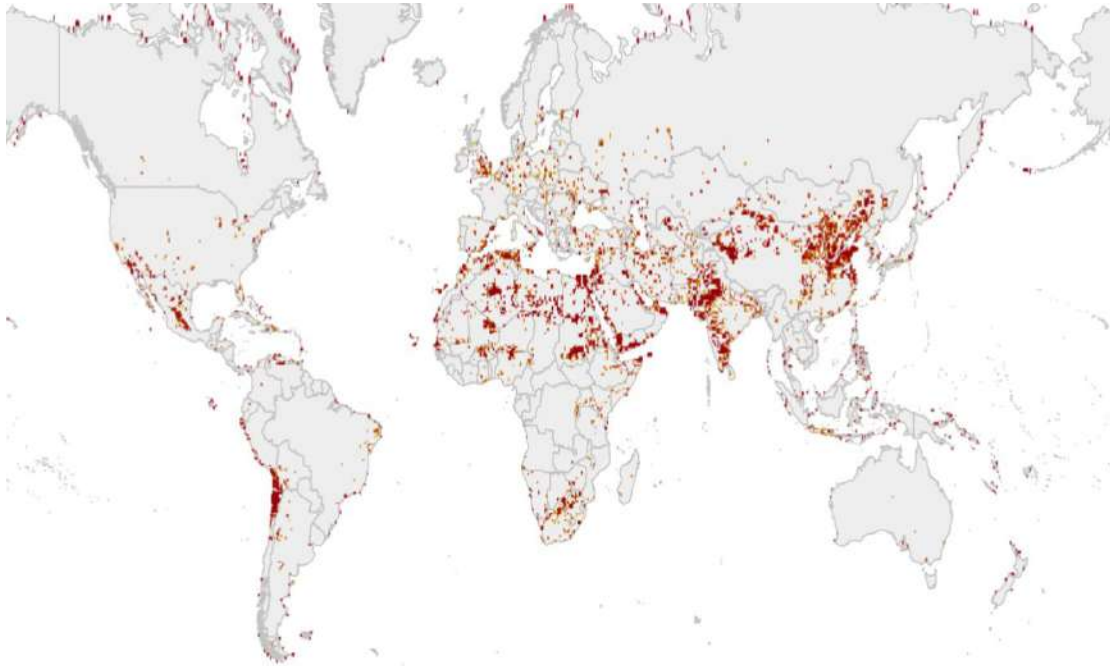
Policy changes

Government programs and initiatives focused on sanitation, esp. in developing markets

"Eco-friendly" policies to support sustainable development

SUSTAINABLE HUMAN WASTE MANAGEMENT WILL BE REQUIRED TO ADDRESS INCREASING WATER SCARCITY

Baseline: 2000



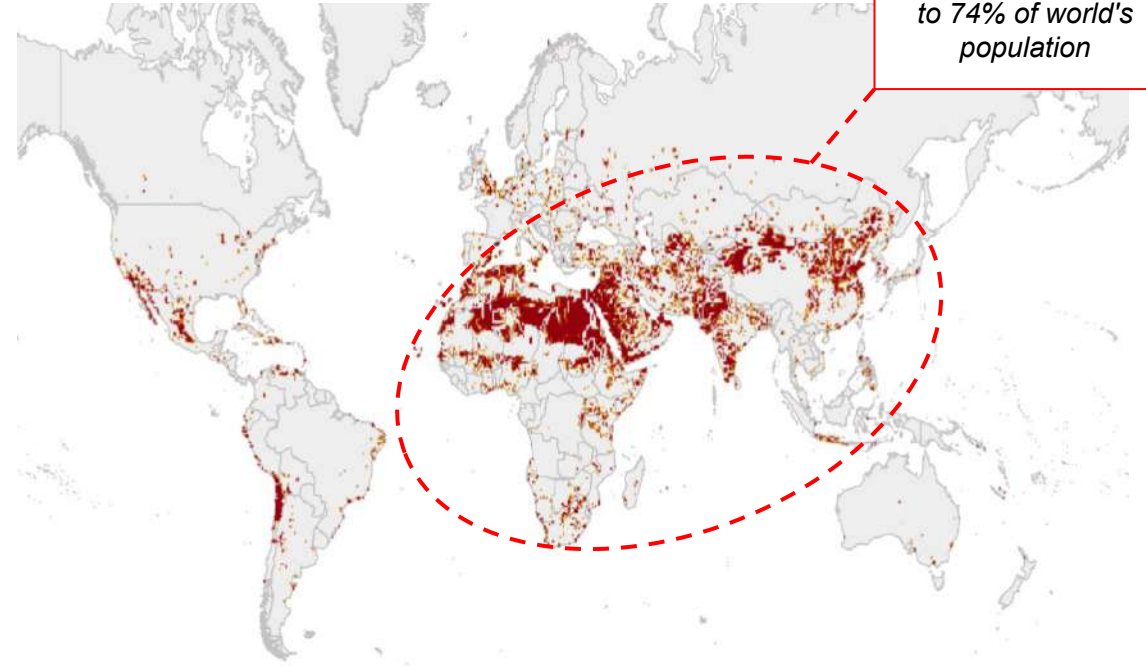
In 2000, ~1.7B people were living in water scarce areas

AVERAGE WATER AVAILABILITY PER PERSON

● <500m³ ● 500-1,000m³ ● 1000-1,700m³ ● >1,700m³

Source: "Water Scarcity Clock" (June 2022), World Data Lab

Future: 2030



Sub-Saharan Africa
& Asia will be home
to 74% of world's
population

By 2030, ~2.7B people will be living in water scarce areas

NEPAL WAS NOT SILENT



2001



ECO-HOME
An approach to sustainable water management
Use water wisely based on Human Values

Urino & Toilet separating
Cold-water saving water to flush
Urino & Toilet collection tanks at the basement
Rainwater first flush tank to washout dirt
Rainwater first flush tank to washout dirt
Rainwater first flush tank to washout dirt
Rainwater first flush tank to washout dirt
Rainwater first flush tank to washout dirt
Rainwater first flush tank to washout dirt
Rainwater first flush tank to washout dirt

