



THE SANITATION ECONOMY IN INDIA

Market Estimates & Insights

A THOUGHT PIECE FROM THE TOILET BOARD COALITION
NOVEMBER 2017



Unilever



In Partnership with: **TATA STRATEGIC MANAGEMENT GROUP**

ABOUT THE TOILET BOARD COALITION

Founded in 2014, the TBC is a unique business-led partnership with the ambition to address the global sanitation crisis by accelerating the Sanitation Economy,

The TBC is enabling private sector engagement; connecting large and small companies; and ensuring close collaboration between private, public and non-profit sectors with the common goal to achieve Sustainable Development Goal 6 (SDG6), universal access to sanitation.

The TBC runs the Toilet Accelerator, the world's 1st accelerator programme dedicated to sanitation entrepreneurs in low-income markets.

The members of the Toilet Board Coalition believe that accelerating the Sanitation Economy will deliver significant impact to business and society.

ABOUT THIS PAPER

OBJECTIVES

- To develop a baseline understanding of the potential of new markets derived from the Sanitation Economy as well as a quantified estimation of the opportunity;
- To identify opportunity spaces for business (vs. specific strategies);
- To inspire action amongst businesses, regulatory bodies and other actors needed to develop new markets.

This study has been produced in collaboration with TATA STRATEGIC MANAGEMENT GROUP (TSMG). All market estimate numbers for India have been analysed and modelled by TSMG unless otherwise referenced.

APPROACH

We have aimed to quantify the potential size of the market for the Sanitation Economy with market estimates in 3 areas: the Toilet Economy, the Circular Sanitation Economy and the Smart Sanitation Economy. With this study we hope to inspire action by presenting early evidence that the context is favourable and the potential is large. This study does not attempt to outline specific business strategies, but rather seeks to identify business opportunity spaces to be further explored.

In terms of its scope, this study provides global context for each of the Sanitation Economy areas however, it provides specific market estimates and aims to provide new insights for the India market only. We have considered available data from global market assessments and focused in on the share of markets if Sanitation Economy opportunities are considered. We have chosen to highlight market estimates specific to the Indian market which we consider to contain the largest share of the total global market.

Tata Strategic Management Group has used a fair mix of primary and secondary research in order to collect data, make appropriate assumptions and thereby estimate the market for the portfolio of products and services in the Sanitation Economy, as available in India. Primary research comprised telephonic interactions with industry experts, officials of municipal corporations and professionals working in the space of sanitation, waste management and healthcare..

This study does not entail detailed market research. Products and services for which numbers could not be established through credible sources replacement product market data has been considered.

For a detailed list of assumptions please see APPENDIX A.

FOREWORD

The Sanitation Economy Quantified

We are publishing this study at an important point in time where the global sanitation crisis has gained a much needed spotlight on the global stage. Directions set in the next few years will have profound impact on future generations. We believe that business has a significant role to play in contributing to important solutions, and in shaping smart sustainable sanitation systems for the future.

We have therefore come together as a group of business leaders and global sanitation community stakeholders - all members of the Toilet Board Coalition - in an effort to create momentum for the acceleration of the Sanitation Economy in the global business community.

We have chosen to focus our first study of the market potential on India because we have been both inspired by the pace of change and progress in India under the Swachh Bharat Mission, while at the same time in awe of the size of the challenge, India being the country with the most people without access to basic sanitation. The market for the Sanitation Economy in India provides a proxy for the potential more broadly across global markets with acute need to improve sanitation.

We are particularly motivated by the findings of this report that show an impressive array of business opportunities in product hardware, consumables, services; as well as a new source of biological materials and renewable resources; and the potential for new information about health and behaviour. The numbers are already big, an estimated US \$32 billion market opportunity today, doubling to US \$62 billion by 2021 in India alone.

We wish for this report to be seen as a first attempt to understand the size of the market potential for a new economy, the Sanitation Economy. It is our hope that our inquiry shows that the Sanitation Economy is much much more than toilets, with acute relevance for a broad set of sectors from consumer goods, to consumer health, food, fibre, agriculture, big data and the internet of things - today and into the future.

We do not claim that our estimates will be definitive, but are rather meant to provide a starting point to engage with the market and as an open invitation to more businesses to join us in building the ecosystems that will unlock the vast benefits for our businesses and society.

We hope that our fellow business leaders become as inspired as we are about these new business opportunities and will join us in accelerating the Sanitation Economy.



Charlie Beevor
Global Vice President
Household Cleaning Brands,
Unilever
TBC Chairman



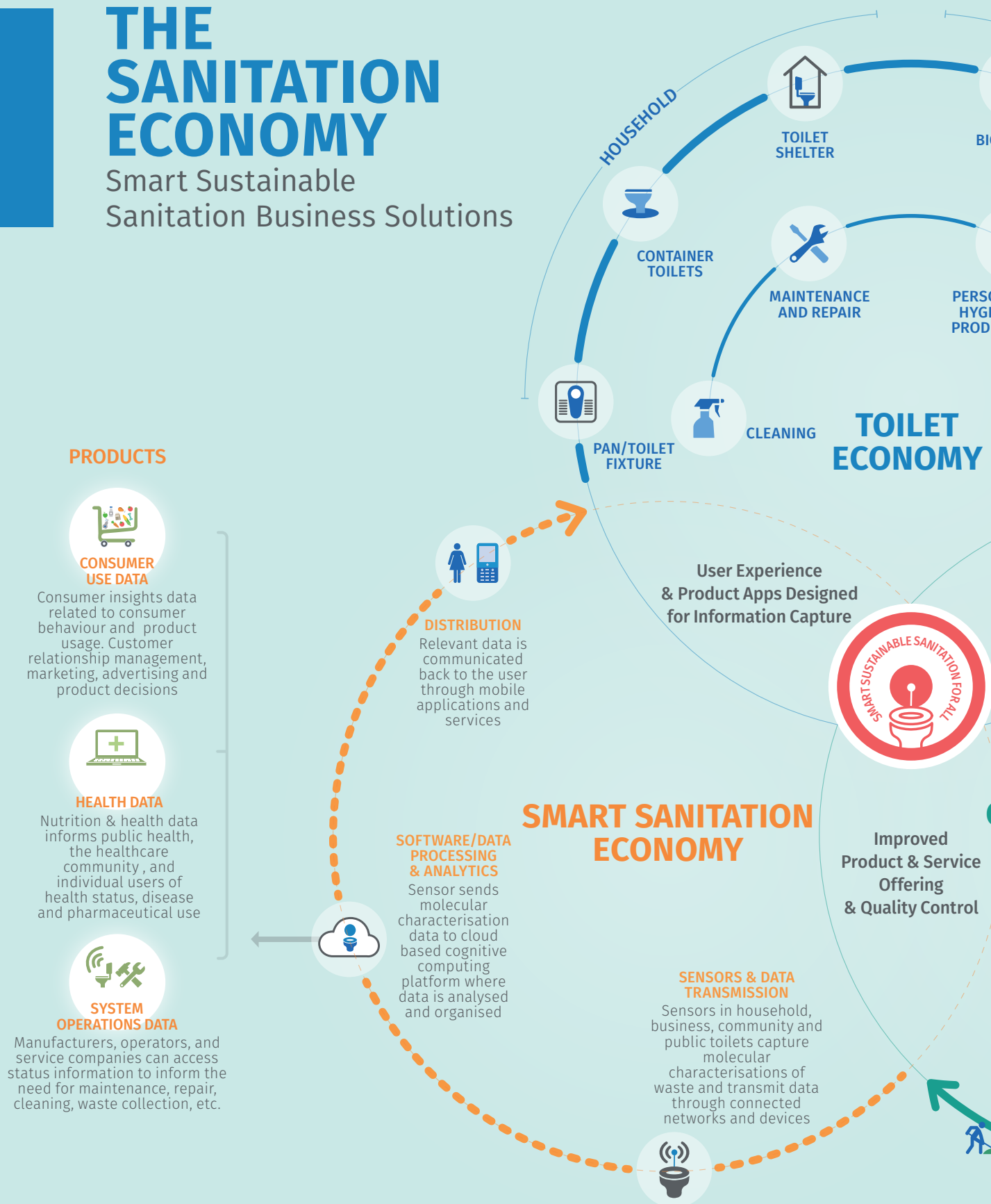
Prabhat Pani
Head of Partnerships and
Technology,
TATA TRUSTS
TBC Steering Committee

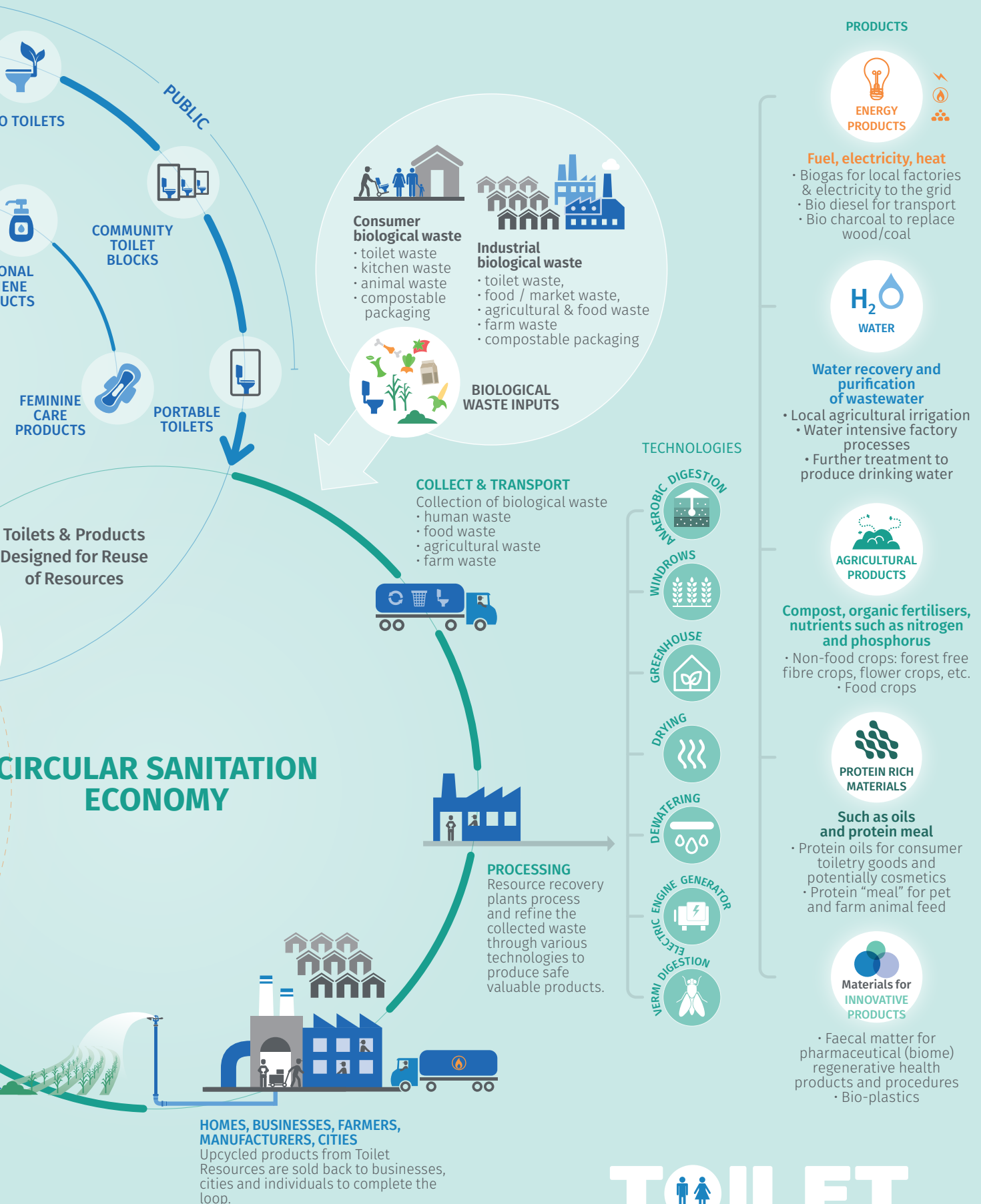


Cheryl D. Hicks
Executive Director,
Toilet Board Coalition

THE SANITATION ECONOMY

Smart Sustainable
Sanitation Business Solutions





IN SUPPORT OF THE REPORT

Mr. Parameswaran Iyer
**Secretary, Ministry
 of Drinking Water
 & Sanitation,
 GOVERNMENT OF INDIA**

“

The revolutionary change in the sanitation narrative in India since the launch of the Swachh Bharat Mission has led to a tremendous increase in the demand for and use of toilets. This has thrown up a huge opportunity for several market players. I am glad that the Toilet Board Coalition has attempted to estimate the size of this massive market, and I hope this will encourage more entrepreneurs to come up with innovative solutions to address the burgeoning demand.

Charlie Beevor
**Global Vice President
 Household Cleaning
 Brands, UNILEVER &
 TBC CHAIRMAN**

“

Millions of Indians are eagerly awaiting access to improved sanitation. The Toilet Board Coalition, with this report, sheds a new light on the impressive market opportunities that addressing this basic need entails, and makes a strong case for broader business engagement. The findings of this report confirm that the time is now for the private sector to engage in the Sanitation Economy, and in doing so, unlock significant benefits for our businesses and society. I hope that our fellow business leaders will see this opportunity and join us in accelerating the Sanitation Economy.

Kunal Kumar
**Commissioner,
 PUNE MUNICIPAL
 CORPORATION, INDIA**

“

Sanitation is the basic building block for any aspirational city/town/village. Swachh Bharat Abhiyan, the Flagship programme of the Government of India, has brought the sanitation, its stakeholders and ecosystem into the prime focus of policymakers, governments and citizens for collaborative action. It is about time to plan for sustainability of sanitation ecosystem by leveraging technology and data. I hope the project PMC is undertaking in collaboration with TBC evolves sustainable sanitation models for replication in Indian urban landscapes.

Prabhat Pani
**Head - Partnerships
 and Technology,
 TATA TRUSTS & TBC
 STEERING COMMITTEE**

“

With the Swachh Bharat Mission completing its third year, a lot of progress has been made both in urban and rural India - about 71% of India's villages have become Open Defecation Free. Tata Trusts has had the privilege of extending its support to the government through the appointment and training of 430 Zilla Swachh Bharat Preraks ("inspirer"), one in each district, to help district administrators with planning and implementation of the program. Tata Trusts have also partnered with various institutions such as MIT, IIT Bombay, University of Chicago, and private sector players to help create affordable technological solutions in the sanitation space. The next few years will see widespread installation of sanitation systems. However, this will not solve the problems of health, social dignity and the impact upon earnings, unless interventions are made across the sanitation value chain, through the coming together of global sanitation community stakeholders from across the sector. Tata Trusts sees its partnership with the Toilet Board Coalition furthering the Swachh Bharat Mission to become a reality, in its entirety.

Ms Seema Arora
**Deputy Director
 General;
 CONFEDERATION OF
 INDIA INDUSTRY (CII)
 & TBC PARTNERSHIP
 COUNCIL**

“

The Indian industry continues to play an active role in Swachh Bharat Abhiyan, be it in construction, developing innovative ways of behavior change communication, technology development, or new service delivery models. CII has stayed committed to the mission, through a number of on-ground initiatives to help communities go open defecation free. Through one such intervention, CII, along with the Toilet Board Coalition is catalyzing a coalition of private players and create a robust business sector for universal access to sanitation.

Ms Naina Lal Kidwai
**Chair of the INDIAN
SANITATION COALITION**

“

Clean water and sanitation were recognised as a basic human right by the UN General Assembly in July 2010. Around the world, as in India, poor water and sanitation have a significant impact on public health, especially on the lives of the poor. This report by the Toilet Board Coalition is an eyeopener as to how political will and private investments in WASH (Water, Sanitation and Hygiene) resulting from the Swachh Bharat Mission have accelerated access to improved sanitation for all. This study explores the various facets of different economies - Toilet, Circular Sanitation and Smart Sanitation. It achieves in shifting the conversation from cost to value, from risk to opportunity, and from waste management to toilet resource revolution, thereby, strongly establishing a business case for improved, safe and sustainable sanitation services.

Peter Bakker
**President, WORLD
BUSINESS COUNCIL
FOR SUSTAINABLE
DEVELOPMENT**

“

This report sheds new light on the opportunities for business to drive a Circular Economy through sanitation while also working to achieve the UN SDGs. This 'Sanitation Economy' is expected to be worth \$62.4 billion by 2021 in India alone, and can stimulate business to better understand the economic opportunities that exist in delivering access to the 2.3 billion people that lack access to basic sanitation. Furthermore, using a 'circular mindset' to explore new market opportunities for Toilet Resources in the areas of renewable energy, organic compost, proteins, nutrients, and more, will accelerate our path towards a Circular Economy.

Vineet Rai
**Founder & CEO,
AAVISHKAAR &
Nisha Dutt**
CEO, INTELECAP

“

Sanitation is a critical issue in India. We are really happy to see this new support for sanitation businesses and creative people with ideas that can change the face of sanitation in this country and become thriving businesses in this sector. We have been partnering with the Toilet Board Coalition through our SANKALP Summits for the past two years to support the development of robust ecosystems for the emergent sanitation sector. This new spotlight on the Sanitation Economy in India is really encouraging. We look forward to the sprouting of an abundance of exciting new sanitation businesses for our smart, circular future as a result.

*Dr. Bérangère
Magarinos-Ruchat*
**Global Head of
Sustainability,
FIRMENICH & TBC
VICE-CHAIR**

“

Toilets that smell luxurious are not a luxury. At Firmenich we are convinced that scent plays a central role in the Toilet Economy, encouraging the use of safe toilets for all and we were committed to being part of the solution. In our work at the Toilet Board Coalition, working with entrepreneurs in India and Africa, we are also learning more about new opportunities for our business in the Circular Sanitation and Smart Sanitation Economies. We encourage our business partners across food and fragrance to join us in this exciting new journey to accelerate the Sanitation Economy.

Jin Montesano
**Chief of Public Affairs,
LIXIL Corporation & TBC
STEERING COMMITTEE**

“

The challenge India is facing is enormous, but not insurmountable. We are impressed by the pace of change and steadfast commitment of the Indian government with its Swachh Bharat Mission. We are optimistic about India's efforts because of the positive impact this initiative is already having on lives and communities, and the size of the market opportunity it has opened up for private sector engagement. Our objectives at LIXIL to tackle sanitation and hygiene challenges are closely aligned with the Swachh Bharat Mission's aims. We are committed to bringing innovative solutions and products, such as the new SATO V-Trap system, to support the growing market opportunity to bring new options to millions of Indian consumers seeking to improve their standard of sanitation.

Jenny Lewis

**Vice President
KIMBERLY-CLARK
FOUNDATION & TBC
STEERING COMMITTEE
MEMBER**

“

The TBC's new framing of the Sanitation Economy touches all of the key priorities of Kimberly-Clark: Sanitation; Women & Girls; Innovation; and Sustainability. We are proud to join our TBC partners in our joint mission to accelerate growth in these important new Sanitation Economies and to stimulate the engagement of more of our business peers and supply chain partners to be the change. Creating new economies will require new collaborations across new ecosystems.

Chris Williams

**Executive Director,
WATER SUPPLY
AND SANITATION
COLLABORATIVE
COUNCIL (WSSCC)**

“

Introducing the Sanitation Economy is a timely and important contribution which helpfully advances our understanding of the potential global sanitation market. Private sector engagement is yet another positive outcome, as demand for products and services is generated through the behavior change of society. This is the exact model that the development world is seeking - community-based solutions that are government supported and commercially operated.

Perry Rivera

**COO MANILA WATER
& Managing Director,
AYALA GROUP &
TBC INDEPENDENT
DIRECTOR**

“

I commend the TBC and its research team for framing the Circular Sanitation Economy. I hope that the new, emerging and leading-edge business-led model will disrupt the market, create exciting opportunities, address the sanitation crisis and make the world a better place for all.

Rajeev Kher

**CEO and Founder 3S
and SARAPLAST PVT
LTD, Chairperson of the
PORTABLE SANITATION
ASSOCIATION OF INDIA
& TBC INDEPENDENT
DIRECTOR**

“

The Sanitation Economy market study is an elaborate effort to create awareness, encourage and even elaborate the opportunities that are prevalent in the circular economy of sanitation which could unleash a huge potential in the sanitation sector making it a main stream industry and an activity that would create not only impact but also boost alternative fuel and allied industry and give impetus to employment generation which would also attract massive capital investment into the sector thus creating phenomenal return on investment and social capital.

Portia Persley

**Office of Water (E3/W),
Bureau for Economic
Growth, Education and
Environment
U.S. AGENCY FOR
INTERNATIONAL
DEVELOPMENT (USAID)
& TBC STEERING
COMMITTEE**

“

With the increasing number of countries around the world devolving authority to the sub-national level and taking a more decentralized approach to governing, it makes perfect sense for the sanitation market to continue to launch solutions that meet governments and people where they are in terms of need - be it urban, rural, sewerage or non-sewerage.

Karl Hofmann

**President and CEO,
POPULATION SERVICES
INTERNATIONAL (PSI)**

“

I applaud the Toilet Board Coalition for framing the sanitation challenge as a business opportunity. This is how we will unlock faster progress for women and their families in particular. We look forward to working closely with governments, the private sector and consumers to make the most of these opportunities.

Jon Lane

**Former CEO of the
WATER SUPPLY
AND SANITATION
COLLABORATIVE
COUNCIL (WSSCC) &
TBC VICE-CHAIR**

“

The sanitation sector in developing countries has been dominated historically by the public sector and development agencies. Despite their best efforts, huge numbers of people still lack safely-managed sanitation. We must therefore harness the energy and ingenuity of the private sector. The concept of the Sanitation Economy is intended both to attract private sector interest and also to explain to other people the benefits of private sector involvement and thus reduce the barriers of misunderstanding that have hampered its uptake until now. India has huge numbers of dynamic entrepreneurs. It also has the large majority of the world's open defecators. A vibrant Sanitation Economy can help the former people to serve not only the latter people but also their many compatriots who have some toilets but are not safely managing the resources from them. I hope that the Toilet Board Coalition's work can help to catalyse and accelerate the development of that Sanitation Economy.

Jessica Brooks

**Head of Innovation &
Strategic Partnerships,
SVADHA WASH PRIVATE
LIMITED & TBC TOILET
ACCELERATOR 2016**

“

The growth of interest in sanitation in India over the last few years has been inspiring. Today, we are seeing more actors and types of actors participating – from the government-led Swachh Bharat Mission, consumer financing schemes led by MFIs and banks, and innovation and incubation across the private sector and academic institutions. This is such an important development, as we believe this sector has largely been overlooked and instead addressed with a 'one-size fits all' approach for consumers. However, there is much more work to be done. The Toilet Board Coalition's work is very timely and important for highlighting how big and diverse the sanitation business opportunity really is. We at Svadha have experienced the dynamism of the Sanitation Economy: last year, we grew our B2B customer base by 600% while launching new products and services – some developed internally and others through partnerships with multinational corporations. Svadha is also exploring opportunities in the Smart Sanitation Economy for the next phase of our mission towards integrating the sanitation ecosystem. We hope this report will encourage other entrepreneurs, businesses, and investors to join us in this challenging but rewarding ecosystem.

Pascale Guiffant

**Former Deputy
VP Sustainable
Development &
Reputation, SUEZ &
TBC INDEPENDENT
DIRECTOR**

“

The sanitation crisis we have been facing for years really needs a broad mobilisation of actors. We know that if we only rely on implementing new sewer systems, many people will still have to wait a long time for sanitation. Sanitation entrepreneurs are bringing innovation and new solutions that will help in accelerating the development of access to sanitation. They are also bringing a Circular Economy vision with innovation, technology and new business models. Operators will gain from contracting with them and helping their solutions to scale up.

Madhu Rajesh

**Director of Partnerships
& Development, WATER
& SANITATION FOR THE
URBAN POOR (WSUP)**

“

Alongside the public sector, the private sector can play a key role in delivering sanitation solutions for the poorest urban citizens, and Water & Sanitation for the Urban Poor welcomes Toilet Board Coalition's work in articulating just how businesses can get involved.

ACKNOWLEDGEMENTS

Project Team

Sourabh Gupta & Manish Sahu, Tata Strategic Management Group (Research)

Prabhat Pani, Tata Trusts & Rajeev Kher, Saraplast (Advisors)

Cheryl Hicks & Sandy Rodger (Editors)

Market Estimates & Insights

Sourabh Gupta & Manish Sahu, Tata Strategic Management Group

About Tata Strategic: Founded in 1991 as a division of Tata Industries Ltd, Tata Strategic Management Group is the largest Indian owned management consulting firm.

TBC Team

Cheryl Hicks

Alexandra Knezovich

Claire Balbo

Floriane Goy

Michael Lindenmayer

Sandy Rodger

Jasmine Burton

We thank all of the Toilet Board Coalition members and experts who have contributed to this report.

DISCLAIMER

The contents of this study provide a synthesis of our discussions, estimates and insights from the study. All information has been subject to the interpretation of the authors, TATA Strategic Management Group and the Toilet Board Coalition Secretariat. It does not necessarily represent the views of all Toilet Board Coalition members, or those companies and experts who participated in the study.

IMPORTANT NOTES

This study attempts to provide first insights into the potential of the Sanitation Economy as a market with estimated market size values. It is a first grouping of products specific to the Sanitation Economy, many of which are not yet present in the Indian market, or are under development. Data has been limited as a result. This study has focused on the use of available data vs. extensive modelling.

While market insights may reflect certain trajectories for growth, our market estimate numbers reflect only data available today, including demonstrated growth rates. In terms of share of market, the market numbers reflect the share of market of the products today, based on available data, and has not modelled growth in product categories or for products competing for the same resources. As a result, views on the potential for the Sanitation Economy market are not necessarily reflected in the market estimates stated in this report, as we do not yet have data to reflect this. Having said that, we have tried to indicate some views on the potential for growth in the form of market insights and the citing of views from respected sources.

It is the aim of this paper, that this first attempt at estimating the Sanitation Economy markets, catalyses a new dialogue amongst stakeholders, and new data capture across product categories in order to further refine the accuracy of the market numbers.

CONTENTS

12	THE SANITATION ECONOMY
21	THE TOILET ECONOMY
35	THE CIRCULAR SANITATION ECONOMY
51	THE SMART SANITATION ECONOMY
63	APPENDICIES

THE SANITATION ECONOMY

MARKET ESTIMATE: THE SANITATION ECONOMY

The SANITATION ECONOMY is a **US \$32 BILLION** per year market in India today and set to double to an estimated **US \$62 BILLION** by 2021.*



*Based on available data from selected product and service categories. Does not entail detailed market research.

WHAT IS THE SANITATION ECONOMY?

The Sanitation Economy is a robust marketplace of products and services, renewable resource flows, data and information that could transform future cities, communities and businesses.

It presents vast potential for global economic growth and the societal benefits of universal access to smart, sustainable sanitation.

It leverages innovative new business models, established businesses with scale and disruptive technologies to transform sanitation systems fit for our common future.

The Sanitation Economy links three distinct areas for business and societal benefit:

THE TOILET ECONOMY

Toilet product and service innovation that provides toilets fit for purpose for all contexts and incomes. This spans centralised and decentralised, sewered and non-sewered, high water tables and low, low-income to high, rural, urban and peri-urban. Toilet designs apply Circular Sanitation Economy principals to minimise waste and GHG, and capture data to feed the Smart Sanitation Economy.

THE CIRCULAR SANITATION ECONOMY

Toilet Resources (the TBC's preferred term for human waste) feeding into a system which replaces traditional waste management with a Circular Economy approach. It connects the biocycle, utilising multiple forms of biological waste, recovering nutrients and water, creating value-adding products such as renewable energy, organic fertilisers, proteins, and more.

THE SMART SANITATION ECONOMY

Digitised sanitation systems that optimise data for operating efficiencies, maintenance, plus consumer use and health information insights - and is a key part of smart cities architecture.

The economic case for the Sanitation Economy is becoming increasingly clear. Evidence now exists of working business models, technologies, and demand - momentum is building.

See our sister report, "The CIRCULAR SANITATION ECONOMY: New Pathways to Commercial & Societal Benefits."
Toilet Board Coalition.
November, 2017.

SANITATION ECONOMY PRINCIPLES

The Sanitation Economy is smart, sustainable, innovative, cost saving and revenue generating. Many businesses do not see their exposure to poor sanitation and have lacked a toolbox of business solutions to address potential risks. The costs to governments and businesses associated with the implementation of centralised sanitation systems - and the costs to society in the case of poor or non-existent sanitation systems - are well documented, US \$260 billion¹. Progress in technological developments, new business models and political will for alternative sanitation solutions that address low-income, water scarce, and non-sewered contexts have evolved significantly over the past decade, and are on the rise. Alternative toilet and waste management solutions can be delivered through the market at a lower cost to governments; can generate revenue for business owners; and can be net producers of valuable resources such as water, energy, nutrients, proteins, data and information. These alternative and complementary models present a new development pathway of opportunities for governments and the business sector to achieve SDG 6, universal access to improved sanitation.

BUSINESS AND SOCIETAL BENEFITS : ADDRESSING RISKS, CREATING OPPORTUNITIES

- 2.3 billion people globally lack access to basic sanitation - a toilet
- 61% of the global population do not use a safely managed sanitation service; that is, excreta safely disposed of in situ or treated off-site
- 892 million people worldwide still practise open defecation²
- Closing the sanitation gap through pit latrines would be expected to cause large increases of India's annual greenhouse gas (GHG) emissions, equivalent to 7% of current levels³
- Water-use efficiency improvements are considered instrumental to address the projected 40% gap between demand and supply and mitigate water scarcities by 2030⁴
- Universal access to water and sanitation by 2030 implies all settings, not only households, but also schools, health care facilities, workspaces and other public spaces⁵
- 3.8 trillion litres (500L p.p./a x 7.6 billion global population 2017)⁶ of Toilet Resources (excreta) created each year (based on current population) reliable, renewable resource (and growing) - which can be used to create treated water, renewable energy, organic fertilisers and protein products
- Data can be captured throughout the sanitation system to inform operational decision-making. Data captured from within the composition of Toilet Resources can provide new information related to human health and behaviour⁷
- For every US \$1 invested in water and sanitation, US \$4.30 is generated in economic⁸ returns through increased productivity
- The delivery of sanitation faster, at scale
- Lower-cost and revenue-generating sanitation delivery
- A flexible, scalable, approach requiring less infrastructure
- Renewable materials and energy, and improved waste disposal
- Private sector and investor engagement

1 World Bank (2013), WB confronts US\$260 Billion a year in Global Economic Losses from lack of Sanitation, Washington, <http://www.worldbank.org/en/news/press-release/2013/04/19/wb-confronts-us-260-billion-a-year-in-global-economic-losses-from-lack-of-sanitation>

2 WHO/UNICEF joint Monitoring Program (JMP), (2017), Progress on Drinking Water, Sanitation and Hygiene 2017 – update and SDG Baselines, Anna Grojec, Switzerland

3 Kulak M., Unger N., King H., (2017), Technology choices in scaling up sanitation can significantly affect greenhouse gas emissions and the fertiliser gap in India, Unilever Safety and Environmental Assurance Centre (SEAC), <http://washdev.iwaponline.com/content/early/2017/06/22/washdev.2017.005>

4 United Nations, (2016), World Water Development report – Water and Jobs, <http://www.unwater.org/publications/world-water-development-report-2016/>

5 WHO/UNICEF joint Monitoring Program (JMP), (2017), Progress on Drinking Water, Sanitation and Hygiene 2017 – update and SDG Baselines, Anna Grojec, Switzerland.

6 H. Zeeuw and Pay Drechsel ed. RAUF Foundation & International Water Management Institute (IWMI) (2015). Cities and Agriculture: Developing Resilient Urban Food Systems. Earthscan by Routledge. New York.

7 MIT underworlds, (2015), A vast reservoir of information on human health and behavior lives in our sewage, <http://underworlds.mit.edu/>

8 WHO/UNICEF joint Monitoring Program (JMP), (2017), Progress on Drinking Water, Sanitation and Hygiene 2017 – update and SDG Baselines, Anna Grojec, Switzerland.

THE SANITATION ECONOMY: MARKET ESTIMATES FOR INDIA

1 THE SANITATION ECONOMY

is a **US \$32 BILLION** per year market in India today and set to double to an estimated **US \$62 BILLION** by 2021.

2

THE TOILET ECONOMY

Toilet construction, operations and maintenance including cleaning are in high demand today to provide universal access to sanitation by 2019. A **\$14 billion** market today and estimated to more than double to **\$31 billion** market per year by 2021. In addition, the toilet upgrade market is already showing that once households have a toilet they spend another 52% of the cost of the original toilet on upgrades and accessories.

3

THE CIRCULAR SANITATION ECONOMY

The recovery of Toilet Resources for water, energy and agriculture are in pilot phases around the country but are already worth an estimated **\$14 billion** today and could be worth **\$25 billion** by 2021. New markets for treated water, renewable energy, organic compost, proteins, nutrients and more.

4

THE SMART SANITATION ECONOMY

The digitisation of sanitation systems and capture of data from them is today undeveloped and untapped but could generate an estimated **\$6 billion** by 2021. If sanitation is brought into smart city design it could tap into an estimated \$4.7 billion market by 2023 enabling the vast reservoir of information on human health and behaviour that lives in our sewage to be monitored. New markets for sensor makers, data analytics, public health, consumer healthcare, pharmaceutical, insurance etc.

5

Opportunity for businesses across sectors to ensure sanitation access for employees and communities where they operate.

6

Opportunity for businesses across sectors to contribute their own Toilet Resources to the Sanitation Economy to achieve zero waste targets and generate new revenue streams.

7

Opportunity for operators to leverage new business models to enable benefits faster and at lower cost.

8

Opportunity for smart cities solution providers to integrate sanitation systems into smart infrastructure and information architecture.

9

Opportunity for governments to deliver sanitation services faster, at lower cost and with revenue generation and promotion of new markets for private sector engagement and investment.

MARKET ESTIMATES

TABLE 1: THE SANITATION ECONOMY MARKET ESTIMATES 2017-2021

	2017	2021	SHARE OF MARKET
SANITATION ECONOMY	\$32 billion	\$62 billion	
TOILET ECONOMY	\$14 billion	\$31 billion	50%
CIRCULAR SANITATION ECONOMY	\$14 billion	\$25 billion	40%
SMART SANITATION ECONOMY*	\$4 billion	\$6 billion	10%

**This study recognises that the Smart Sanitation Economy is the least developed economy of the 3 Sanitation Economy market opportunities that the TBC has identified. That said it is an important one as it could be a game changer for sanitation for lowering sewage management costs and providing revenue generating opportunities in the use of data extracted from the sanitation system.*

TABLE 2: THE SANITATION ECONOMY MARKET ESTIMATES BY PRODUCT / SERVICE

IN BILLIONS \$USD	2017	2021	SHARE OF MARKET
SANITATION ECONOMY	\$32	\$62	
<u>TOILET ECONOMY</u>	\$14	\$31	50%
Household Toilets	\$6	\$17	
Community Toilets	\$0.2	\$0.5	
Portable Toilets (Slums)	\$0.1	\$0.2	
Cleaning	\$7	\$11	
Maintenance & Repair	\$1	\$3	
<u>CIRCULAR SANITATION ECONOMY</u>	\$14	\$25	40%
Water	\$10	\$19	
Compost	\$0.9	\$2	
Proteins	\$0.6	\$0.9	
Electricity from Biogas	\$2	\$3	
Biochar	\$0.1	\$0.3	
<u>SMART SANITATION ECONOMY*</u>	\$4	\$6	10%
Health Data	\$2	\$3	
Smart Logistics	\$2	\$3	

** The 2021 market estimates are made by projecting forward based on a variety of factors, including population and economic growth, inflation, and specific factors which may grow these markets ahead of the wider Indian economy - e.g. policy on renewable energy. Within this, inflation accounts for 26% of the growth - ie to put these numbers in 2017 money, divide by 1.26.*

*** Market estimate numbers have been rounded to the nearest billion for simplicity. Numbers below a billion have been rounded to the first decimal point.*

SETTING THE SCENE FOR THE SANITATION ECONOMY IN INDIA

We have focused this report on India (our first endeavour to estimate the market value of the Sanitation Economy) because we have been inspired by the actions, evidence and results of accelerated access to improved sanitation which can in large part be attributed to the shift in political will from the Modi government to take swift action to achieve universal access to improved sanitation in India in just 5 years 2014-2019 under the Swachh Bharat Mission (SBM) campaign.