Total Water Demand and Consumption	
Person	100-150 ltr/day
Drinking & cooking	20-30 ltr/day
Showering, bathing & laundry	70-80 ltr/day
Household cleaning, gardening & gardening	10-20 ltr/day
Water for drinking	10-20 ltr/day
Water for drinking	10-20 ltr/day
Water for drinking	10-20 ltr/day
Water for drinking	10-20 ltr/day

NGO Forum
SUSTAINABLE WATER MANAGEMENT

2002

DEMONSTRATION AND SCALING OF DECENTRALIZED WASTEWATER TREATMENT (1997 TO DATE)

1. **Dhulikhel Hospital (1997)**
2. **Septage Treatment Plant, KMC (1998)**
3. **Gray Water Recycling, Private House (1998)**
4. **Malpi International School (2002)**
5. **Sushma Koirala Memorial Plastic & Reconstructive Surgery Hospital (2000)**
6. **Kathmandu University (2001)**
7. **Staff Quarter, Middle Marsyangdi Hydro Power Station (2002)**
8. **Recycling of Wastewater from toilet and laboratory, ENPHO (2002)**
9. **Kapan Monastery (2003)**
10. **Faecal Sludge and Landfill Leachate Treatment Plant (2002)**
11. **Gray Water Recycling, Private House (2003)**
12. **Shuvatara School (2004)**
13. **Bagmati Area Sewerage Construction/Rehabilitation Project, BASP**
14. **Community Scale Madhyapur Thimi Municipality Wastewater Treatment Plant (2005)**
15. **Wastewater Treatment in Dhulikhel (Under construction) 2007**
16. **Waste Water Treatment in Gumba.....(2008)**
17. **Wastewater Treatment in 8UEIP towns (under construction)**



WHY ARE WE LAGGING THOUGH WE STARTED 20 YRS BACK?



Running behind only technologies (hardware) without thinking about its business and service models



Not running as a public service – projectized or the business of a couple of NGOs or professionals



Never consider the value of O&M – Low maintenance means NO maintenance



No standards, lack of accountability, and regulatory body

THE EMERGENCE OF FECAL SLUDGE MANAGEMENT (FSM) – 2014 TO DATE



Re-invented toilet solution will address the issue within this dotted area

↑ Critical part of value-chain – current infrastructure includes central sewer network where available or septic tanks with de-sludging trucks. Huge capital cost to government, impacting city-wide health and sanitation.

↑

↑

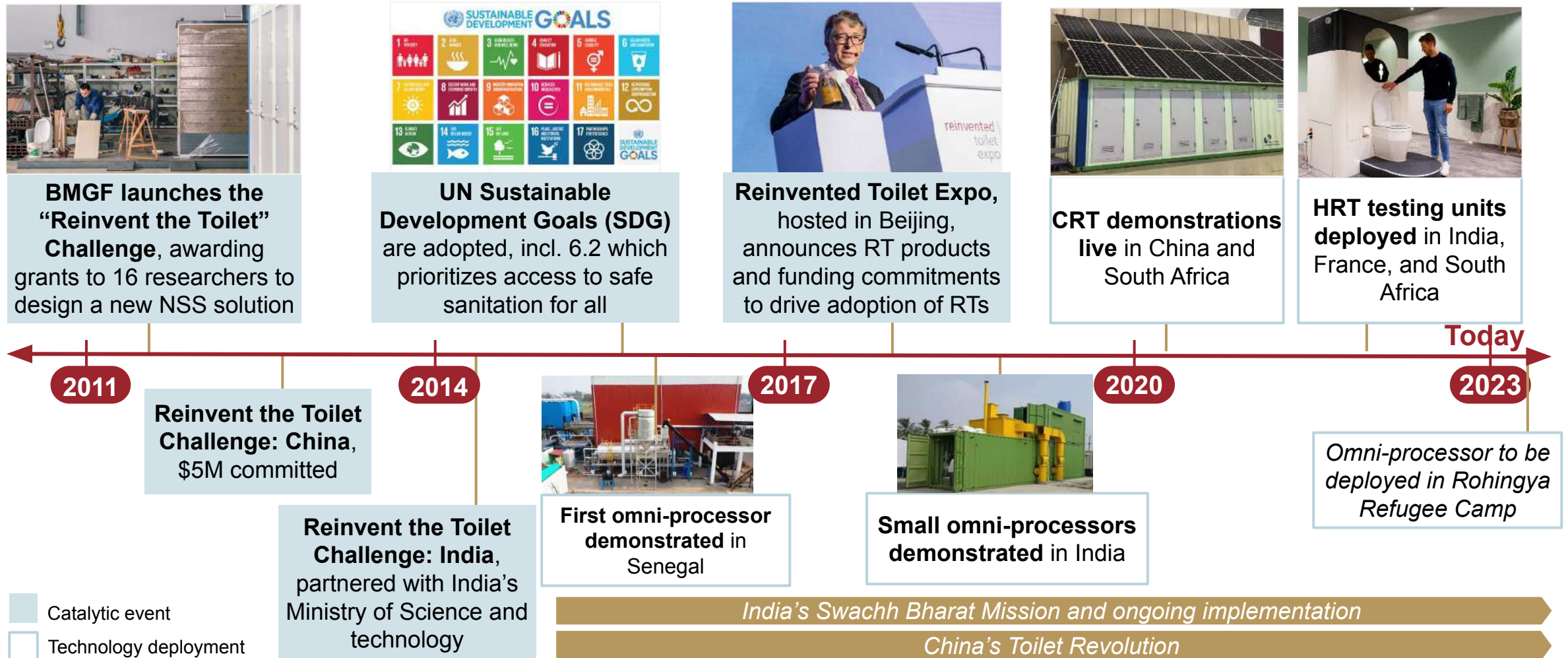
↑



Re-invented Toilet

On-site containment & Treatment of Fecal Sludge

THE FOUNDATION HAS PRIORITIZED THE TRANSFORMATION OF SANITATION FOR OVER 10 YEARS



Transformative Technology Commercialization

DEVELOP SUPPLY:

Develop compelling products and validate their commercial application to create a supply of NSS solutions

REDUCE RISK:

For new sanitation technologies, reduce the risk of market entry for commercial partners

STIMULATE EARLY MARKET

Stimulate the growth of a market ecosystem that drives demand for non-sewered sanitation industries in Launch countries early adopters' market

We try to be thoughtful about the role of philanthropy – and one of the things we're best placed to do is lower barriers and risk for the private sector and for governments to adopt new solutions to solve big problems.

Bill Gates, RTE, Beijing, Nov. 6, 2018



THE REINVENTED TOILET (RT) IS DESIGNED TO ADDRESS THE LIMITATIONS OF INCUMBENT TECHNOLOGIES

Eliminates pathogens



- Waste is treated on-site, no potential to spread disease
- Improves environmental safety
- All outputs are safe to handle

Conserves water



- Flush toilet experience without requiring any water connection
- Flush water is cleaned and reused, reducing household water needs, costs

Attractive



- Toilet is attractive, robust, and easy to install
- User-centered design for day-to-day maintenance by user, with only simple professional servicing expected

Affordable



- Designed for low cost of manufacturing, at scale, and low cost of operations
- Eliminates ongoing cost of tank emptying

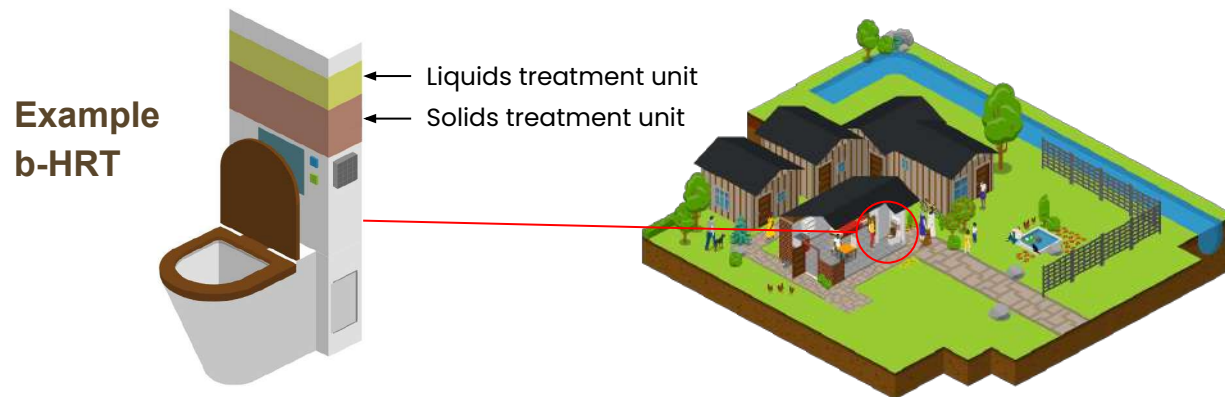
Household Reinvented Toilets (HRT)

Blackwater HRT (b-HRT): Each toilet in the home is a fully self-contained RT, processing liquids (excluding greywater) and solids with no plumbing connection. *Pictured below.*

Greywater & Blackwater HRT (gb-HRT): Each toilet in the home is connected to a treatment unit that processes all liquids and solids with no external sewage connection.

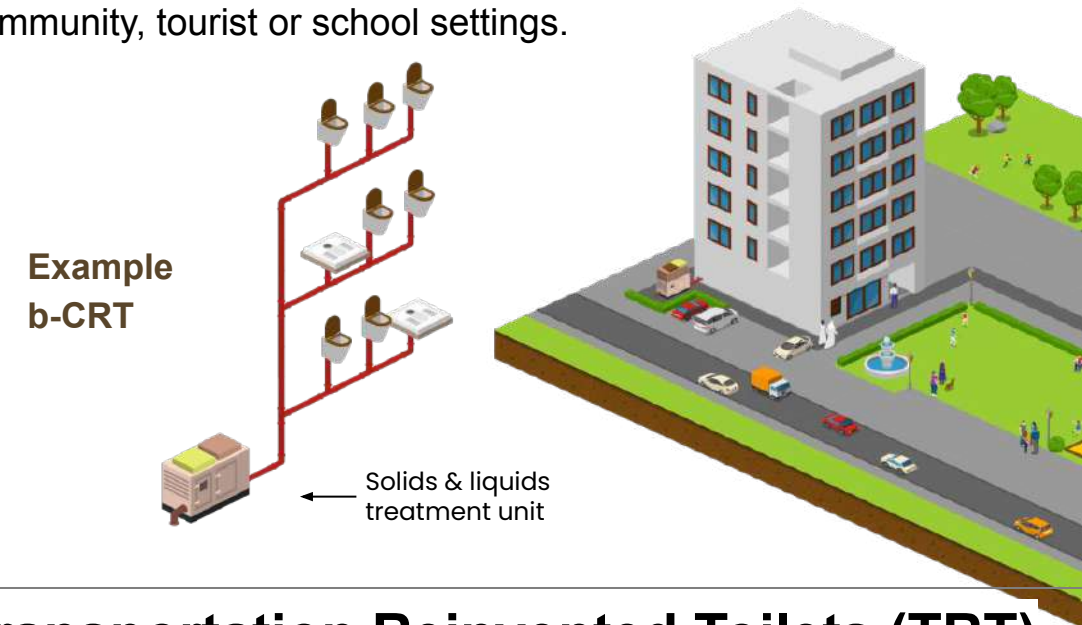
Liquids-only HRT (l-HRT): A liquids-only treatment unit is incorporated into the existing sanitation system in the home; typically used to treat and recycle septic tank effluent.

Solids-only HRT (s-HRT): Each toilet separates liquids from solids and processes the solids in the unit, while diverting liquids to sewer systems; potential to be paired with small-bore / shallow sewer systems.



Community Reinvented Toilets (CRT)

Blackwater CRT (b-CRT): Multiple heads connected to a treatment unit to create a self-contained system of on-site sanitation that processes liquids (with potential for greywater processing depending on treatment capacity) and solids. Can be integrated into the plumbing of multi-unit building (as pictured below) or a standalone detached toilet unit for use in public, community, tourist or school settings.

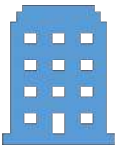


Transportation Reinvented Toilets (TRT)

Blackwater TRT (b-TRT): Self-contained RTs and/or treatment units with multiple heads made for use in trains, buses, etc.