We have considered two key drivers in the Indian context – the first being a strong push in sanitation by the government (through its ministries and initiatives such as SBM⁹) as well as international bodies (United Nations, SDGs¹⁰), and the second being the investments by corporates and private players in the areas of Water, Sanitation and Hygiene (WASH).

India faces two major challenges – first is waste generation and its management, and the second is lack of access to a basic sanitation facility like a toilet. As per Tata Strategic estimates, India produces around 54 million tonnes of solid waste every year. And as per UNICEF India, around 564 million people (nearly half the population of India), defecate in the open.¹¹

Swachh Bharat Mission (SBM)¹². The programme of the Ministry of Drinking Water & Sanitation, has been assigned specific targets on access and use of toilets, waste management and sanitation to make India Open Defecation Free (ODF) by October 2, 2019. The government has allocated an envelope of US \$3 billion as a budget for this mission for the year 2017. In addition to this, the initiative has been accompanied by regulations, provisions and participation of other stakeholders supporting the agenda of sanitation in the country. Some of them are as follows:

- Solid Waste Management Rules (SWM) 2016¹³ – A new directive under the Ministry of Environment, Forests and Climate Change includes features such as waste to wealth creation, processing of bio-degradable waste at sources such as restaurants, resident welfare and market associations, utilisation of non-recyclable waste for generating re-use
- Pradhan Mantri Awas Yojana – Housing for All (2015-2022)¹⁴ aims for in-situ rehabilitation of existing slum dwellers through affordable housing and subsidy for beneficiary-led individual house construction/enhancement
- Smart Cities Mission (2015), a part of the Digital India initiatives is an urban renewal and retrofitting programme under the Ministry of Urban Development with a US \$15 billion budget to develop 100 Smart cities across the country making them citizen friendly and sustainable¹⁵
- Allocation of targets under SDG goals to respective government departments
- Focus of Corporate Social Responsibility programmes on the issue of WASH (Water Sanitation & Hygiene) with 90% of companies having at least one CSR programme in WASH¹⁶.

9 SBM: Swachh Bharat Mission

10 SDG: Sustainable Development Goal

11 Angus Ingham, 'Five Facts about Poop in India, UNICEF

12 <http://swachhbharatmission.gov.in/SBMCMS/sbm-mis.htm>

13 http://www.moef.nic.in/content/so-1357e-08-04-2016-solid-waste-management-rules-2016?theme=moef_blue

14 <http://www.mygovschemes.in/central-government/pradhan-mantri-awas-yojana-pmay-housing-for-all-by-2022>

15 <http://smartcities.gov.in/content/>

16 Capital Market – Live news, (2016), Report Mapping the CSR trends in Water Sanitation and Hygiene in India, http://www.business-standard.com/article/news-cm/report-mapping-the-csr-trends-in-water-sanitation-and-hygiene-in-india-116052700437_1.html

TABLE 3: INDIA SANITATION IN NUMBERS

INDIA SANITATION IN NUMBERS		
SIZE OF POPULATION (UN Sept.29.2017)	1'342'826'972	PPL
NO. PPL OPEN DEFECACTION (ODF) - 50% OF POPULATION (UNICEF/WHO 2011)	564'000'000	PPL
NO WITHOUT TOILETS (PPL / HH) - 2017	82'800'000	HH
NO. TOILETS BUILT SINCE 2014 (SBM WEBSITE OCT 2017)	54'300'000	TOILETS
TOILET RESOURCES AVAILABLE BY TOTAL POPULATION (500 L PPI/YR)	671'413'486'000	L
FAECAL SLUDGE COMPONENT ONLY CURRENTLY CAPTURED & TREATED	46'000'000	T
BIOLOGICAL WASTE GENERATED (T/YR)	295'000'000	T
THOSE WITH ACCESS TO BASIC HEALTH INFORMATION (Estimated 30% urban vs. Rural population)	402'848'091.6	PPL
GOV'T SPEND ON SWACHH BHARRAT MISSION (SBM)	3'000'000'000	US\$/YR
GOV'T SPEND ON SMART CITIES	7'300'000'000	US\$
CORPORATE SPEND (MEDIAN CSR WASH BUDGET)	750'000	US\$

Inadequate sanitation facilities causes India economic losses of US \$53.8 billion a year¹⁷.

India loses up to \$600 million on medical treatment and lost production and 73 million working days are lost each year due to water-borne diseases¹⁸.

The median CSR WASH budget was '4.65 crore' or \$715'000¹⁹.

This study estimates that the Sanitation Economy in India is a business opportunity which could well be worth \$32 billion in 2017 and could double to \$62 billion by 2021. The scope for application of smart, sustainable business solutions within the Sanitation Economy is significant, and relatively untapped. The combination of estimates for the Toilet Economy, the Circular Sanitation Economy and Smart Sanitation Economy offer a unique opportunity for growth.

These estimates, derived from this study conducted by the Tata Strategic Management Group between the period August-October 2017, are based on available data for twelve product and service categories associated with the Sanitation Economy's smart sustainable sanitation business solutions portfolio - outlined in Table 2.

The twelve product and service categories studied in this report do not represent the full range of products and services associated with the Sanitation Economy. These products and services were selected based on best available data, prominence in the Indian market, and experience of Toilet Board Coalition members and Toilet Accelerator cohorts.

Future challenges for the Sanitation Economy in India may include: public and / or government reception of reinvented toilets, Circular Sanitation Economy waste management solutions' use of Toilet Resources, and the acceptance of technological interventions, especially when it comes to data privacy; policy change in relation to

17 World Bank Group – Water and Sanitation Program (WSP), (2010), The Economic Impacts of Inadequate sanitation in India, <https://www.wsp.org/sites/wsp.org/files/publications/wsp-esi-india.pdf>

18 USAID Factsheet: <http://populationfoundation.in/wp-content/uploads/2015/09/Water-For-Health-and-CSR.pdf>

19 Anushree P., Poorvaja P., Richa M., Dakshini B., (2016), CSR in Water, Sanitation & Hygiene (WASH) What are India's Top Companies up to?, Samitha & India Sanitation Coalition, India.

renewable energy, water scarcity, and organic fertilisers.

The Swachh Bharat Mission, provides an ideal platform within which to support the Sanitation Economy and its solutions that propose significant benefits for business and society.

To realise these benefits strong and visionary business leadership is needed to disrupt current sanitation lock-ins and to lead the way through the transition phase. Policy-makers and NGOs will play important roles, simultaneously setting the direction and facilitating collaborative initiatives.

India's experience in pioneering the Sanitation Economy could provide inspiration and evidence for its future in our society, and not just for India but for our world.

THE SANITATION ECONOMY ADDRESSES THE GLOBAL SANITATION CRISIS & SUPPORTS KEY STAKEHOLDER INITIATIVES

Transforming our world: the 2030 Agenda for Sustainable Development

In September 2015 the United Nations, launched the Sustainable Development Goals (SDG) to 2030. A follow on to the Millennium Development Goals 2000–2015 which sought to 1/2 world poverty in that time, the new SDGs pledge that no one will be left behind with 17 Sustainable Development Goals and 169 targets to achieve global sustainable development.

Goal SDG 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

Citywide Inclusive Sanitation

Initiated by a growing group of institutions, this Call to Action seeks to mobilise all stakeholders to embrace a radical shift in urban sanitation practices deemed necessary to achieve citywide inclusive sanitation. Citywide inclusive sanitation means that: everybody benefits from adequate sanitation service delivery outcomes; human waste is safely managed along the whole sanitation service chain; effective resource recovery and re-use are considered; a diversity of technical solutions is embraced for adaptive, mixed and incremental approaches; and onsite and sewage solutions are combined, in either centralised or decentralised systems, to better respond to the realities found in developing country cities.

Source: Citywide Inclusive Sanitation Call To Action

<http://pubdocs.worldbank.org/en/589771503512867370/Citywide-Inclusive-Sanitation.pdf>

Corporate Investment in Sanitation in India

Along with providing government funding, the Swachh Bharat Mission has also sought active participation from the corporate sector to tackle the issue. Companies have responded to this call-to-action with enthusiasm; many leveraging Section 135 of the Companies Act, 2013, which introduced mandatory Corporate Social Responsibility (CSR), to contribute to the campaign. 90% of the 100 companies reported at least one CSR intervention in WASH over the last three years. Heavy Engineering and Manufacturing and Fast-Moving Consumer Goods (FMCG) companies were more likely to support WASH programmes than other industries. Data indicated that the most popular states for CSR in WASH were Maharashtra, Uttar Pradesh, Rajasthan, Gujarat, Tamil Nadu and Karnataka. Of the 86 companies that published information on geographical coverage, 52% were focused exclusively on rural areas, compared to only 17% which focused on urban areas. The remaining 31% were spread across mixed geographies. Despite compelling evidence that the construction of toilets alone cannot eliminate open defecation, 75% companies were supporting programmes related to creating infrastructure, such as the construction of toilets and water facilities, with little focus on programmes aimed at influencing behaviour. The operation and maintenance of sanitation facilities is essential to ensure that there is no 'functionality' gap due to poor conditions that render these facilities unusable. However, only 15% of companies reported incorporating the repair and maintenance of toilets as part of their CSR initiatives.

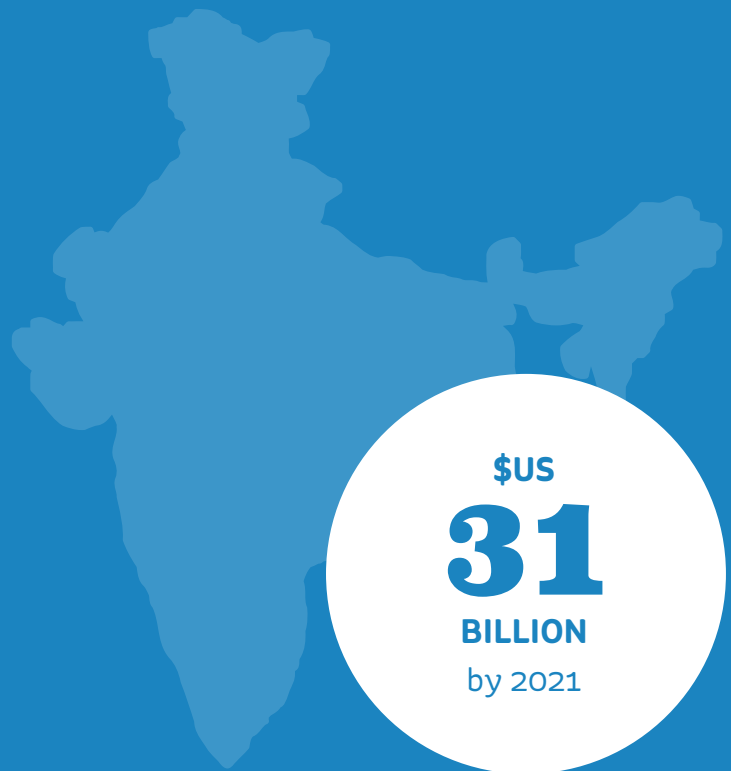
Source: CSR in Water, Sanitation and Hygiene (WASH): What are India's top companies up to? Samhita & India Sanitation Coalition 2016

THE TOILET ECONOMY

TOILET PRODUCTS & SERVICES

MARKET ESTIMATE: TOILET ECONOMY INDIA

The total market for construction of individual & community toilets, deployment of portable toilets, maintenance, repair & cleaning is estimated to be worth **\$14 BILLION** in 2017 and could more than double to **\$31 BILLION** by 2021.*



*Based on available data from selected product and service categories (Table 2) including: current number of toilets to be built under SBM; ULB's indications for the provision of community and portable toilets; and current data for maintenance, repair and cleaning. It does not entail detailed market research.

MARKET INSIGHTS: INDIA

Toilet construction is a big opportunity now to 2021, 54% of the current market and estimated to double by 2021 with a sharp decline once Swachh Bharat Mission (SBM) / Clean India goals are met - estimated 2019. However, continued population growth expected in India will continue to grow the market

Construction of household toilets in rural areas is the major contributor to the overall market (70-80%) and is expected to have a market worth of \$17 billion by 2021

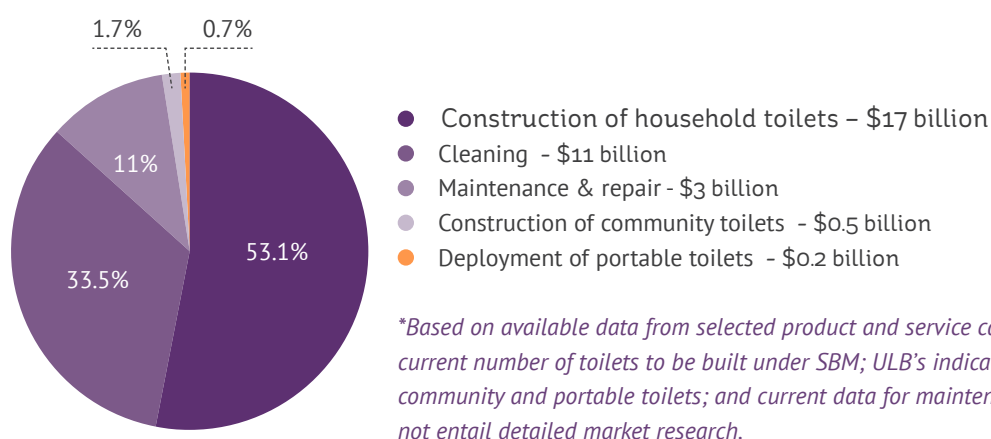
Cleaning, operations, maintenance, and repair will be the recurring revenue opportunity estimated to grow to - 14 billion per year by 2021 with 11 billion of that estimated for cleaning products and services, 34% of the market. Community & portable toilets offer a significant market opportunity in the area of maintenance & repair due to its high usage

Household toilet upgrades will be another recurring opportunity with households already spending an additional 52% of original cost of toilet on upgrades (even in lowest income households) such as tiling and consumables²⁰

The government has considered portable toilets as an immediate solution to address open defecation in urban slums. Government run Urban Local Bodies (ULBs) have been directed to provide portable toilets where community toilets cannot be constructed or are yet to be constructed. This could total about 26,000 community toilet blocks per year

Toilet innovations that enable efficient recovery of Toilet Resources for energy, agricultural products and data are not currently being deployed in India, and are not represented in the market estimates for the Toilet Economy shown here, but could be a key consideration for the future²¹

FIGURE 4: MARKET SHARE OF TOILET ECONOMY PRODUCTS & SERVICES STUDIED



An estimated 2.3 billion globally do not currently have a toilet.²²

892 million people globally defecate in the open, more than half live in India.²³

The majority of rural Indian households still do not have access to proper sanitation facilities, 70-80% according to various studies.²⁴

20 Interview with Shelter Associates CEO, Pune India, 9 October 2017

21 Ministry of Housing and Urban affairs, (2017), Guidelines for Swachh Bharat Mission – Urban, India.

22 WHO/UNICEF joint Monitoring Programme (JMP), (2017), Progress on Drinking Water, Sanitation and Hygiene 2017 – update and SDG Baselines, Anna Grojec, Switzerland

23 World Health Organisation, (2010), factsheet 2010, Tony Waddell.

24 Office of the Registrar General & Census Commissioner, (2011), Census 2011, India

WHAT IS THE TOILET ECONOMY?

The Toilet Economy is a robust marketplace of toilet product and service innovation that reinvents the toilet²⁵ to be fit for purpose for all contexts and incomes centralised and decentralised (sewered and non-sewered, high water tables and low, low-income to high, rural, urban and peri-urban), that are sustainably designed to:

- minimise GHG, water use, hazardous chemical use and malodour, as well as
- enable the Circular and Smart Economies to recover nutrients, generate energy and potentially health data.

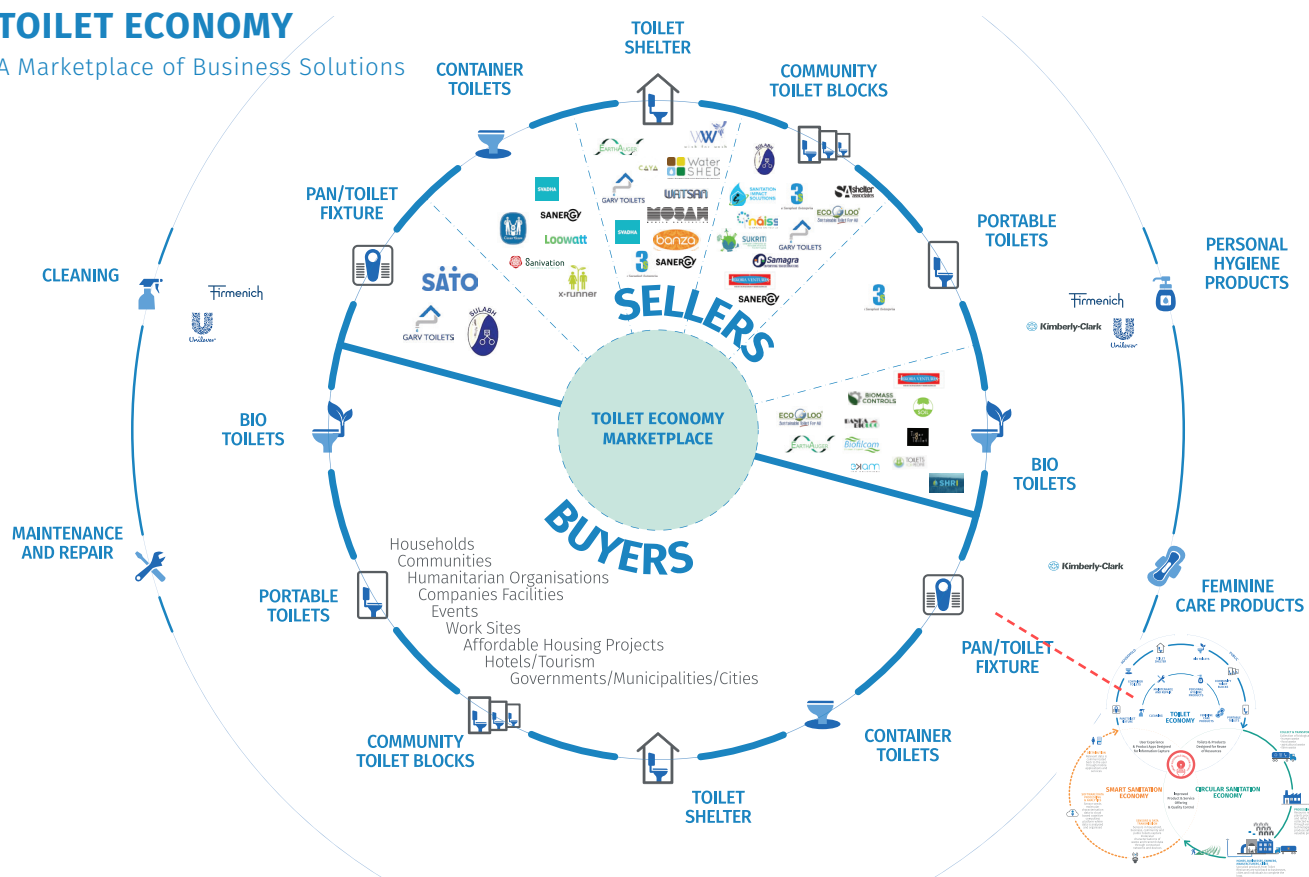
Billions of people globally currently do not have toilets. It has been said that more people have mobile phones than toilets. Viewed through an economic or commercial lens, these are billions of potential new customers for toilets, toilet or bathroom products and services, and their continuous improvements.