Overview of RT Market Opportunities in India

Segmentation



Premium Residential

Household & Community-scale RT (HRT/CRT)

- Near-term opportunities – premium apartments, villas with OSS mandate
- On-field demo units among innovators to establish feasibility



Commercial & Institutional

CRT

- Green mandate by commercial and industrial entities – Airports, Institutions, industrial houses
- High visibility, scope for robust demo
- Explore private investments – Build, Own , Operate model



Private Institutional

CRT/HRT

- Schools, community toilets, malls, hospitals
- Industry houses – on-site sanitation solutions
- Some level of subsidy/grants needed
- Target specific states to establish use case



Government/CPT

CRT/HRT

- High volume segment, serving low-income groups and BoP
- State-run schools, hospitals, religious trusts and tourist places
- Subsidy-driven in the long run
- Highest impact in meeting our sanitation goals by 2030

Innovators

Exploratory Opportunity

Early Adopters

Majority - Scale

THERE IS SIGNIFICANT OPPORTUNITY TO TRANSFORM THE SANITATION INDUSTRY IN INDIA VIA THE REINVENTED TOILET

The Opportunity



Revolutionize the toilet market with a transformative solution that treats waste on-site, recovers resources, saves money, improves health



Help solve a critical infrastructure need – safely managed sanitation without heavy investment in centralized sewer systems or large treatment plants



Access to global platforms and markets to productize and commercialize a unique solution

The Potential

~\$3Bn USD opportunity
estimated in India over 10 years

First mover advantage
for industry participants to develop product offerings across customer segments with compelling value-prop

Manufacture an integrated solution by building on engineering expertise and collaborating with top global technology developers and partners across the value-chain

The Approach

How to get involved

1. **Meet with the Foundation** to understand the technology options and market opportunity in order to ascertain strategic fit
2. **Sign an NDA with one or more technology providers** to access further details on the relevant technologies
3. **Negotiate a commercial license** with Foundation technology partners to productize and manufacture the solution in India

ISO 30500 Standard

Adopted in 29 countries (including USA, Canada, France, South Africa, Senegal, China (soon), Brazil, etc.



TÜV SÜD Water Services| Certification for ISO 30500

The image shows a sample of a TÜV SÜD Certificate form. The form is titled "CERTIFICATE" and includes the following fields:

- No. [#CERT_NO#]
- Holder of Certificate: [#CERT_HOLDER#]
- Production Facility(ies): [#FACTORY#]
- Certification Mark: [Certification Mark]
- Product: [#PRD_TERM#] [#ADD_PRD_TERM#]
- Model(s): [#MODEL#]
- Parameters: [#PARAMETERS#]
- Brand Name: [#BRAND_NAME_T#]
- Tested according to: [#TEST_REQ#]
- Test report no.: [#ORDER_NO#]
- Valid until: [#VALID_UNTIL#]
- Date, [#ISSUE_DATE#] [#TC_NAME#]

The form also includes a vertical strip on the left side with the text "ZERTIFIKAT ♦ CERTIFICATE ♦ CERTIFICADO ♦ CERTIFICAT" and a small TÜV SÜD logo in the top right corner. At the bottom, it states "Page 1 of 1" and "TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany".



Household Reinvented Toilets (HRT)

Georgia Tech RT Product Portfolio



HOUSEHOLDS REINVENTED TOILETS TECHNOLOGIES IN THE PIPELINE (NOT YET AVAILABLE FOR PURCHASE)

All systems use combustion for solids processing, recycle water for flushing, and can fit indoor bathroom, or configured to have the treatment systems outside.



Design by Georgia Tech
Tech transfer under
discussion



Design by Cranfield University,
licensed by Huatie and JOMOO



Design by Samsung /
SAIT tech transfer
under discussion

EXAMPLE b-HRT MODEL



The Circular Toilet Dimensions

Integrated Industrial Pilot Modules: Pre-wetting Module + Cranfield Liquids Treatment Module + Torrefaction and Emission Scrubber Module







Community Reinvented Toilets (CRT)

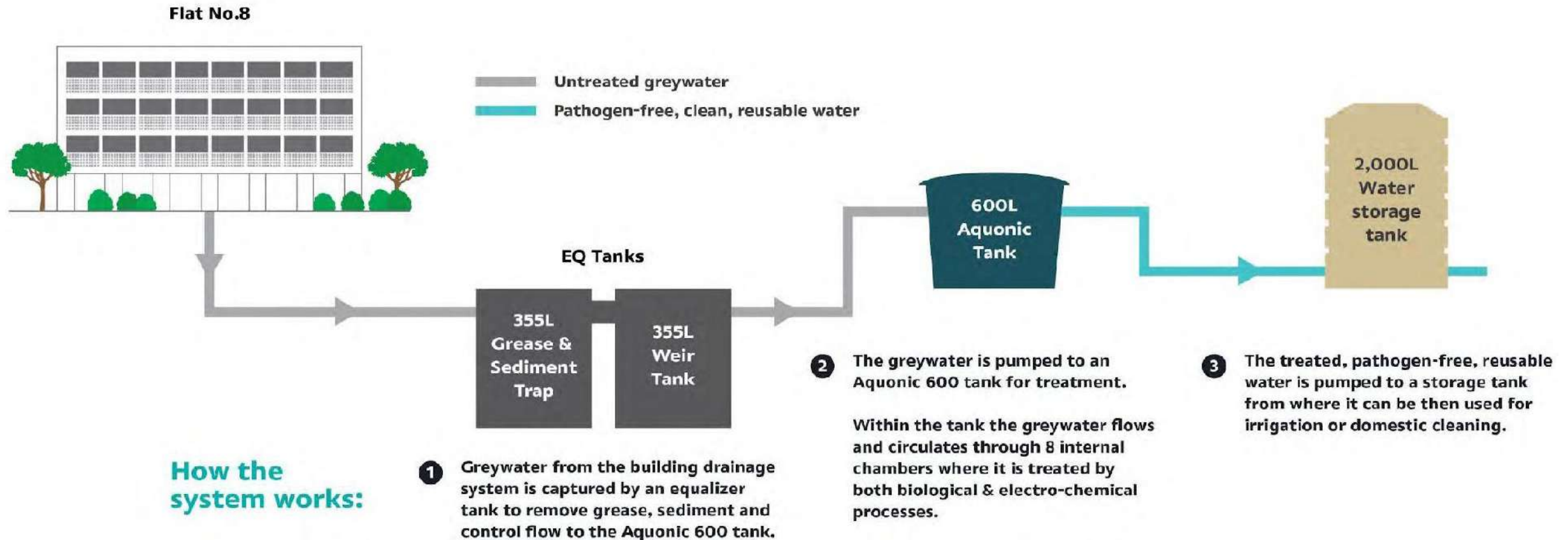


ECO-SAN TOILET INTEGRATED UNIT

By Yinxing Eco-Sanitary Manufacture CO., Ltd

R EIN VEN TED TO ILET

Police Apartments – Liquid treatment demo (Greywater)