Around the world we are also seeing sanitation systems evolve in different ways. Not all toilets are seated flush toilets or pans. Toilets are being reinvented to be waterless, chemical-less, waste or “Toilet Resource” recovering, and are often not connected to centralised sewerage waste treatment systems. Communities and governments are now presented with new choices for the toilets and waste management systems that fit their specific context.

This section seeks to estimate the potential market of Toilet Products & Services in India 2017-2021, based on available data, and review of products and services in scope of this study – towards a market where if everyone has a toilet and there is a thriving marketplace of service provision for toilets. We compare current global estimates of toilets to be produced, cleaned, maintained and repaired, and focus in on market estimates for India.

TOILET ECONOMY

A Marketplace of Business Solutions



25 Bill & Melinda Gates Foundation, (2013), WATER, SANITATION & HYGIENE: REINVENT THE TOILET CHALLENGE, Seattle USA.

Currently 82.8 million households in India do not have access to toilets.²⁶ The majority of these households reside in rural India.²⁷ If each Indian household is to be ultimately provided with improved sanitation, this would require construction of nearly 170 million new, fully functioning toilets (Unilever SEAC calculations based on World Bank).²⁸

The UNICEF/WHO Joint Monitoring Report 2017 estimates that approximately 2.3 billion people globally do not have access to basic sanitation, including toilets, and 5.3 billion are without safely managed sanitation at home. (WHO/UNICEF, Progress on Sanitation and Drinking Water and Hygiene - 2017 Update and SDG Baseline 2017)

It is an unprecedented time in India's history where the most toilets are due to be built in the shortest period of time, as part of the ambition of the current Indian government to reach 100% coverage, or Open Defecation Free (ODF) by 2019. Recent governmental initiatives like the Swachh Bharat Mission (SBM) have accelerated the pace of construction of toilets in India. The SBM focus is on providing every household with a toilet. As a result of this initiative, 54.3 million toilets²⁹ have been built since October 2014 – when this initiative began. Demand for toilets is expected to continue to grow beyond the SBM campaign, which currently has an end date of 2 October 2019, given expected continued growth of the national population and increasing demand for affordable housing³⁰.

Additionally, the government is providing incentives and financial support for two categories of families: those living Below Poverty Line³¹ (BPL), and marginally Above the Poverty Line (APL), for construction and water provision.

Swachh Bharat Mission (SBM) Toilet Subsidy

4.4 Central government incentive for the construction of household toilets will be Rs. 4,000 per household toilet for each identified beneficiary household.

4.4.6 States will contribute a minimum of 40% funds (Rs 2,667 per IHHL) towards individual toilets to match 60% Central Share (Rs 4,000 per IHHL) (10% in the case of North East States and special category states). For UTs without legislature, Central share will be 100% (Rs 5333 per IHHL) and UT share will be nil. For UTs with legislature, Central share will be 80% (Rs 4,266 per IHHL) and UT share will be 20% (Rs 1,067 per IHHL). For North Eastern and Himalayan States, the Central share will be Rs 10800 per IHHL (90% of Rs 12000), and state share will be Rs 1200 per IHHL.

Source: Swachh Bharat Mission Guidelines

http://www.swachhbharaturban.in:8080/sbm/content/writereaddata/SBM_Guideline.pdf

26 Tata Strategic Management Group analysis basis on household data from Census 2011 and number of household toilets built under Swachh Bharat

27 Ibid

28 Kulak M., Unger N., King H., (2017), Technology choices in scaling up sanitation can significantly affect greenhouse gas emissions and the fertiliser gap in India, Unilever Safety and Environmental Assessment Council (SEAC). <http://washdev.iwaponline.com/content/early/2017/06/22/washdev.2017.005>

29 Swachh Bharat Mission Guidelines August 2017 http://www.swachhbharaturban.in:8080/sbm/content/writereaddata/SBM_Guideline.pdf

30 Ministry of Housing and Urban Affairs, (2015), Pradhan Mantri Awas Yojana-Housing for All (URBAN) 2015-2022, <http://pmaymis.gov.in/>

31 Below Poverty Line (BPL) families are those which are having an income of less than \$1.90 per day. APL families are those which are just above these families

TOILET ECONOMY PRODUCTS IN INDIA



HOUSEHOLD PAN & PIT (VARIATIONS WITH SHELTER, WITH TWIN PIT, OR SEPTIC TANK)
- Toilets in urban and rural areas for private/personal usage



COMMUNITY BLOCKS OF 6-8 / 20-40
- Fixed structures with multiple toilets being used by people residing in areas with high population densities where a community block services a set group of people in close proximity.



PORTABLE - SLUMS & TEMPORARY WORKERS
Temporary toilets that fit small spaces being used by people residing in dense areas, such as slums, as a temporary solution. Portable toilets are also used for temporary workers on construction sites and for festivals.



PUBLIC - ROADSIDE
Toilets for floating population in public spaces, most comply by the roadsides for travelers. **(MARKET ESTIMATES NOT IN SCOPE FOR THIS STUDY)**



BIO - (TRAINS)
Toilet installation & maintenance specific to Indian railways **(MARKET ESTIMATES NOT IN SCOPE FOR THIS STUDY)**



CLEANING
Cleaning of household, community and portable toilets



MAINTENANCE & REPAIR
O&M of household, community and portable toilets

KEY CONSIDERATIONS

This section provides some additional context regarding ecosystem developments that will be required to accelerate the Toilet Economy - including some insights into the current business context in India as well as some indications of innovation from around the world that could be relevant to the Indian context of the Toilet Economy in the future.

INCUMBENTS

Currently the market for toilets is served by NGOs, corporate social responsibility programmes (CSR) and government subsidy. Selling into this market will require awareness and market building, ensuring that customers perceive the toilets to be safe and as good as or better quality than what they would receive for free or at lower cost from governments or NGOs.

TOILET DESIGN

The current estimations consider only pan and pit designed toilets, mostly serving the majority of the rural population currently without toilets. The number could be bigger if new toilet innovations such as container toilets are taken into account for households that currently cannot support the pan-pit structure (such as dense urban communities).

Reinvent the Toilet & Non-sewered Sanitation (The Bill & Melinda Gates Foundation (BMGF))

The Bill & Melinda Gates Foundation's Water, Sanitation & Hygiene programme focuses on developing innovative approaches and technologies that can lead to radical and sustainable improvements in sanitation in the developing world.

A key part of the effort to radically improve sanitation in the developing world is the Reinvent the Toilet Challenge (RTTC). BMGF are funding research to develop truly aspirational "next-generation" toilets that do not require a sewer or water connection or electricity, cost less than 5 cents per user per day, and are designed to meet people's needs. Most of the projects use chemical engineering processes for energy and resource recovery from human waste.

Source: <https://www.gatesfoundation.org/What-We-Do/Global-Development/Water-Sanitation-and-Hygiene>

UPGRADE MARKET

The 'upgrade market', is largely unestimated and refers to households that wish to upgrade their first toilet purchase as toilet innovations evolve, creating repeat sales for companies selling and constructing toilets. There is some current evidence of upgrades of the space and accessories around the toilet, with some households spending another 52% of the cost of the original toilet on upgrades such as tiles and consumables³².

The replacement market is also currently unestimated and refers to new toilet design that will be needed to realise the Circular Sanitation Economy and the Smart Sanitation Economy.



PUBLIC TOILETS (out of scope of this report)

Community toilets are not to be confused with public toilets. Community toilets serve a specific community where there are no household toilets. The users remain constant.

Public toilets then refer to non-household toilets, but toilets available in public spaces when people are outside the home.

While this the provision of public toilets is also currently a priority for many local governments, we have not included public toilets in the scope of this study due to more limited data.



BIO-TOILETS (out of scope of this report)

Also public toilets, but specific to India, the Indian Railways in their two-year mission plan, have outlined the intention of installing every coach with a bio-toilet. Thus, the government plans to install bio-toilets in all of the 55,000 coaches by 2019. Bio-toilets may not present a tremendous opportunity owing to following reasons:

- The contracts and tenders for the bio-toilets are already given or being given out. Thus, by the time a new business for bio-toilet manufacturing and selling is set-up, all bio-toilets would have already been built
- Thus remaining market available would only exist for repair and maintenance, which is estimated to be small.

32 Interview with Shelter Associates CEO, Pune India, 9 October 2017

Public Toilets - Extract from SBM Guidelines

6.1. Under Swachh Bharat Mission (Urban), States and ULBs will ensure that a sufficient number of public toilets and urinals are constructed in each city. All prominent places within the city attracting floating population should be covered.

6.2. Care should be taken to ensure that public toilets have adequate provision for men, women and facilities for the disabled (e.g. ramp provision, braille signage, etc.) wherever necessary.

6.3. ULBs should ensure that all Public Toilets and Urinals being constructed under SBM (Urban) are built in tandem with water supply arrangements in ULBs.

6.4. Central government incentive for the construction of public toilets and urinals will be in the form of 40% Grant/VGF, for each toilet block constructed. The base unit cost of PTs will be calculated at Rs 98000 per seat, wherein the VGF/Grant will be upto 40% of the project cost (i.e. VGF/Grant of Rs 39,200 per seat). For urinals, base unit cost of PTs will be calculated at Rs 32000 per seat, wherein the VGF/Grant will be up to 40% of the project cost (i.e. VGF/Grant of Rs 12,800 per seat). This will be subject to overall state-wise funds envelope – sum of allocation under IHHL and CTs for the entire Mission period.

6.5. States will contribute a minimum of 40% funds (Rs 26,134 per seat towards public toilet projects to match 60% Central Share (Rs 39,200 per seat) (10% in the case of North East States and special category states). For UTs without legislature, Central share will be 100% (Rs 52,267 per seat), and UT share will be nil. For UTs with legislature, Central share will be Rs 41,814 (80%) per seat while UT share will be Rs 10,454 (20%) per seat.

6.6. For Urinals, the Central share of Rs 12,800 per seat will comprise 60% of the cost. Hence, state share per urinal will be Rs 8,534. For UTs without legislature, Central share for urinals will be Rs 17,067 (100%), and UT share will be nil. For UTs with legislature, Central share for urinals will be Rs 13,654 (80%), and state share for urinals will be Rs 3,414 (20%).

6.7. Additionally, states and ULBs may also identify land for public toilets, and leverage this land and advertisements to encourage the private sector to construct and manage public toilets through a PPP agreement. Additional funding support by any other means can also be used for public toilets. ULBs may also put up mobile toilets for use as public toilets.

6.8. The Projects will be prepared, sanctioned and implemented by ULBs. In the entire project approval and procurement process, all provisions and procedures as prescribed by respective State Governments for ULBs must be followed in their entirety. The entire approval procedure should end at the ULB level. To this end the States are required to empower the ULBs if not already done so. This includes the delegation of powers to allot land (for this purpose) to ULB's and mechanisms to leverage this land to make the Public Toilet a viable project.

6.9. All Public Toilets and urinals constructed under SBM must have a minimum 5 year maintenance contract.

6.10. ULBs should ensure that for the convenience of the public, at every public place (banks, post offices, bus stops, petrol pumps, metro stations, hospitals, restaurants, schools, health centres, anganwadis, citizen centres) there should be at least one public toilet available, and that the facility should be kept functional and open for public use.

Source: Swachh Bharat Mission Guidelines August 2017 http://www.swachhbharaturban.in:8080/sbm/content/writereaddata/SBM_Guideline.pdf

Environmental Impacts of Toilet Choices

Life cycle assessment to compare environmental impacts and nutrient recovery potentials of four different options for providing everyone in India with access to improved sanitation: (i) centralised wastewater treatment with sequential batch reactors (SBR), (ii) twin-pit latrines, (iii) latrines with source separation only and (iv) latrines with source-separation of urine and faeces connected to biogas plants. Results revealed large variability. Closing the sanitation gap through pit latrines would be expected to cause large increases of India's annual greenhouse gas (GHG) emissions, equivalent to 7% of current levels. Source separation only and centralised plants with SBR will be associated with lower GHG emissions, while the biogas scenario shows a potential to provide net emission reduction. The study revealed that source separating systems can provide significant quantities of plant available nitrogen and phosphorus at the country level.

The annual direct methane emissions from pit latrines alone would have the potential to increase the GHG emissions of India by 6% compared to this baseline.

The issue of methane emissions may be particularly relevant to India, as pour flushing toilets are likely to be adopted and this leads to anaerobic conditions in the pit. Such negative impacts could be mitigated by investing in more innovative types of toilets that could reduce methane emissions to the air.

Source: Kulak M., Unger N., King H., (2017), Technology choices in scaling up sanitation can significantly affect greenhouse gas emissions and the fertiliser gap in India, Unilever Safety and Environmental Assurance Centre (SEAC), <http://washdev.iwaponline.com/content/early/2017/06/22/washdev.2017.005>

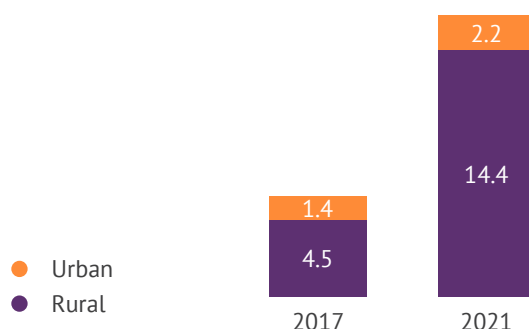
PRODUCTS

HOUSEHOLD TOILETS

MARKET ESTIMATE: INDIA

Based on the census 2011 data and SBM figures, the market for constructing household toilets for individual usage is currently **\$6 BILLION** and is expected to touch **\$17 BILLION** in 2021.

FIGURE 5: MARKET FOR CONSTRUCTION OF HOUSEHOLD TOILETS (IN BN\$)



MARKET INSIGHTS

Household toilets refer to one toilet used by a household of an average of 5 people (according to 2011 Census data). It is important to note that other sources report that the reality could be closer to up to 15 people that could be part of an average Indian household where extended family members often inhabit the same dwelling.

In India three types of toilet systems are primarily used by households for individual use.

- Toilets connected to a sewage network
- Twin-pit latrines: In low to medium density areas and where there is space to install pits
- Septic tank system: toilets where there is no sewage network

The current demand for household toilets is driven by rural families where the majority of the population do not currently have a toilet. The SBM focus is on providing every household with a toilet.

The \$6 billion currently spent annually on household toilet construction equates to the SBM numbers of 54.3 million toilets³³ which have been built since October 2014 and their estimated cost for a household toilet in the urban context is \$615 and \$385 in the rural context.

Please see APPENDIX A for all assumptions.

33 Swachh Bharat Mission website: <http://www.swachhbharaturban.in/sbm/home/#/SBM>

CURRENT BUSINESS MODEL - SVADHA, INDIA

Founded in 2015, Svadha WASH Private Limited (Svadha) was created with the vision of addressing the access to safe drinking water, sanitation and hygiene (WASH) problem for the Bottom of Pyramid (BoP) Market¹ in India. As an organisation, the company fills a unique position in the Indian WASH industry by organising the entire ecosystem for rurally based customers: research and development (R&D), product development, supply chain operations, logistics and direct sales into its retail sales level. This way, Svadha not only creates value from different parts of the value chain, which allows full quality and cost control over the organisation's output, but it also sustainably develops its entrepreneurial base. Svadha identifies, trains, and supports local entrepreneurs in manufacturing latrine components, commercialising them and ensuring installation after sales through the use of Information and Communications Technologies (ICT).

www.svadha.com

1 Hammond, A., Kramer, W., Katz, R., Tran, J. and Walker, C. (2007). The Next 4 Billion : Characterizing BoP Markets. [online] Openknowledge.worldbank.org. Available at: <https://openknowledge.worldbank.org/handle/10986/9508> [Accessed 13 Oct. 2017].

CURRENT BUSINESS MODEL - LIXIL, INDIA

In 2016, LIXIL created a specialised and dedicated business unit called SSI, or Social Sanitation Initiatives, to accelerate the design and production of new toilet and water technology solutions that are fit for purpose for low income families, water scarce and non-sewered locations around the world, as well as exploring new systems for the Circular Sanitation Economy. SSI is an entrepreneurial startup nestled inside a \$16 billion company, able to take advantage of the resources and expertise found inside one of the world's largest players in sanitary ware.

Though the SSI unit has several prototypes and/or toilet technologies in development, it already operates a commercial business in its award-winning SATO brand of products (<http://www.sato.lixil.com/>). Launched in 2013 with one model – the “SATO Pan” – this business is now global, offering a range of products tailored to local market preferences, including India where we have launched a culture-specific SATO V-Trap Connection System, a twin-pit sealing and switching system for toilet pans. SATO delivers improved sanitation to over 6 million users in over 15 countries today. SATO products are designed and produced to suit the needs and preferences of users in different regions and offer high quality, durable products with price points that start at \$2 per pan. Created to improve the user experience and safety of open-pit latrines in rural communities, SATO products enable communities to achieve ODF goals with convenient, affordable, and sustainable product innovations.

www.sato.lixil.com



COMMUNITY TOILETS

MARKET ESTIMATE: INDIA

The estimated market for construction of community toilets is currently estimated at **\$0.2 BILLION** and could be worth **\$0.5 BILLION** by 2021.

80% of urban settlements without access to toilets have been identified by ULBs³⁴ for community toilet provision. In the current year, there is a requirement of around 26'000 community toilets³⁵ in the urban slums of India.