Aquonic 600 – solution



Capacity

600 liters of liquid per unit p/day

Treatment process

Biological and electro-chemical

Energy requirement

Approx. 4kWh per tank p/day

– 2 x submerged pumps + EC electrodes
+ control box

Maintenance

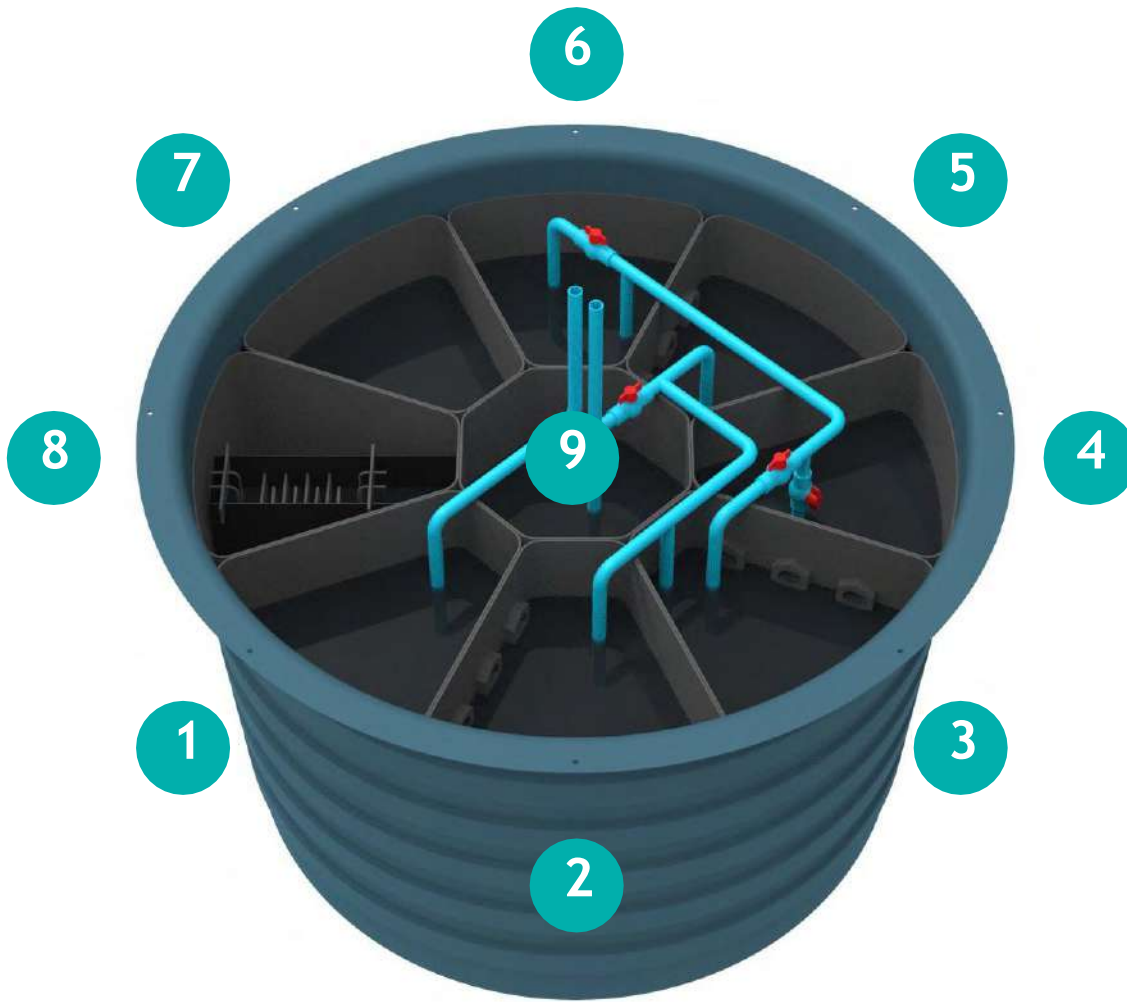
Filter media changed every 2-3 years

Electrodes yearly

Product material

Polyethylene

Aquonic 600 – treatment process



1. Up-flow filter chamber
2. 1st Sedimentation chamber
3. Anaerobic chamber
4. Aerobic chamber
5. Anoxic chamber
6. Recirculation chamber
7. 2nd Sedimentation chamber
8. Electrochemical disinfection
9. Treated water chamber

Police Apartments – Liquid treatment demo (Greywater)



Installation Example 1



Kindergarten Islamic School

Minburi, Bangkok, Thailand

Status: Operational since September 2022

Facility:

- 20 toilet cubicles
- School with over 300 pupils and staff
- Lunchtime kitchen

Treated Waste:

- Blackwater from flushing toilets + grey water from kitchen
- Approx. 2000L p/day

Technology setup:

- 2 x Aquonic 1000L tanks with EC Box
- Site designed 3 chamber septic tank made from pre-cast cement rings and grease trap for kitchen water

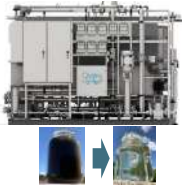
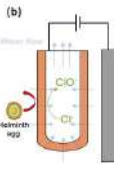
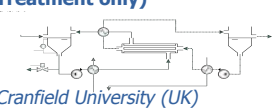
Kempton Park, South Africa



Installation Type	: Industrial
Project Type	: Retrofit
No. of Users	: 13
Influent	: Grey & Black Water
Treatment Capacity	: 2000 lt/day
Energy Supply	: Grid Supply

Overview of opportunities

- MORE THAN 19 ADVANCED TECHNOLOGIES ARE LOOKING FOR COMMERCIAL PARTNERS.
- 24 LICENSES SIGNED SINCE 2019

Single-Use Reinvented Toilet HTClean Helbling (Switzerland) 	Single-Use Reinvented Toilet Firelight Toilet Sedron Technologies (USA) 	Multiple-Use Reinvented Toilet Integrated Unit Back End Yinxing Eco-Sanitary (China) 	Multiple-Use Reinvented Toilet NEW generator 100/1000 University of South Florida (USA) 	Multiple-Use Reinvented Toilet TT-1, TT-3, TT-5B TT-6 Clear Technology (China) 
Omni Ingestor (OI) Oystra® Crane Engineering (USA) 	Omni Processor (OP) Large OP- JOP JOP/ OP CS50 Processor CRRG / Beijing Feb. 7th Locomotive Industry (China) 	Omni Processor (OP) Large OP- SCWO Supercritical Water Oxidation Sys. (SCWO) Duke University (USA) 	Omni Processor (OP) Small OP- POP 5 Biogenic Refinery Models Biomass Controls PBC (USA) 	
Components Entrustech ETEST (plate electrode) Yinxing Entrustech (China) 恩创环保 	Components Reactive Electrochemical Membrane (REM) Caltech (USA) 	Components Seva Self-diagnosis and smart maintenance solution Caltech (USA) 	Components Trash Excluder North Carolina State University (USA) 	Components Front-end Cranfield / MSR (Front End) Module Cranfield University (UK) in partnership with MSR Cascade Designs 
Interface Urine Trap EOOS (Austria) 	Liquid only CalTech Electrochemical Reactor - Ultron Liquid Treatment System Caltech (USA) 	Liquid only Cranfield / MSR (Liquid Treatment only) Cranfield University (UK) 	Liquid only Reclaimer Liquid Treatment Module (SURT), Reclaimer (SURT), Reclaimer Liquid Treatment Module (MURT) Duke Center for WaSH-AID (USA) 	Liquid only UWE Pee Power - Microbial fuel Cell (MFC) technology that turning urine into electrical power Bristol BioEnergy Centre, University of the West of England (UWE) 

BMGF WILL CONTINUE TO INVEST TO ACCELERATE MARKET DEVELOPMENT



R&D to overcome technical challenges and de-risk product and component innovation



Marketplace Readiness

- Government engagement to enhance demand for sanitation, focus on pathogen removal and water reuse
- Support implementation of international product standards (ISO 30500)
- Engage Development Finance Institutions to facilitate access to financing



Awareness & Perception

- Build awareness and change perception of the decentralized sanitation



Early Adoption

- Identify early adopter opportunities & early market entry requirements
- Develop value proposition and economic positioning for RT as a category



Technical & GTM Assistance

- Develop product requirements for identified customer segments
- Assist in pilot and demonstration projects
- Guide GTM strategy and tactics

THE FUTURE: CITY WIDE INCLUSIVE SANITATION [CWIS]



CORE CWIS OUTCOMES



EQUITY

Services reflect fairness in distribution and prioritization of service quality, prices, deployment of public finance/ subsidies



SAFETY

Services safeguard customers, workers and communities from safety and health risks by reaching *everyone* with safe sanitation



SUSTAINABILITY

Services are reliably and continually delivered based on effective management of human, financial and natural resources



CORE CWIS FUNCTIONS

RESPONSIBILITY

Authority(s) execute a clear public mandate to ensure safe, equitable and sustainable, sanitation services for all