MARKET INSIGHTS

Community toilets refer to toilet blocks of 6-8 “seat” toilets in very dense urban areas to 20-40 “seat” toilets in less dense urban areas. Some are monitored by staff with full-time security and cleaners and some are not. Some community toilets also offer additional revenue generating services such as water kiosks, showers, etc.

Population density and resulting space crunch characterises urban India. There is a significant gap between the toilets required for households in urban areas, and the toilets which are actually being built. This gap is estimated to only grow, as the urban population registers a steep growth. According to UN estimates, the population in urban India will grow to 830 million in 2040 - a 500 million increase over the current figure of 330 million.

In this case the aspiration to ensure every household has a toilet, toilets for all, also considers community and portable toilets for urban areas. Most houses are not self-owned and/or are constructed in an area less than 120 square foot, thereby eliminating the scope for construction of traditional Indian toilets, pan and pit, within those premises.

With the current pace of construction - and refurbishment - of community toilets under SBM, it is estimated that around 26 thousand community toilets could be built per year and the pace of construction would double per year with more players stepping in to capitalise on the opportunity. According to our estimates, market for construction of community toilets currently stands at \$0.2 billion and would be worth \$0.5 billion by the year 2021.

Please see APPENDIX A for all assumptions.

34 Urban Local Bodies

35 TMSG Estimates

CURRENT BUSINESS MODEL - SAMAGRA, INDIA

Inspired by the success of Unilever's Suvidha Centre¹, which is located in one of Mumbai's most challenging slums and seeks to offer a holistic approach to the issues of poor personal hygiene, lack of laundry facilities, lack of safe drinking water and poor sanitation, Samagra operates as an offline-online service providing community hub and business that includes the provision of quality communal toilets as one of the many customer offerings. Distinctively, Samagra seamlessly bundles other aspirational and value-added services such as financial services via savings account support, access to digital product services via mobile phone recharge stations and television subscriptions, and access to life-improving products and services via assisted e-commerce all in concert with the use of their quality toilets. Essentially, Samagra creates a community centre network in which clean and safe public toilets are the nucleus. Effective partnerships with municipal institutions and other service providing organisations have enabled Samagra to utilise and upgrade existing toilet infrastructure from which their "one stop shop" business model for slum-dwellers is catalysed. The host of bundled and valued services that is provided by Samagra has proven to be attractive in retaining toilet users and promoting hygienic sanitation behaviours while also making profit. Revenue is generated through vendor subleases and advertisements throughout the Samagra space.

www.samagra.co

1 https://www.hul.co.in/Images/suvidha_hygiene_centre_tcm1255-495963_en.pdf

CONTAINER-BASED SANITATION - TOILETS FOR DENSE NON-SEWERED CONTEXTS

Over the last 10 years, container-based sanitation (CBS) models have emerged as an alternative service model for the urban poor to that of either network-based sanitation or on-site sanitation services. Rather than building a sanitation facility, households or public toilet operators sign up for a service whereby the CBS service provider provides a toilet with sealable waste receptacles and commits to emptying it on a regular basis. CBS service models have been developed and implemented by a small number of sanitation entrepreneurs around the world.

CBS solutions can be deployed with different types of toilets (seated or squat; shared or private) so as to be responsive to customer preferences. The majority of CBS toilets are seated portable units that are placed inside the household, whilst Sanergy's service (a CBS solution based in Kenya) involves shared squat toilets. The toilets vary considerably in price with a general increase in convenience and comfort at higher prices, but there is no clear optimum cost/quality point. The CBS service providers collect the waste either in the customers home (or public toilet), at the doorstep, or at a drop-off point, depending on the physical constraints and customer preferences. Various combinations of transport are used to get the waste to the treatment site, depending upon the terrain and road access, and usually involve a combination of hand carriage, handcarts, three-wheeled transporters (auto-rickshaws or tuk-tuks), tractor-trailers, flatbed trucks and box trucks. To optimise the use of transport, waste is usually temporarily stored and consolidated at one or more points (transfer stations).

Source: World Bank (2017). Evaluating the Potential for Container Based Sanitation (CBS): Overview Report. Authors: Julian Parker, Sophie Tremolet and Adrien Mazeau, World Bank Water Global Practice.

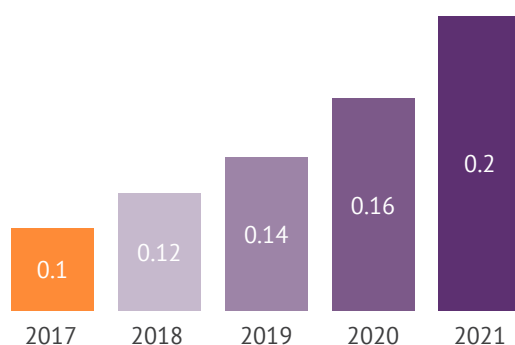


PORTABLE TOILETS

MARKET ESTIMATE: INDIA

There is an estimated current requirement of **~210,500** portable toilets for adequate coverage of all urban slums with toilet access. Considering the requirement of community toilets in urban slums, the current market for portable toilet in 2017 is **\$0.1 BILLION** and would touch **\$0.2 BILLION** by 2021.

FIGURE 6: MARKET FOR DEPLOYMENT OF PORTABLE TOILETS (IN BN\$)



MARKET INSIGHTS

The unmet requirement of community toilets in urban slums could be addressed through the usage of portable toilets. The government has considered portable toilets as an immediate solution to address open defecation in urban slums. Government run Urban Local Bodies (ULBs) have been directed to provide portable toilets where community toilets cannot be constructed or are yet to be constructed.

As per Tata Strategic estimate, currently there is requirement of ~210,500 portable toilets for adequate coverage of all urban slums with toilet access. Considering this requirement of community toilets in urban slums, the current market for portable toilet in 2017 is \$0.06 billion and would be worth \$ 0.22 billion by 2021.

Globally alternative toilet designs are being tested, especially for dense urban and low-income dwellings. Container-based sanitation is also seen as a promising solution for urban slums. (See Box on page 32). Current tests are underway in several countries in Africa, Latin America and South-East Asia.

Please see APPENDIX A for all assumptions.



MAINTENANCE, REPAIR & CLEANING

MARKET ESTIMATE: INDIA

The market for maintenance & repair for individual and community toilets are almost the same size. The total market for maintenance & repair of toilets in the current year is **\$1 BILLION** and will grow with an increase in the number of toilets. The market in 2021 is expected to be worth **\$3 BILLION**. The current market for cleaning toilets is estimated at **\$7 BILLION** and expected to grow to **\$11 BILLION** by 2021.

FIGURE 7:
MARKET FOR MAINTENANCE & REPAIR
(IN BN\$)

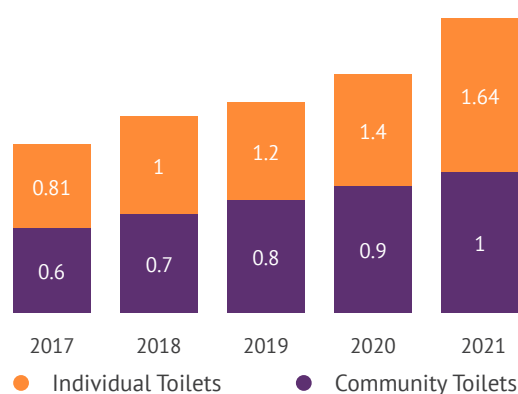
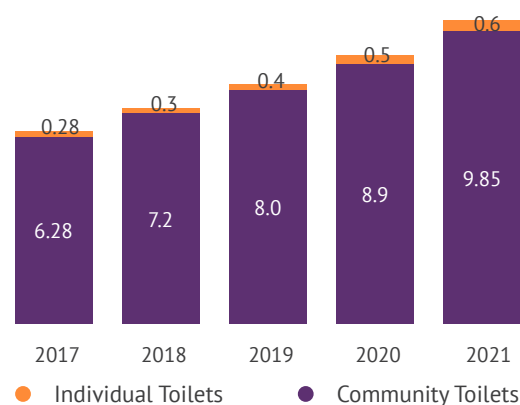


FIGURE 8:
MARKET FOR CLEANING TOILETS
(IN BN\$)



Mandatory 5 years contract for maintenance of community toilets under SBM

- Provision for incentives for cleaning toilets under SBM
- Market for cleaning is now getting more organised with service offered by professional agencies for cleaning of household toilets
- Market for cleaning in India is primarily urban locations
- Behaviour change communication to prevent open defecation, promote hygiene practices and maintenance of toilets

MARKET INSIGHTS

Generally, cleaning is carried out by domestic workers or by the local sweeper. The charge for cleaning a toilet varies along cities and towns in India. The market is now getting more organised with service providers like Urbanclap, Taskbob, Housejoy etc. providing professional cleaning service for individual toilets. The market for cleaning in India is primarily in urban locations, where individual users are ready to pay an extra cost for a professional cleaning service. Also, share of community toilets in urban locations is much higher as compared to rural locations.

All community toilets constructed under SBM are mandated to have a minimum 5 year maintenance contract and are supposed to be cleaned twice a day. The market for maintenance, repair & cleaning for individual toilets is driven by an individual perception of sanitation, health and hygiene. Increased ownership and use of toilets is driving demand for cleaning maintenance and repair. This will be an ongoing consumer need vs. construction of the toilet. Share of community toilets in urban location is also much higher as compared to rural locations.

THE CIRCULAR SANITATION ECONOMY

PRODUCTS DERIVED FROM TOILET RESOURCES

MARKET ESTIMATE: CIRCULAR SANITATION ECONOMY IN INDIA

Products derived from Toilet Resources, and organic / biological waste such as water, fuel, electricity, proteins, and organic fertilisers or compost offer tremendous scope for growth. Considering both the supply side¹ and demand side scenarios in India², the overall market for these products is estimated to be **\$14 BILLION** in 2017 and is expected to grow to **\$25 BILLION** by 2021.*



\$US
25
BILLION
by 2021

¹ Depending upon the availability of waste, volume/value of product that could be produced

² Existing market that could be captured by the product

* Based on available data from selected product and service categories (Figure 9). It does not entail detailed market research.

Important Notes: The capture, safe management and treatment for reuse of Toilet Resources in India is currently in its infancy. The market estimates consider the amount of Toilet Resources currently being captured and treated, with a margin for growth based on the current growth rate. This number is still relatively small in relation to the total amount of Toilet Resources being produced by the population. As it is not certain how the different technologies and products will develop in the Indian market, we have aimed to consider only data available today for the market estimates, however, providing a number of market insights that may provide early indications of future market potential.

As an illustrative example, data analysed for this study found that 46 million tonnes of faecal sludge are currently captured for treatment annually. However, based on the common understanding that each person excretes about 500 L of Toilet Resources (urine and faeces) per year multiplied by the population of India, 1.3 billion (UN Sept.2017) would amount to approximately 650 billion tonnes of Toilet Resources that could be used as feedstock for the products discussed in this paper. Of course Toilet Resources are also not the only biological feedstock, this study also considers agricultural waste, biological municipal solid waste, and non-hazardous biological waste. Current volumes of these feedstocks have also not been optimised between what is available and what is currently being captured.

In addition, this study finds a major market for treated water, bigger than the other re-use markets combined. This is undoubtedly a major opportunity in water-stressed areas and where the sanitation systems use large amounts of water. However this number may not be as big where water stress is a lesser issue or systems handling Toilet Resources from pits, or container toilets with urine diversion, rather than flush toilets with sewers, so much less water is present and available to recover. As the world looks to close the global water gap of 40% more demand than available supply it is expected that water saving systems will be in favour, and therefore in the scenario where the original use of water is less, there would also be less wastewater to treat and reuse.

MARKET INSIGHTS : INDIA

Water is the largest potential market (77%)³⁶ of the overall market for products from biological waste. Treated water could replace current water usage in manufacturing / industrial sectors

Organic fertilisers (or compost) could become more prevalent in the market due to current government incentives and as modern farming practices trend towards more organic base with mineral supplements. The compost market in India currently represents (6%)³⁷ of the potential market for products from biological waste. It is a high potential market segment which is expected to grow significantly as the Indian government has mandated its production and providing support for its marketing

Demand for proteins for poultry and aquaculture are growing in India. India is the largest and fastest growing compound feed market. The protein feed market currently represents 4% of the potential market for products from biological waste. Aqua feed comprises (43%)³⁸ of market share in the overall protein feed market, poultry feed has the major share (57%)³⁹

Electricity from biogas is the second-largest potential market (at 12%)⁴⁰ of the overall market (for products from Toilet Resources). The future potential market is expected to grow as the government aims to increase its renewable energy sources and electricity from biogas is part of a major initiative in the area of waste to energy.

36 Ministry of Environment, Forest & Climate Change - Central Pollution Control Board (CPCB), (2015), Annual Report 2014-2015, Chandu Press, New Delhi.

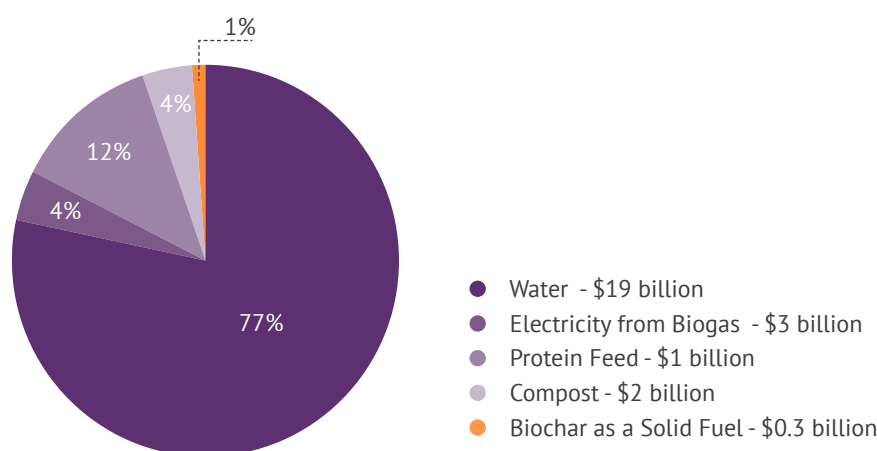
37 Non-hazardous waste

38 J.S. Kamyotra and R.M. Bhardwaj, (2011), India Infrastructure Report 2011 - Municipal Wastewater Management in India, Oxford University Press, p. 299, India.

39 The Times of India, (June 2015), Farmers must learn to managing agro waste: Experts, 150 million tonnes of agri waste generated in India, estimated basis on growth for 2017 to 2021, <https://timesofindia.indiatimes.com/city/nagpur/Farmers-must-learn-to-managing-agro-waste/Experts/articleshow/47569956.cms>

40 Faecal sludge collected in any system (sewage line or septic tank)

FIGURE 9: MARKET SHARE OF CIRCULAR SANITATION ECONOMY PRODUCTS = \$25 BILLION (2021)



WHAT IS THE CIRCULAR SANITATION ECONOMY?

The Circular Sanitation Economy is a robust marketplace of sanitation and waste management integrated into a Circular Economy that connects the biocycle, recovers nutrients and water, and generates value-adding products such as renewable energy, organic fertilisers, proteins, and more.

Bringing sanitation into the Circular Economy enables us to recover vast amounts of valuable, renewable, and reliable biological materials, generated everyday by a growing population. The value in biological waste is starting to be recognised, however, the biological waste source from our toilets are rarely included.

In our 2016 report, **Sanitation in the Circular Economy: Transformation to a Commercially Valuable, Self-Sustaining, Biological System⁴¹**, the Toilet Board Coalition introduced the vast business opportunity to monetise the biological resources flowing through our toilets, which we reframed as “Toilet Resources”, value that is virtually untapped and currently flushed down the toilet.

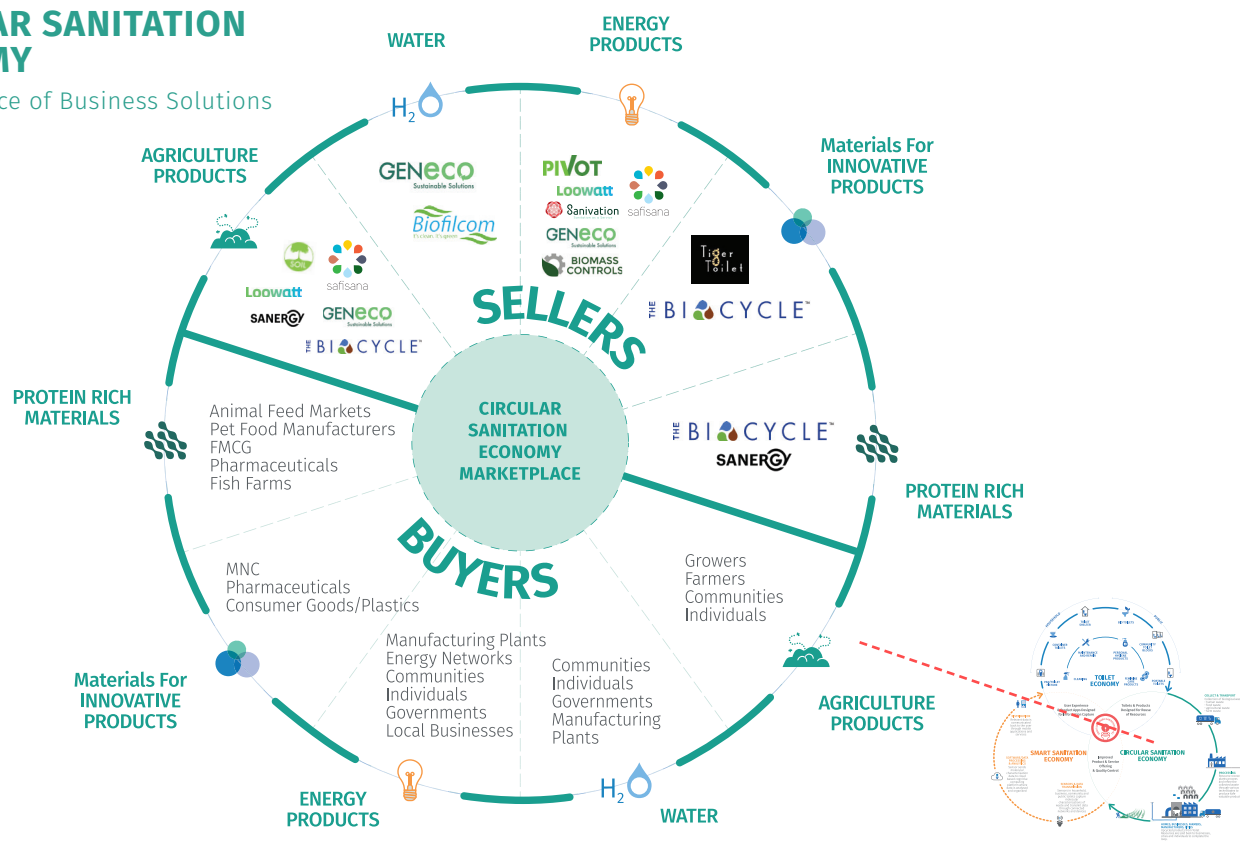
In 2017, the Toilet Board Coalition reviewed the economics of current circular sanitation business models and found that circular sanitation businesses could bring significant commercial and societal benefits faster and at scale, at lower cost and while generating revenue. Therefore offering an alternative development pathway for both incumbent operators and small scale innovators that is less large infrastructure dependent and faster to implement. See our report, **The Circular Sanitation Economy: New Pathways to Commercial and Societal Benefits Faster at Scale**.

This section seeks to estimate the potential market value of Toilet Resources if they are fully captured from sludge, wastewater, biological municipal solid waste, and managed to optimise market value. We compare current global estimates of several products derived from Toilet Resources, and focus in on market estimates for India. Amounts of biological waste, including Toilet Resources, available and captured drive this economy.

41 http://www.toiletboard.org/media/17-Sanitation_in_the_Circular_Economy.pdf

CIRCULAR SANITATION ECONOMY

A Marketplace of Business Solutions



A NEW RESOURCE BASE

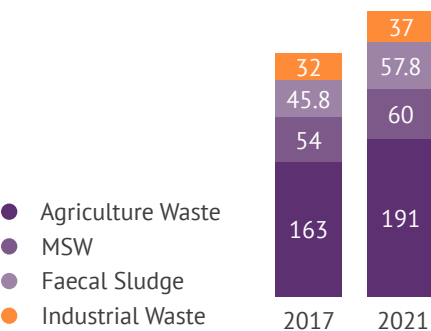
To understand the market potential for Toilet Resources and biological waste derived products we seek to understand the current availability of biological waste inputs, and new potential to drive growth in the capture and use of biological resource base.

BIOLOGICAL WASTE = Compostable Municipal solid waste (MSW), industrial (non-hazardous) biological waste, agricultural waste, and Toilet Resources (faecal sludge, and sewage).

SCENARIO OF BIOLOGICAL WASTE GENERATION IN INDIA

As per Tata Strategic estimates, currently India generates 295 million tonnes of biological waste annually. This constitutes of:

FIGURE 10: WASTE GENERATION SCENARIO IN INDIA



UNTAPPED RESOURCES IN OUR WASTEWATER

If a value could be attached to the resources in sewage flows, the idea of wastewater treatment would shift from an expensive cost centre to a profit-generating 'resource factory'; one that creates a variety of useful end products. "Wastewater is the largest untapped waste category – as big as all solid waste categories taken together. It is a natural starting point for the circular revolution", states Martin Stuchtey in Rethinking the Water Cycle.

Extracted from Ellen MacArthur Foundation (2017) URBAN BIOCYCLES Report

1. SLUDGE AS A RESOURCE

A person produces an average of 500 litres of urine and faeces every year (quantity may vary +/- 10% based on volume and components of food intake).⁴² Translated to a market like India, with a current population (2017) of 1.3 billion (UN Sept.29.2017), and based on above 500L per person per year, India could produce 670 billion L / year of sludge (urine and faeces) if all Toilet Resources are captured and treated. Currently TSMG estimates ~46 million tonnes of faecal sludge alone are collected for treatment (2017), just a fraction of the total available (but not necessarily accessible) resource base.

2. WASTEWATER AS A RESOURCE

The most common way to capture sludge, or Toilet Resources is via wastewater channels, where pure Toilet Resources are mixed with the water used to flush and wash (black water and grey water combined).

Taking a Circular Sanitation Economy view wastewater can be seen as a valuable reservoir of energy, carbon, nitrogen, phosphorus and other ingredients that yield different products at different stages. The final and often most valuable product would be clean water, which can be reused or safely returned to the biosphere." It has been estimated that if 100% of these nutrients could be captured in household sewage, nearly 30 million tonnes of nitrogen, 5 million tonnes of phosphorus and 12 million tonnes of potassium could be recovered globally, representing about a third of the annual total global demand for fertiliser. For a city of four million people, the total value of the carbon, ammonia, and phosphorus recovered has been estimated at USD 300 million per annum.⁴³

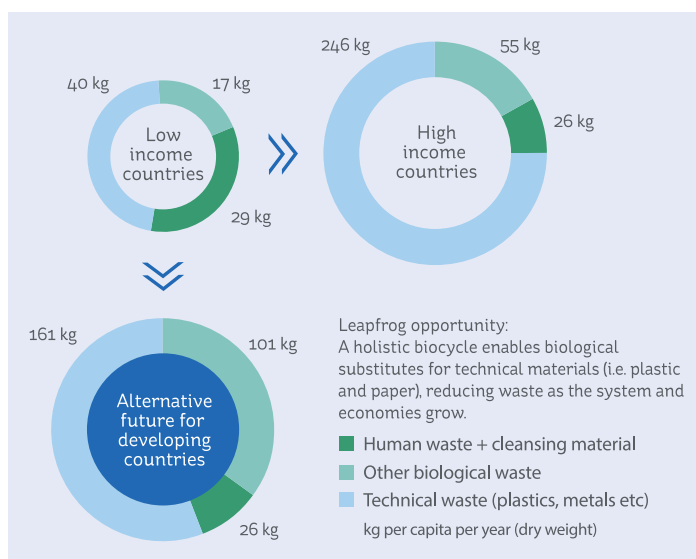
3. MUNICIPAL SOLID WASTE (MSW) AS A RESOURCE

To derive maximum value from Toilet Resources through the valuable biological resources contained within, the bigger opportunities lie in mixing total biological waste streams found in municipal solid waste (MSW) and agricultural waste with Toilet Resources. This enables larger amounts of biological input resource for conversion to energy, agricultural products, animal feed, pharmaceuticals, personal care products and more.

The 2016 study of the Toilet Board Coalition, Sanitation in the Circular Economy, found that biological material makes up the largest proportion of a country's waste in low-income countries, the opposite of high-income countries (Figure 11). In India, the government's Solid Waste Management Rules (SWM) 2016, has mandated the source segregation of waste so that it can be recovered, reused and recycled efficiently.

India currently generates ~295 million tonnes of biological municipal solid waste, sludge, agricultural and biological industrial waste (all non-hazardous) annually. The waste generation is expected to increase to ~346 million tonnes by 2021. The major source of biological solid waste is generated from the agricultural industry followed by municipal solid waste from cities.

FIGURE 11: WASTE GENERATION FROM TBC'S 2016 SANITATION IN THE CIRCULAR ECONOMY REPORT



42 H. Zeeuw and Pay Drechsel ed. RAUF Foundation & International Water Management Institute (IWMI) (2015). Cities and Agriculture: Developing Resilient Urban Food Systems. Earthscan by Routledge. New York.

43 Ellen MacArthur Foundation, (2017), Urban-Biocycles, EU.

KEY CONSIDERATIONS

SORTING AND TRANSPORTING BIOLOGICAL WASTE STREAMS

In order to capture biological resources from waste streams, they need to be sorted from other non-biological waste streams. This relies on the individual generator of the waste to separate waste at the source or often costly separation technics (manual or machine) that separate after the fact from mixed waste streams. Transport of waste from its source to treatment plants also needs to be considered and can be an interesting market opportunity. While out of scope for this study, we did find that the market for collection & transportation of MSW in India is estimated at \$1.9 billion in 2017 and is expected to be worth \$2.7 billion by 2021. Municipal bodies (government agencies) are bearing the cost of collection & transportation of waste. The work of waste collection & transportation is generally outsourced.

STANDARDISATION

A key enabler of these markets will be the assurance of the safety and quality of products derived from Toilet Resources. Currently the risk of exposure to pathogens is a key deterrent for the development of these markets and adoption by local and international industrial value chains and operations or facilities management. Having said that progress is being made. Sweden, the UK and US have developed such standards and as a result robust markets are beginning to emerge.

The Toilet Board Coalition advocates for the safe handling of human waste to become an added feature of current organisational quality standards such as the ISO or the REVAQ (highlighted in the boxes below) and supports the development of new standards which are specific to Toilet Resource derived products.

REVAQ SWEDEN CERTIFICATION

REVAQ is a voluntary certification system used to regulate the application of wastewater sludge on agricultural land in Sweden. The system ensures that nutrients from wastewater fractions can be sustainably reintroduced to agricultural land in accordance with national environmental regulations and goals. The system provides stakeholders with information regarding the composition and end use of the sludge and sets guidelines for the continuous improvement in the quality of influent wastewater and sludge with respect to metals and other prioritised substances.

The REVAQ system started in 2002 as a development project involving Swedish Water, LRF (The Federation of Swedish Farmers), Lantmännen (agricultural supplier cooperative) and grocery chains. Swedish Water is the sole owner of the system today in its current form. Currently half of the sewage sludge produced in Sweden is treated at plants with REVAQ certification.

Source: REVAQ Certification <https://www.aquaenviro.co.uk/proceedings/revaq-the-swedish-certification-system-for-sludge-application-to-land-experiences-at-the-rya-wwtw-in-gothenburg-and-challenges-for-the-future/>

ISO STANDARD

ISO - International Organization for Standardization is developing standards that can be used to address the absence of standards in evolving sanitation systems or improve those existing.

For example ISO 24521 is providing guidelines for the management of basic on-site wastewater services (i.e. pit latrines, water-less urinal, etc.). This standard includes the following:

- guidelines for the management of basic on-site domestic wastewater services from the operator's perspective, including maintenance techniques, training of personnel and risk considerations;
- guidelines for the management of basic on-site domestic wastewater services from the perspective of users;
- guidance on the design and construction of basic on-site domestic wastewater systems;
- guidance on planning, operation and maintenance, and health and safety issues.

PC 305 (<https://lnkd.in/dJBMCQQ>) is working on technical specifications that would offer toilets with an integrated treatment solution.

Source: <https://www.iso.org/standard/64679.html>

CIRCULAR SANITATION ECONOMY PRODUCTS IN INDIA



ENERGY PRODUCTS

FUEL, ELECTRICITY, HEAT

- Biogas for local factories & electricity to the grid
- Bio diesel for transport
- Biocharcoal as solid fuel



WATER

WATER RECOVERY AND PURIFICATION OF WASTEWATER

- Local agricultural irrigation
- Water intensive factory processes
- Further treatment to produce drinking water



AGRICULTURAL PRODUCTS

COMPOST, ORGANIC FERTILISERS, NUTRIENTS SUCH AS NITROGEN AND PHOSPHORUS

- Non-food crops: forest free fibre crops, flower crops, etc.
- Food crops



PROTEIN RICH MATERIALS

SUCH AS OILS AND PROTEIN MEAL

- Protein oils for consumer toiletry goods and potentially cosmetics
- Protein "meal" for pet and farm animal feed



MATERIALS FOR INNOVATIVE PRODUCTS

- Faecal matter for pharmaceutical (biome) regenerative health products and procedures
- Bio-plastics

PRODUCTS

DERIVED FROM TOILET RESOURCES

The following market estimates focus on biological resources and products derived from toilet resources, fully or in part. This section aims to identify the new market potential, should the selected biological or organic products and renewable resources include Toilet Resources as part of their feedstock, a new and currently abundant and untapped resource.

Everyone on the planet produces approximately 500 L (+/- 10%) of Toilet Resources per year. This would equate to 3.8 trillion L of resources globally (based on a global population of 7.6 billion in 2017) and 671 billion L in India (based on Indian population of 1.3 billion in 2017). Toilet Resources include urine and faeces. Of the 500L pp/a, about 90% is urine and 10% faecal matter.

This section considers the production of 0.15 L/kg pp/d of faecal sludge (faecal matter only), due to available data, and where total faecal sludge collected in India in 2017 (estimated at 62% of the current population) is estimated at 46 million tonnes. In the market estimates for each product derived from toilet resources, this current availability of faecal sludge is split evenly as a source of new feedstock between the relevant product categories selected for this study. (See Appendix A for full list of assumptions and references).

Growth in the capture of Toilet Resources to optimal levels could significantly increase the market estimates shown in this section based on approximately 40% more available feedstock for these products.

The following chart outlines the market study assumptions of biological resource inputs to each product category for the purpose of market sizing and data availability. Not all toilet resource derived products use the indicated combinations of feedstocks. Producers are innovating with their use of different biological feedstocks as differentiating and value adding factors.

PRODUCTS	TYPE OF WASTES BIOLOGICAL RESOURCE FEEDSTOCKS
TREATED WATER	Sewage (urine & faeces (blackwater) & greywater)
COMPOST	Organic content in MSW, non-hazardous industrial waste, fecal sludge, agricultural Waste
PROTEIN FOR AQUA & POULTRY FEED	Fecal sludge (faeces only)
ELECTRICITY FROM BIOGAS	Organic content in MSW, non-hazardous industrial waste, agricultural waste & fecal sludge
BIO-CHARCOAL	Fecal sludge (faeces only)

Note: All market estimates in this section focus on toilet resource derived products (which may mix other biological feedstocks together with toilet resources). It is not an estimate of all biological resource feedstock derived products.

PRODUCTS

WATER



MARKET ESTIMATE: INDIA

Treated wastewater could replace current water usage in industry. The share of treated wastewater (Grade III & IV) market is estimated to be **\$10 BILLION** in 2017 and expected to grow to **\$19 BILLION** by 2021.

MARKET INSIGHTS: INDIA

India is transitioning from an agrarian economy to an industrial and services based economy and with rapid urbanisation. These trends are leading to an increased demand for water for domestic and industrial purposes.

87% of the water in India is consumed by agriculture followed by industry (8%) and domestic use (5%)⁴⁴.

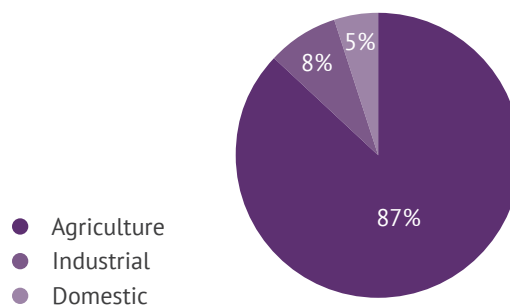
Industrial annual water consumption in India is estimated to be 40 billion cubic metres. Thermal power plants are currently the major consumers with ~88% of water⁴⁵. Other industries like pulp and paper (2.2 %), textiles (2%), steel, (1.3%), sugar (0.5%), fertiliser (0.2%) have less than 5% of overall water consumption. The estimated market for water usage in the thermal power industry alone is around \$56 billion in 2017 and is expected to grow to \$63 billion by 2021.

The market estimate, for Toilet Resource derived treated water, considers the amount of available treated grade III and grade IV water, to be approximately 8,031 billion litres in 2017.

The treated water is derived, as per TSMG estimates, from 25,845 billion litres of sewage produced in 2017⁴⁶. Out of this 23,261 billion liters is collected and only 10,039 billion litres of wastewater is treated⁴⁷. The treated water could generate 8,031 billion liters⁴⁸ of grade III⁴⁹ and grade IV⁵⁰ water suitable for industrial use.

There could be an additional opportunity in wastewater, 31,983 billion litres of wastewater is produced annually in India, out of which only 12,770 billion liters of that wastewater is treated. Of this installed capacity, 70% is estimated to be non-functioning due to the high cost of energy to run the plants. All of this puts a huge strain on the national economy as well as environmental and public health - estimated impact is 54 billion, 6.4% of GDP⁵¹.

FIGURE 12: WATER CONSUMPTION IN INDIA



44 Ajay Jindal, Shama Kamat, (2011), Water Recycling and Reuse for Domestic and Industrial Sectors, https://www.chemtech-online.com/WAT/Ajay_Shama_july11.html

45 Chandra Bhushan, Centre for Science & Environment, (2013), Industrial Water Challenges, p.5, New Delhi.

46 Ministry of Environment, Forests & Climate Change, (2016), National status of waste water generation & treatment, 61,754 MLD sewage generated in 2015 and only 30% is treated.

47 Tata Strategic Management Group analysis basis on household data from Census 2011 and number of household toilets built under Swachh Bharat

48 Ibid

49 Grade III water: Membrane-based reverse osmosis process removes dissolved solids in water used in industries

50 Grade IV water: Disinfection process to inactivate bacteria and microbial pathogens used as potable water for

51 Ellen MacArthur Foundation, (2015), Towards the Circular Economy - Economic and business rationale for an accelerated transition.

Notes:

This study finds a major market for treated water. This number may not be as big where less water is present and available to recover. As the world looks to close the global water gap it is expected that water saving systems will be in favour, and therefore in the scenario where the original use of water is less, there would also be less wastewater to treat and reuse.

For clarity, sewage, which contains other household, industrial and agricultural wastewater, and sometimes storm water, is differentiated from the Faecal Sludge numbers cited for the waste generation scenario for India (46 million litres in 2017).



ORGANIC FERTILISERS - COMPOST - AGRICULTURAL PRODUCTS

MARKET ESTIMATE: INDIA

New government directives support the production and purchase of organic compost. It is estimated that compost has a market potential of **\$0.9 BILLION** in 2017 and could be worth about **\$2 BILLION** by 2021. This is based on the current capacity of production of compost from biological resources.

MARKET INSIGHTS: INDIA

The government of India is promoting the production and marketing of compost. Under the Solid Waste Management Rules (SWM) 2016, the Union Ministry of Environment, Forests and Climate Change (MoEF & CC)⁵² have advised that all bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation. The rule also outlines the setting up of waste processing facilities by all local bodies having a population of one million.

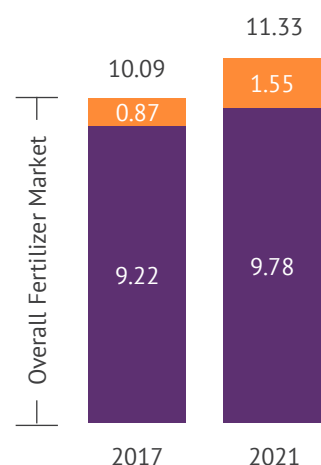
The government of India is promoting the production of compost from city waste through existing fertiliser companies⁵³. Some waste to energy plants in India are converting biological municipal waste to compost and other products. The compost produced in these facilities is procured mainly by chemical fertiliser companies as it is mandatory to purchase this produce.