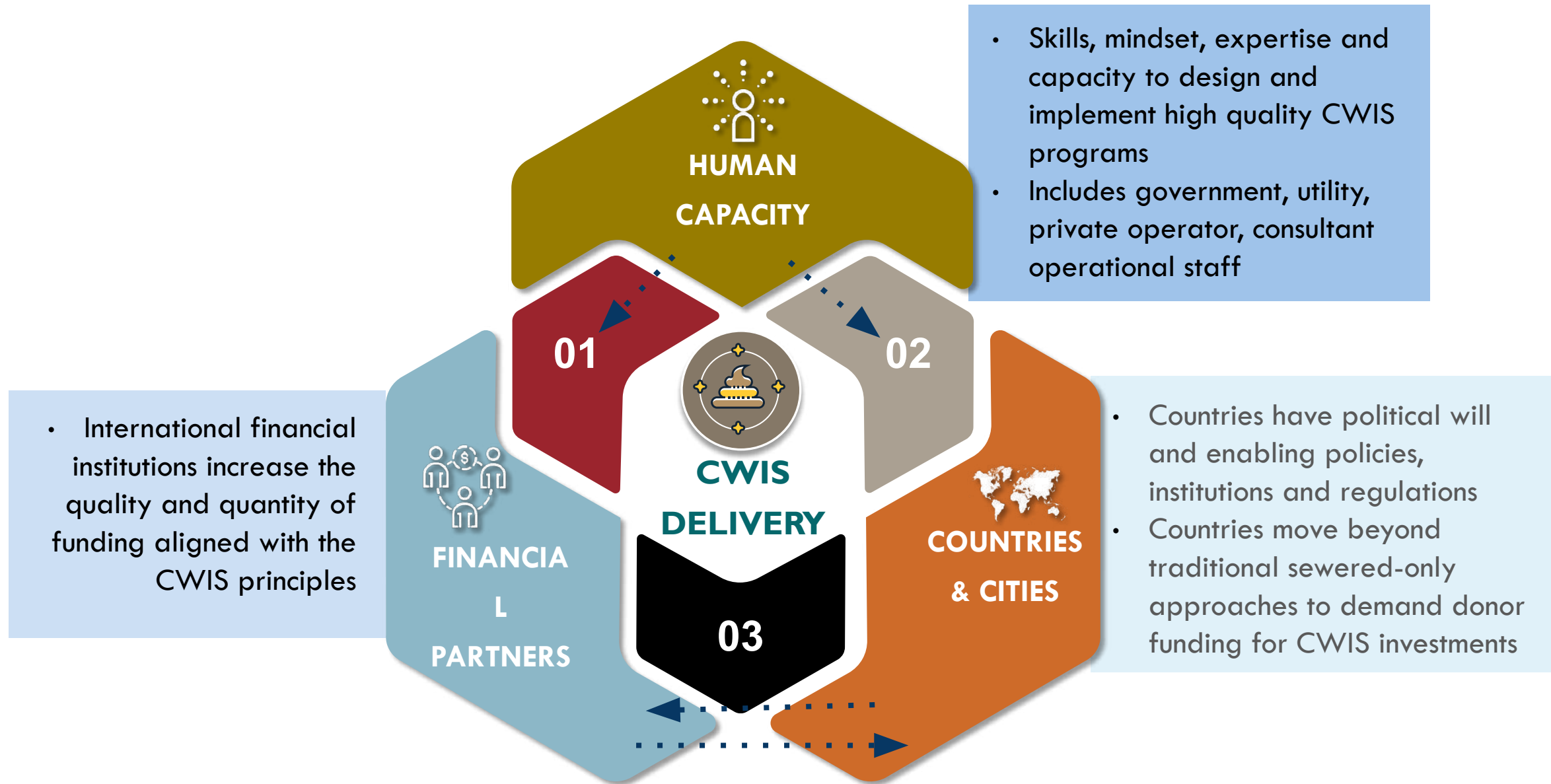
ACCOUNTABILITY

Authority's(ies') performance against mandate is monitored and managed with data, transparency, and incentives

RESOURCE PLANNING & MANAGEMENT

Resources—human, financial, natural, assets—are effectively managed to support execution of mandate across time/space

WHAT WILL IT TAKE TO SCALE CWIS?



THE ECOSYSTEM OF STAKEHOLDERS

Strategic Partners, Program Partners, Execution Partners, Funding Partners

Objectives delivered
in collaboration with
sector partners and
experts



A go-to place for water and sanitation related services





Ambition 2019-2030:

10,000⁺

sanitation professionals educated by

100⁺ academic institutions.

GLOBAL
SANITATION
GRADUATE
SCHOOL

BILL & MELINDA
GATES foundation

FSMA



unicef



UTEC

TU Delft

eawag
aquatic research

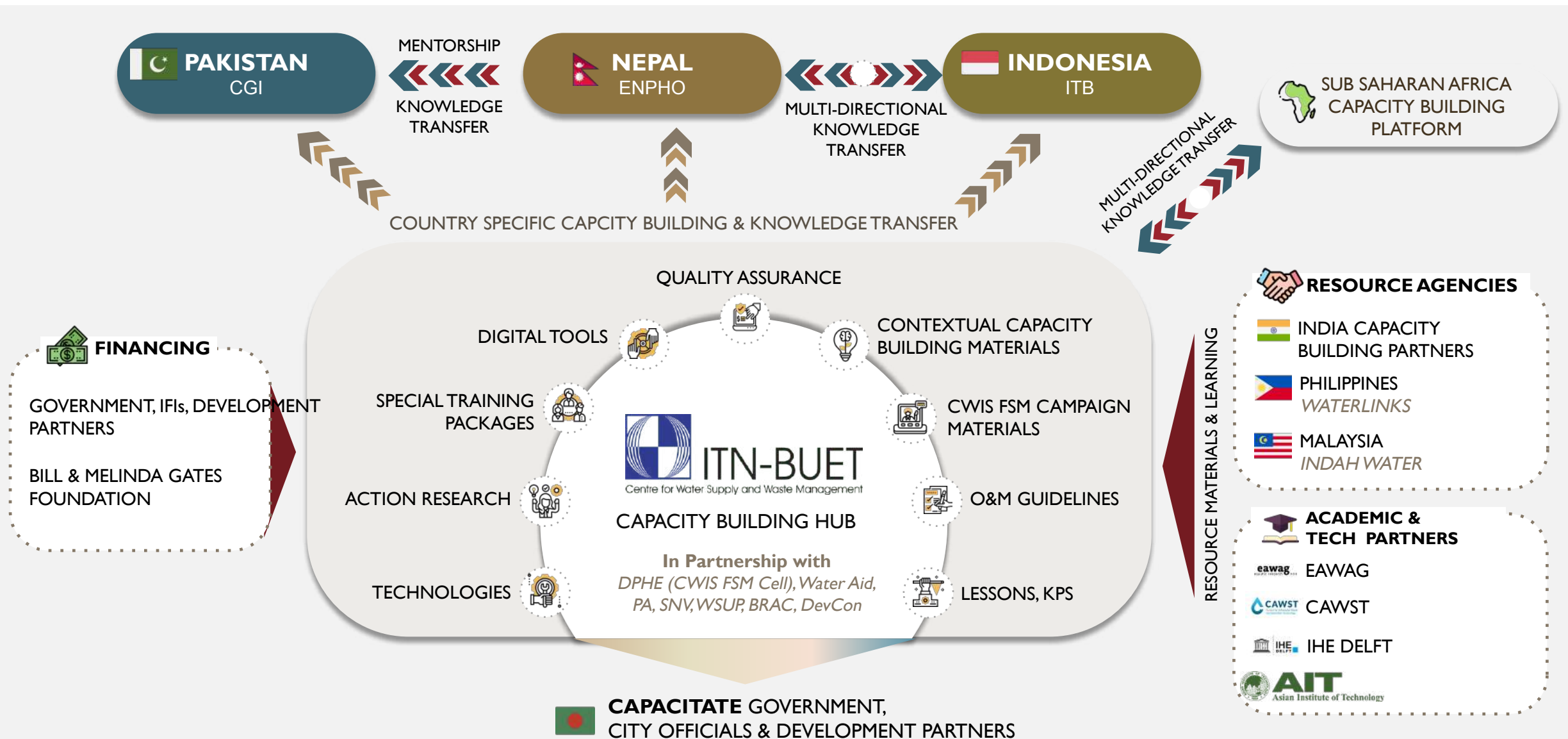
香港科技大学
THE HONG KONG
UNIVERSITY OF SCIENCE
AND TECHNOLOGY