On the marketing of compost, the Department of Fertilisers has been asked to provide market development assistance on city compost and to ensure the promotion of co-marketing of compost with chemical fertilisers.

Market development assistance equates to \$23 per tonne of city compost produced.

This study finds that more and more farmers in India are switching to the usage of compost/ organic fertilisers. In some cases, organic farming has been found to cut cultivation and input

FIGURE 13: COMPOST REPLACING FERTILISER MARKET IN INDIA (IN BN \$)



● Chemical Fertilizer Market
● Compost Market

⁵² Ministry of Chemicals & Fertilisers, (2016), Policy on promotion of City compost, New Delhi

⁵³ Ibid

costs by up to 70%. Current chemical fertiliser consumption is estimated around 55.8 metric tonnes in India during FY17⁵⁴ and expected to touch ~61 metric tonnes by 2021. The estimated market for chemical fertilisers is ~\$10 billion.

The market estimate for compost is based on the current capacity of production of compost from currently available biological waste streams. Agriculture waste, non-hazardous biological industrial waste, biological municipal waste plus faecal sludge are considered as input material for producing compost. (Please refer to the appendix for more details).

Approximately 0.14 tonne of compost is derived from one tonne of biological waste⁵⁵. Hence a total of 16.5 million tonnes of compost would be produced from 120 million tonnes of biological waste in 2017.

Growth in the compost market will depend on increasing the feedstocks of biological resource streams, which will require more systematic capture of biological waste including Toilet Resources and source separation of biological waste from municipal solid waste and industrial waste streams.

Current buyers of compost are fertiliser companies, farmers and government agencies. While the average price for selling compost to fertiliser companies is estimated to be \$54 per tonne, for government agencies it is estimated to be \$37 per tonne and \$.04 per kgs for retail purchase⁵⁶.

CURRENT BUSINESS MODEL: SANERGY, KENYA

Sanergy has developed a cost-effective sanitation model in Nairobi's urban slums by offering desirable and affordable products to their customers while also guaranteeing that waste is safely and professionally removed and treated. Their model provides a community led solution to the poor sanitation conditions that have historically characterised Nairobi by way of designing and manufacturing prefabricated low cost, high quality sanitation facilities such as the Fresh Life Toilet, building a network of Fresh Life Operators who are local operators and franchise partners with Sanergy, collecting waste from the Fresh Life Toilets on a daily basis by wheelbarrow or truck and converting the waste at a centralized facility into useful end products such as organic fertilizer, insect-based animal feed and renewable energy. Of all the converted waste outputs, the organic fertiliser is in the highest demand and distributed to small and medium sized farms around the country.

www.sanergy.co.ke

54 Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation and Farmers, (2016), State of Indian Agriculture 2015-16, p.80, New Delhi

55 Dr Indrani Chandrashekar, Planning commission, 'Integrated Waste Management in India', p.3

56 Raviprasad Kamila, The Hindu, (2015), Compost from city waste ready for sale, <http://www.thehindu.com/news/cities/Mangalore/compost-from-city-waste-ready-for-sale/article6863732.ece>



AQUA AND POULTRY FEED

MARKET ESTIMATE: INDIA

The market for proteins for feed is one of the fastest growing markets in India. The protein market derived from Toilet Resources, based on current sector growth, is estimated at \$0.6 BILLION in 2017 and expected to grow to \$0.9 billion by 2021.

MARKET INSIGHTS: INDIA

India is one of the largest and fastest growing compound feed markets in the world. Poultry, aqua and dairy industry occupies a major share in overall feed demand. The feed industry requirements that are met with the compound feed are 11 percent for cattle, 14 percent for aqua feed and 55 percent for poultry feed⁵⁷.

Poultry and aqua feed consumption is estimated at 18 million tonnes in 2017 and increase to ~26 million tonnes by 2021⁵⁸. The poultry and aqua feed market in India is estimated at ~\$10 billion in 2017 and expected to grow to \$17.8 billion by 2021.⁵⁹ The protein market is estimated at \$3.32 billion in 2017 and \$5.9 billion by 2021. The estimated market price for poultry feed in India is \$0.46/Kg⁶⁰ while aqua feed market price is estimated at \$1.35/Kg⁶¹. Protein content in poultry feed is considered to be 55% and 14% in aqua feed.

Faecal sludge is considered a feedstock for the production of proteins from larvae (as produced by the black soldier fly process). One tonne of waste produces 0.33 tonnes of larvae⁶². Protein is extracted from larvae and used to produce protein content for aqua and poultry feed. (See more about the Black Soldier Fly technology in the Current Business Model Box: Agriprotein & The Biocycle, South Africa).

From the supply side perspective, an estimated 3.5 million tonnes of protein feed could be generated from 11.4 million tonnes of sludge⁶³. This protein feed could in turn be used as

FIGURE 14:
PROTEIN FEED MARKET IN BN \$

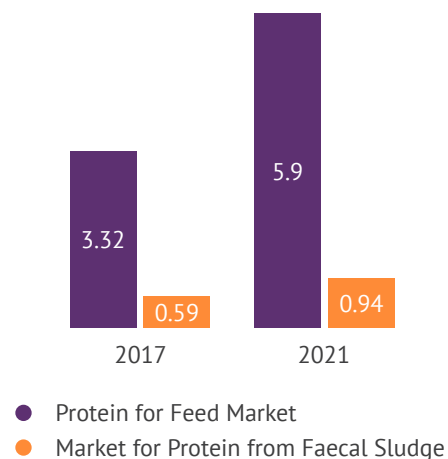
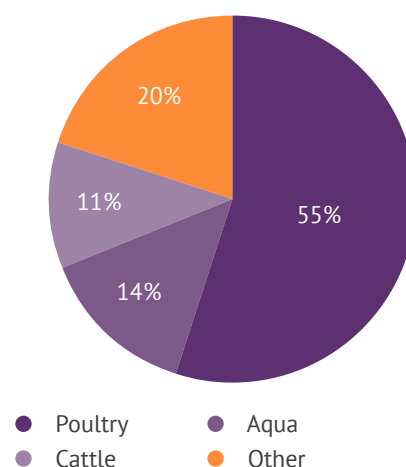


FIGURE 15:
MARKET SHARE IN PROTEIN FEED



57 Yes bank – Food and Agribusiness Strategic Advisory and Research (FASAR) Team, (2015), Indian feed industry: revitalizing Nutritional Security, Gurgaon

58 Estimated based on: Yes bank – Food and Agribusiness Strategic Advisory and Research (FASAR) Team, (2015), Indian feed industry: revitalizing Nutritional Security, p.16&19, Gurgaon

59 Yes bank – Food and Agribusiness Strategic Advisory and Research (FASAR) Team, (2015), Indian feed industry: revitalizing Nutritional Security, p.16, Gurgaon

60 Ashish Kulshrestha - The Economic Times, (2017), Low feed prices take poultry industry's profits to four year high, <http://economictimes.indiatimes.com/industry/cons-products/food/low-feed-prices-take-poultry-industrys-profits-to-four-year-high/articleshow/57378694.cms>

61 New India Express, (2017), CIBA's shrimp feed proves an instant hit among farmers, <http://www.newindianexpress.com/states/tamil-nadu/2017/feb/09/cibas-shrimp-feed-proves-an-instant-hit-among-farmers-1568581.html>

62 An average of 33% is considered. This is based on the conversion ratio mentioned by various studies & reports <https://www.ncbi.nlm.nih.gov/pubmed/19502252>

63 25 % of fecal sludge (~ 11.4 million tonnes) out of the available ~46 million tonnes are considered

aqua and poultry feed. The protein market from faecal at current sector growth rates is estimated to be around \$0.59 billion in 2017 and expected to grow to \$0.94 billion by 2021.

Currently, there is no established market for proteins produced from faecal sludge in India. The growth of this market will depend on the deployment of new technologies to extract proteins from faecal sludge (such as the Black Soldier Fly technology), standards for quality and safety management, and acceptance of the new feedstock to the market.

Given the growth in this sector and increased demand for protein feeds, the use of Toilet Resources could provide a new (and abundant) resource for the feedstock base to enable growth in supply to meet the demand.

CURRENT BUSINESS MODEL - AGRIPROTEIN/THE BIOCYCLE, SOUTH AFRICA

One of the most promising emerging technologies for converting Toilet Resources into valuable products is based on the lifecycle of the black soldier fly technology. This is a non-pest insect species common in tropical countries. The flies only eat during their larva life-stage, when they naturally eat a variety of biological materials. The new technology seeks to industrialise this natural life-cycle, so that the larvae can be put to work, at scale, in processing biological waste.

AgriProtein have already established this process in Cape Town, South Africa. The AgriProtein plant uses food waste, and is already established at scale, selling the resulting protein products as animal feed. AgriProtein's second plant uses the same technology, but applied to Toilet Resources. It has been set up through their subsidiary The BioCycle, and built in collaboration with Ethekewini municipality (Durban, South Africa), with funding from the Bill & Melinda Gates Foundation.

The BioCycle process produces firstly the cooked larvae (dead but by this point very well fed!), and these can be used intact, or further processed to produce protein, oil, and biochar products. Each of these have multiple potential applications.

<https://thebiocycle.com/>



ELECTRICITY FROM BIOGAS

MARKET ESTIMATE: INDIA

Current government incentives aim to increase the contribution of renewable power in the energy supply mix of the country which is showing current growth. The market for electricity from biogas is estimated to be worth **\$2 BILLION** in 2017 and is expected to grow to **\$3 BILLION** by 2021.

MARKET INSIGHTS: INDIA

The focus of the Ministry of New and Renewable Energy (MNRE) has been to promote the development and deployment of various technologies aimed at increasing the capacity of grid interactive and off-grid renewable power.

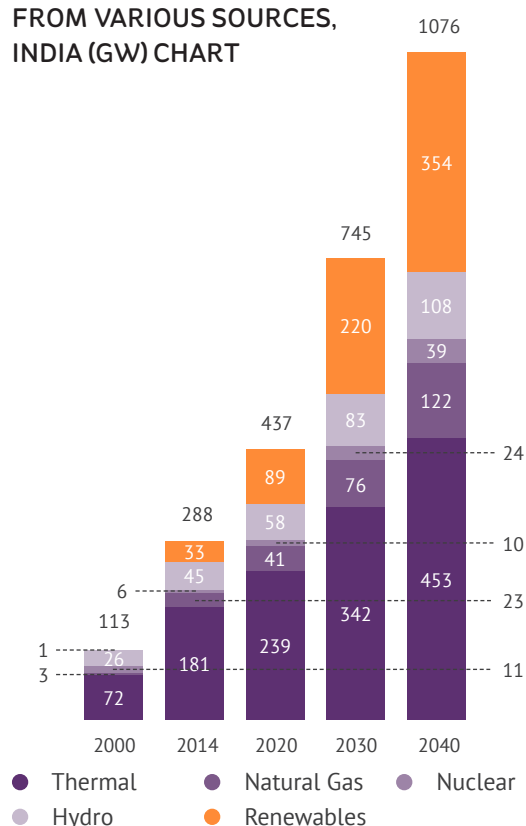
The government has been offering a number of fiscal and financial incentives to investors to increase the contribution of renewable power in the energy supply mix of the country. India's renewable energy installed capacity has grown from 3.9 GW in 2003-14 to about 50 GW in December 2016. Wind energy has been the predominant contributor to this growth. It accounts for 28.70 GW or 57.4 per cent of the installed capacity followed by Solar power which accounts 9.01 GW, small hydro power (4.33 GW) and biomass power (7.85 GW).

Renewable energy currently makes up a negligible share (0.36%) of total primary commercial energy supply while 96.9% of such supplies come from fossil fuels and 2.76% from hydro and nuclear resources⁶⁴. However, renewable energy production in India is picking up pace and expected to grow.

The government has a target of adding 175 GW of renewable power in the country by 2022. Out of this 10 GW is expected to be supplied through biomass. Also it has set a target of setting-up 650000 biogas plants across the nation, under the National Biogas and Manure Management Programme (NBMMMP). Over 530 biomass power plants of about 7.9 GW capacity per plant, have been installed in the country up to December 2016.

Currently in India, big waste to energy plants (capacity of processing 200 tonnes per day or more) focus on generating electricity from RDF⁶⁵ segregated from municipal solid waste collected from cities.

FIGURE 16: ENERGY GENERATION FROM VARIOUS SOURCES, INDIA (GW) CHART



⁶⁴ Ramprasad S – Ideas for India, (2013), Renewable energy and India's future, http://www.ideasforindia.in/article.aspx?article_id=127

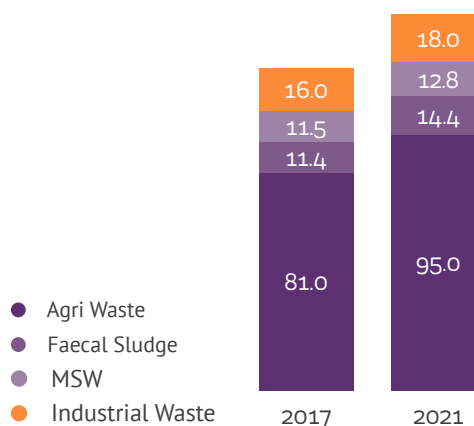
⁶⁵ Refuse Derived Fuel (RDF)-Derived from MSW and which doesn't have any organic content, non-recyclable and having no commercial value. As understood by players in the area of waste to energy from RDF

Potential users for electricity from biogas - industrial/ commercial players (50%), domestic usage (24%) and agriculture usage (26%). The average tariff per unit for commercial usage is \$0.08 per Kwh, \$0.07 per Kwh for domestic usage and \$0.02 per Kwh for agriculture usage⁶⁶.

This market estimate considers the added feedstock of Toilet Resources (the faecal sludge component) to the biological content in Municipal Solid Waste (MSW), agricultural waste, industrial waste (non-hazardous) as inputs for generating biogas from waste which in turn could be used to generate electricity.

This study estimates the potential for generation of electricity from biogas in India at 29.3 GW in 2017 from 120 million tonnes of biological waste with expected growth to be 34.4 GW in 2021 from 141 million tonnes of biological waste. This would translate into a market estimated to be worth of \$ 2 billion in 2017 with the expectation to grow to \$3 billion by 2021 considering an average tariff per unit for commercial usage of \$0.08 per Kwh, \$0.07 per Kwh for domestic usage and \$0.02 per Kwh for agriculture usage.

FIGURE 17: WASTE CONSIDERED FOR BIOGAS (IN MILLION TONNES)



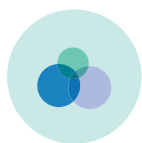
CURRENT BUSINESS MODEL - SAFI SANA, GHANA

Safi Sana offers the installation of turnkey factories for waste re-use and sale of power, fertiliser and seedlings. It fills an existing gap or replaces traditional utilities as an economically sustainable solution for governments to manage waste, while providing improved sanitation, energy and agricultural input material for the local community.

They use these multi-waste streams as inputs into their factory where the waste is treated in a digester to create organic fertiliser, irrigation water, and biogas. Their biogas is the first of its kind to be used to produce citywide electricity, while the irrigation water and part of the organic fertilisers are used on farmlands to grow seedlings. Their factory's end-product sales including biogas powered electricity, biofertiliser, and seedlings cover Safi Sana's operational costs which allows them to ensure long term organizational sustainability. Safi Sana is running a demo-factory based in Ashaiman, Ghana and designed to treat 25 tonnes of faecal and solid organic waste daily. Full operations started in September 2016 and are expected to run break even in Q3 2017.

www.safisana.org

66 <https://data.gov.in> - Figure is averaged across all the suppliers for commercial usage



BIOCHAR

MARKET ESTIMATE: INDIA

Biofuel derived from Toilet Resources in the form of biocharcoal is an estimated market of **\$0.1 BILLION** in 2017 and could grow to **\$0.3 BILLION** by 2021.

MARKET INSIGHTS: INDIA

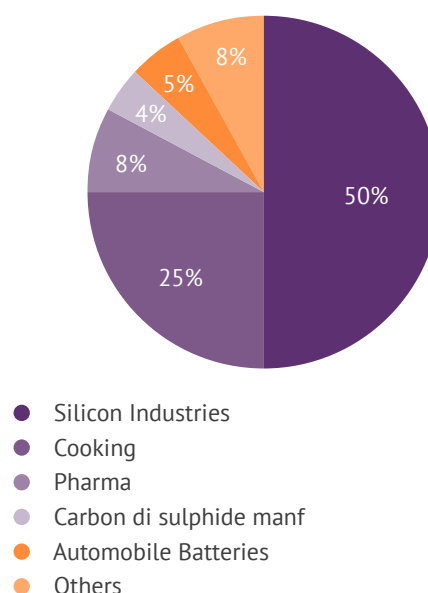
Biocharcoal made with Toilet Resources is considered a viable form of biofuel which is being tested in different parts of the world. This product is not yet established in India, however based on global market experiences and the potential to replace charcoal with biofuels such as biochar, this study has estimated the market potential in India. Considering the current market for charcoal in India, an estimated \$0.1 billion market in 2017 with expected growth to \$0.3 billion by 2021⁶⁷.

The industrial users of charcoal in India include: silicon (50%), cooking (25%) and other industries.

Currently charcoal consumption is estimated to

be at 3.7 million tonnes in India and is expected to increase to 4.4 million tonnes by 2021.

FIGURE 18: CHARCOAL CONSUMPTION IN INDIA



Human faecal matter is considered to be an input material for producing biocharcoal as fuel. The current population of India is 1.34 billion⁶⁸. Considering the potential for Toilet Resource derived bio-char in this market we have reviewed the current Toilet Resource feedstock availability (focusing on the faecal sludge component) for supply. The amount of faecal sludge available for use as a feedstock is still relatively small in India (compared to the amount of resource produced daily by the population) due to currently undeveloped methods to optimally capture and prepare Toilet Resources for use in such processes. In addition, this study considers that Toilet Resource feedstock will be in demand for other products discussed in this study and therefore includes only 25% of total faecal sludge or 11.4 million tonnes (total faecal availability in a year based on current collection is 45.8 million tonnes) as input material for biochar. An important note, biochar derived from toilet resources can also be used as a soil conditioner for agriculture⁶⁹. This is a different product however. This study focuses on the solid biofuel opportunity where biofuel briquettes are produced from faecal sludge and other biological resource feedstock. Biofuel derived from toilet resources is showing evidence of performance advantages in pilots around the world.