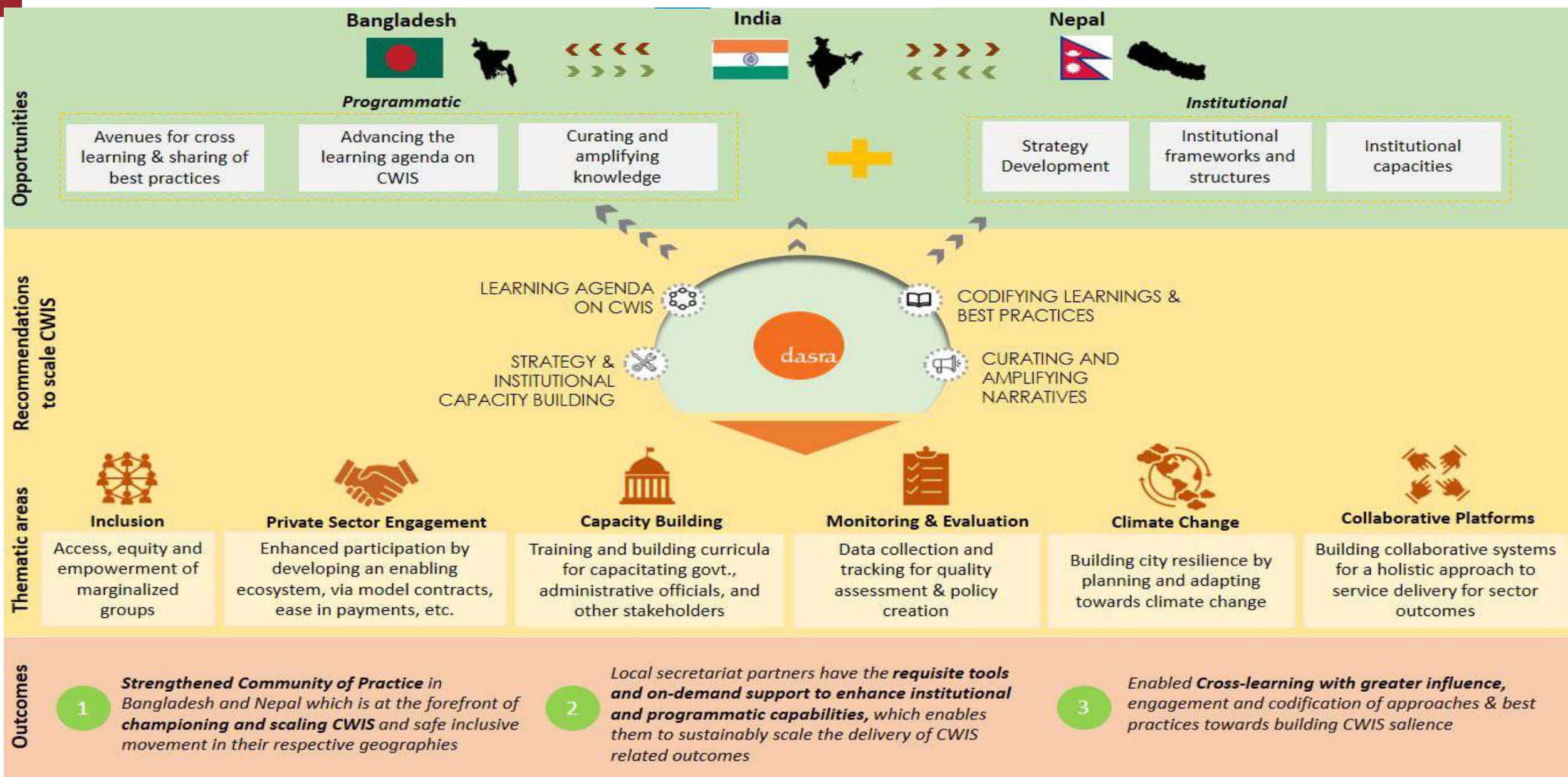
CEPT
UNIVERSITY



REGIONAL CAPACITY BUILDING & RESEARCH FOR SCALING



COUNTRY TO COUNTRY COLLABORATION

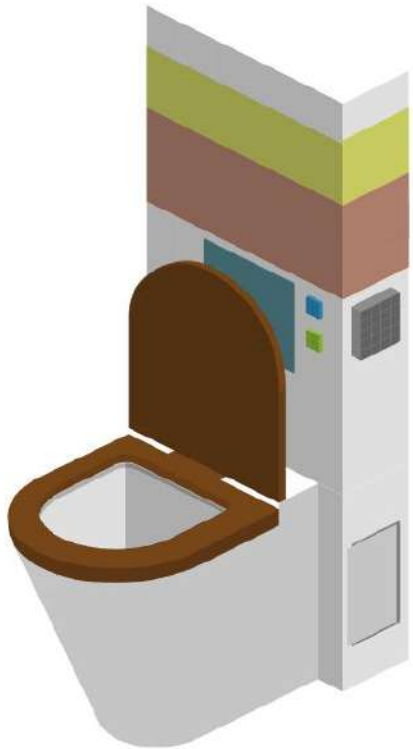


**IF YOU WANT TO GO FAST,
GO ALONE.**

**IF YOU WANT TO GO FAR,
GO TOGETHER.**

— African proverb

BMGF has invested in the Reinvented Toilet (RT) as part of its commitment to improve sanitation globally



RTs are a new generation of toilets that treat waste and kill pathogens without the need for connections to sewers, treatment plants, water supply, or continuous electricity



These new sanitation solutions use a variety of innovative technologies to break down human waste and eliminate dangerous pathogens, leaving behind clean water and solids that won't harm people or the environment



Reinvented toilets can be used by individual households (Household RT or "HRT") or in multiple stall facilities serving local communities, schools, apartment buildings, and commercial facilities (Community RT or "CRT")



These systems all treat blackwater. In the future, certain systems may also treat greywater or offer solids or liquids-only treatment for specific scenarios (e.g., solids-free sewers, transportation vehicles)



RT design goals:

- 1 kWh of electricity
- \$450 capex and \$0.15/day opex
- Requires no plumbing or sewerage
- Safely recycles water for flushing
- Operation requires no behavioral change for users and accommodates squatting or sitting preferences
- **Can be adapted to cold and dry climate**