MARKET FOR BIOCHARCOAL

Biochar can be used as a replacement for charcoal. The current cost of charcoal in India is approximately \$277 per tonne (Rs. 18000 per tonne⁷⁰). Considering the estimated volumes of biocharcoal that could be produced from faecal sludge today, the market for biochar in India is estimated at \$0.1 billion in 2017 with potential growth to \$0.3 billion in 2021.

67 Indian Institute for Forest Management (IIFM), (2016), The Feasibility of wood based charcoal in industrial processes, India.

68 United Nations, (2017), World Population Prospects 2017 revision, p. 29

69 British Biochar Foundation, http://www.britishbiocharfoundation.org/?page_id=52

70 Indiamart website, Natural Wood Charcoal price, <https://www.indiamart.com/proddetail/natural-wood-charcoal-15503070655.html>

THE SMART SANITATION ECONOMY

DIGITAL TECHNOLOGY APPLICATIONS FOR SANITATION

MARKET ESTIMATE: SMART SANITATION ECONOMY INDIA

The Smart Sanitation market could get started with an estimated value of **\$4 BILLION** in 2017 and could grow to an estimated **\$6 BILLION** by 2021 considering available data comparisons to some digital healthcare and smart cities applications.*

Health prevention data through the capture of data from sanitation systems is not yet being monitored today, but could be worth **\$3 BILLION** in 2021 as part of the healthcare Internet of Things (IoT) market.



\$US
6
BILLION
by 2021

*Based on available data from selected product and service categories (Table 2). It does not entail detailed market research.

MARKET INSIGHTS: INDIA

The Indian government's \$7.3 billion Smart City mission is aimed at applying smart solutions to improve infrastructure and service delivery in Indian cities

The Smart Cities Market revenue in India is expected to grow at a Compound Annual Growth Rate of 18.5% during the forecast period 2017–2023 to touch an aggregate of \$47.70 billion by 2023

The Indian government plans to create a \$15 billion IoT market in the country

The market for health data through smart toilets could be a strong opportunity provided that the cost of service is cheaper and users are able to see more value against what they are presently using (lab and handy monitoring devices)

Senior-level pathologists in India are short in numbers to serve 120,000+ pathology labs across the country⁷¹

The Global Big Data in Healthcare Market is estimated at \$34.27 Billion 2015–2022. The global (IoT) healthcare market is estimated to grow from USD 32.4 billion in 2015 to USD 163.2 billion by 2020. The IoT healthcare market is expected to have a CAGR (compound annual growth rate) of 43.01% during the period 2016–2022, mainly driven by growing investments in the healthcare market by governments and various other stakeholders⁷²

Healthcare spending in the Indian economy is forecasted to grow 16% per year, from INR 5 trillion in 2011 to INR 19 trillion by 2020.⁷³ The market share for government spend on disease surveillance is ~54% of the total market

India currently possesses half of one hospital bed per thousand of its population, with almost three million new hospital beds expected to be required to meet demand by 2025⁷⁴

India's rural populations struggle to have basic healthcare needs met, only 13% of rural populations have access to primary healthcare centers, and fewer than 10% have access to a hospital – healthcare challenges are compounded by poor sanitary conditions⁷⁵

Less than 25 percent of India's population currently has any form of health insurance coverage⁷⁶

SMART SANITATION ECONOMY NOTE: This study recognises that the Smart Sanitation Economy is the least developed economy of the 3 Sanitation Economy market opportunities that the TBC has identified. That said it is an important one as it could be a game changer for sanitation for lowering sewage management costs and providing revenue generating opportunities in the use of data extracted from the sanitation system. However, data to analyse in this category was extremely scarce. Therefore this study chose two product categories where secondary sources could be modelled to provide some illustrative examples of a potential market. For example, the case of health data derived from Toilet Resources, was extrapolated from the current market for diagnostic testing. Smart logistics was also chosen as current applications with data in the area of solid waste management for example could be modelled for a potential sanitation logistics market.

71 Suparna Goswami – Forbes, (2017), These 3 Healthcare Startups are tapping into India's soon-to-be booming IoT Market, <https://www.forbes.com/sites/suparnagoswami/2017/02/22/3-healthcare-startups-tapping-into-indias-soon-to-be-booming-iot-market/#b6ce7d050402>

72 Healthcare IoT market to grow at a CAGR of 43% to 2022 says a global report available at ReportsWeb.com. (2016, Feb 18).

73 BMI Research, (2015) India Pharmaceuticals and Healthcare report.

74 "Healthcare." Indian Brand Equity Foundation download, accessed January 25, 2017. January 2017. <http://www.ibef.org/download/Healthcare-January-2017.pdf>

75 Panagariya, Ashok. "The Challenges and innovative solutions to rural health dilemma." National Center for Biotechnology Information. Annals of Neurosciences. October 2014. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4248476/>

76 "Healthcare." Indian Brand Equity Foundation download, accessed January 25, 2017. January 2017. <http://www.ibef.org/download/Healthcare-January-2017.pdf>

WHAT IS THE SMART SANITATION ECONOMY?

In the Toilet Board Coalition's 2016 report, [The Digitisation of Sanitation](http://www.toiletboard.org/media/18-Digitisation_of_Sanitation.pdf)⁷⁷, we introduced the new business opportunities associated with the use of new smart, digital and Internet of Things (IOT) technologies to drive efficiencies in sanitation business models (such as customer relationship management, collections and transportation). But also new value generating opportunities from sanitation using smart technologies and IoT to capture new data and information from sanitation systems including consumer behaviour data, and potentially preventative health data. New digital technologies enable the managing and sharing of large amounts of data across the sanitation system from toilets to waste management and logistics. This delivers valuable benefits, including better understanding of sanitation usage, when there is a need for the maintenance of toilets, volumes of material flows for waste management and waste to resource opportunities; support in making complex decisions, such as choice or optimisation of business models; knowledge and information-sharing platforms. While useful in any market, digital solutions are particularly relevant in emerging markets providing low cost solutions, and enabling decentralised models with limited investment requirements.

The rapid deployment of “smart cities” infrastructure across global cities including Indian cities could offer new breakthroughs for sanitation and new opportunities for private sector engagement:

1. Including sanitation in smart city design, infrastructure and information (data) management could enable efficiencies in smart toilet usage, operations and maintenance, smart wastewater management, smart sewage management, and smart logistics - by leveraging sensing and IoT technologies.
2. Leveraging smart technologies to develop new revenue generating opportunities from sanitation systems through the monetisation of data captured from the system such as health prevention information and monitoring.

This section aims to assess the potential market opportunities in leveraging the trends towards smart city development and digital health globally in India to present new market opportunities also for sanitation.

Smart Cities in India

A Smarter City uses technology to transform its core systems and optimise finite resources. At the highest levels of maturity, a Smarter City is a knowledge-based system that provides real-time insights to stakeholders, as well as enabling decisionmakers to proactively manage the city's subsystems. Effective information management is at the heart of this capability, and integration and analytics are the key enablers (IBM, 2013).

“A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects as well as cultural” (United Nations Smart City Definition).

The smart cities market in India will experience significant growth in the next 5 years due to the increasing demand for high-performance computing, increasing reliability, stability, and supportability, reduction in ongoing cost, elimination of traditional systems and manual processes, and better security. The Smart Cities Market revenue in India is expected to grow at a CAGR of 18.5% during the forecast period 2017–2023 to touch an aggregate of \$4.70 billion by 2023⁷⁸.

77 http://www.toiletboard.org/media/18-Digitisation_of_Sanitation.pdf

78 Infoholic Research LLP, a global market research and consulting organization, (2016), Smart Cities Market in India (By Applications: Smart Governance, Smart Building, Smart Security, Smart Energy, Smart Infrastructure, Smart Mobility, Smart Healthcare and Smart Education; By Cities: Tier 1, Tier 2, and Others) Forecast to 2023.

Smart cities utilise the internet and digital technology to improve the quality of life of citizens, while improving the performance of the services, and reducing costs. A smart city is enabled with technologies encompassing a network of sensors, cameras, wireless devices, IT infrastructure, and data centres to efficiently provide essential services, such as electricity, water supply, sanitation, recycling, and transportation, and ensure their effective management.

The Indian government's \$7.3 billion Smart City mission is aimed at applying smart solutions to improve infrastructure and service delivery in Indian cities. In 2015, the Indian cabinet approved US \$7.5 billion for the development of 100 Smart Cities and around another US \$7.5 billion for urban rejuvenation in another 300 cities. Of the 24 features identified by the Ministry of Urban Development as areas that cities need to address in their plan, three are directly related to water and another seven are indirectly related to it. Water-related topics to be addressed and implemented include: smart meter management, leakage identification, preventive maintenance, and water quality modelling⁷⁹.

Digital Healthcare in India

Demand for healthcare in India is growing significantly. Increased awareness of underlying healthcare drivers and better lifestyle choices – along with vastly improved pharmacological treatment of chronic diseases and higher standards of living – are dramatically extending the life expectancies of Indians in urban areas. Consequently, citizens expect more and better healthcare options as access to disposable income increases (see Figure 1). Healthcare spending in the Indian economy is forecasted to grow 16 percent per year, from INR 5 trillion in 2011 to INR 19 trillion by 2020.⁸⁰

Advances in technology are bringing important benefits to healthcare in terms of quality, availability and cost. Digitisation enables care delivery – including hospitals – to become significantly more efficient, while at the same time dramatically improving the patient experience. Analytics supports data mining that draws immediate prescriptive and predictive insights from patient data. Cloud provides the platform and supports the ecosystem that gives physicians appreciably better management of information and processes. Remote monitoring removes the constraint of physical proximity, enabling remote consultation and follow-up with specialists. In addition, it acts as a channel for essential healthcare education to help prevent diseases, especially for rural populations.⁸¹

KEY CONSIDERATIONS

Due to limited data available for this emergent economy, market estimates have been made based on potential market scenarios. The best available data for modelling was found in the areas of health data and logistics. These are generic markets, which are already being addressed by conventional players. Smart water management (including wastewater) and smart waste management (including sewage and other biological resources) is considered an important opportunity for the Smart Sanitation Economy in the future, however local market data was not available at the time of this study to estimate market scenarios.

79 Infoholic Research LLP, a global market research and consulting organization, (2016), Smart Cities Market in India (By Applications: Smart Governance, Smart Building, Smart Security, Smart Energy, Smart Infrastructure, Smart Mobility, Smart Healthcare and Smart Education; By Cities: Tier 1, Tier 2, and Others) Forecast to 2023.

80 BMI Research, (2015) India Pharmaceuticals and Healthcare report.

81 IBM Institute for Business Value India Healthcare Survey 2016

The following market segments have been considered:

1. Health data generated through smart toilets. This scenario considers that toilets would be equipped with sensors/bacteria monitoring systems through which samples (primarily urine or stool) could be analysed and/or diagnosed to determine health indicators. Health data generated from toilets could be an important component of public health and individual health monitoring in the future. Two areas were modelled to determine a scenario for market estimates:
 - a. An individual paying for his/her testing on wellness and monitoring
 - b. Government spend on disease surveillance programmes
2. Logistics for waste collection – Use of RFID tags and sensors to monitor the usage, fill rates or need for maintenance and repair to deploy and optimise transport routes and frequency.

SMART SANITATION ECONOMY

A Marketplace of Business Solutions



PRODUCTS



HEALTH DATA

MARKET ESTIMATE: INDIA

Based on our modelling of the potential for health data generated through smart toilets we found an estimated **\$2 BILLION** in 2017 with growth prospects to **\$3 BILLION** by 2021.

MARKET INSIGHTS: INDIA

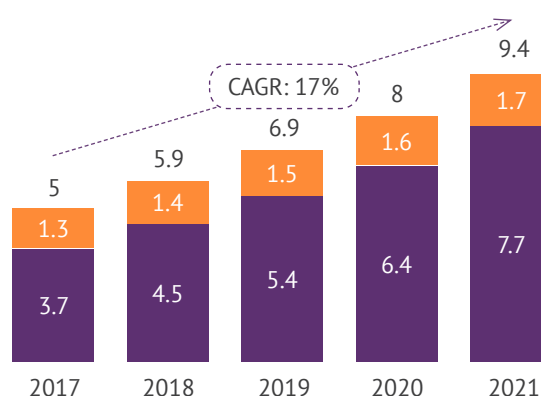
Smart Toilet Scenario

Imagine you could easily receive updates on your health status and biomedical parameters with an “invisible” digital health technology. Companies are developing sensors that will make your toilet smart. Instead of (literally) flushing data down the toilet, the sensor analyses your “Toilet Resources”, urine, faeces and blood. Toilets become smart devices for monitoring health conditions in a non-invasive and simple way, every day.

The future of medicine is considered to be prevention through a healthier lifestyle improved by personalised data.⁸² When we take a look at the trends, we see that the hospital of the future could be our home. Personalised medicine is essential for future medical care and this is going to be possible through personal data. Digital health is the tool and IoT the way to make it simple.

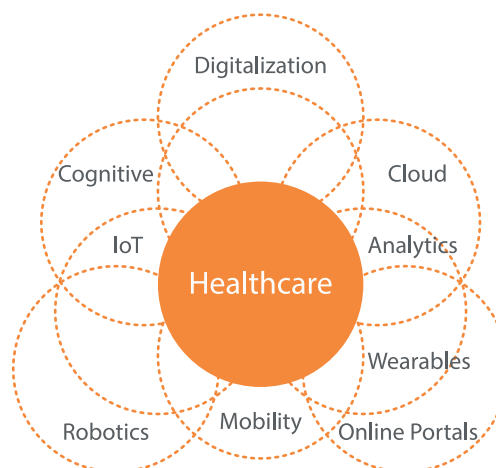
The next 5 years are expected to be focused on implementing online systems such as electronic health records accessible to people everywhere and collecting data in a prospective way to make clinical use of artificial intelligence (AI).⁸³

FIGURE 19: MARKET FOR HEALTH DATA (IN BN \$)



- Market for Pathological Tests
- Govt. Spend on Health Monitoring

FIGURE 20: TECHNOLOGY INFUSES HEALTHCARE



Source: IBM Institute for Business Value India Healthcare Survey 2016

⁸² IBM (2016): The future of health is cognitive <https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=HL-W03025USEN>

⁸³ Theresa Kern – Digitalhealthcareers, interview of Adrian Gomez Campos, Co-Founder of S-There (2017), Digital Health Champions: Smart sanitation solutions that flush up health data, <https://digitalhealthcareers/digital-health-champions-smart-sanitation/#.WfLyHmi0OM8>

A vast reservoir of information on human health and behaviour lies in our sewage, and this resource is untapped. We imagine a future in which sewage is mined for information that can inform policy makers, health practitioners, designers, and researchers alike. Such is the idea behind Underworlds: a cross-disciplinary data platform for monitoring urban health patterns, shaping more inclusive public health strategies, and pushing the boundaries of urban epidemiology.⁸⁴

SCENARIO OF HEALTH DATA IN INDIA:

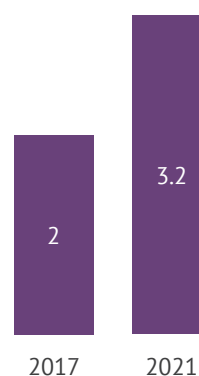
For the scope of this analysis, we have assumed that health data can be collected via sensor enabled and connected toilets. These sensors embedded in toilets would collect bacteria data, diagnose and generate test reports against blood, stool and urine samples. The data generated through toilets installed in public/community toilets could be used by government/agency for public health disease surveillance.

While sizing the potential market, the study team considered:

- The diagnostic market for pathology i.e. individuals paying for basic pathology service to monitor their health as part of wellness & preventive care
- Government spend on health monitoring - spend on disease surveillance/health monitoring by government. Primarily pharmaceutical companies rely on data generated through government surveillance programmes.

Based on available data and modelling, our analysis found the addressable market for pathology testing and screening, that would be applicable to smart toilets, to be about 8% of the market. Together with an estimated addressable market of about 70% of programme costs for disease surveillance, our analysis has estimated the market for health data from smart toilets to be \$2 billion in 2017 and up to \$3 billion by 2021.

FIGURE 21: MARKET FOR HEALTH DATA THROUGH SMART TOILETS (IN BN \$)



84 MIT underworlds, (2015), A vast reservoir of information on human health and behavior lives in our sewage, <http://underworlds.mit.edu/>



SMART LOGISTICS

MARKET ESTIMATE: INDIA

Smart logistics and transportation market has an estimated current market of ~\$2 **BILLION** and could grow at a rate of 8.6% to touch **\$3 BILLION** by 2021.

MARKET INSIGHTS: INDIA

Scenario of Smart logistics for waste collection

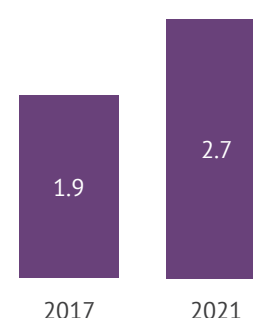
The management of municipal solid waste is one of the main functions of all Urban Local Bodies (ULBs) in the country. Waste from various temporary storage points are transported to the dumping grounds through a fleet of vehicles, either owned by the ULBs or outsourced to a third party.

It is essential to synchronise the operation of the collection of waste with the transportation for effective management of the waste and for achieving efficiency in the process. Smart logistics solutions leveraging digital technologies and smart traffic monitoring are being proliferated. For example, temporary waste storage units could be sensor enabled to monitor fill rates, indicating the control centre when it is full and ready for emptying ~80%. New technologies deployed for traffic monitoring could benefit waste collection, by automatically designing the most efficient route map for transportation of the waste from these temporary storage units (those filled up-to 80%) and fleet owners could communicate digitally with their vehicles for more efficient transport of the waste to treatment plants.

Large investments are being made by municipal corporations for collecting, separating and transporting waste. The figure varies from \$46 per tonne of Municipal Solid Waste (MSW) in tier 1 cities to \$26 and \$20 in tier 2 & 3 cities⁸⁵.

When applied to sanitation systems logistics we estimate a possible current market of ~\$2 billion which could grow at a rate of 8.6% to about \$3 billion by 2021.

FIGURE 22: MARKET FOR COLLECTION & TRANSPORTATION OF MSW (IN BN \$)



85 Tier 1 cities – Cities with population 1 million and above; Tier 2 cities - Cities with population 0.1 million and above; Tier 3 cities - Cities with population below 0.1 million (Source: Ministry of Housing & Urban affairs)

KEY CONSIDERATIONS

SMART WATER MANAGEMENT (OUT OF SCOPE)

The term “smart water” incorporates water and wastewater infrastructure that ensures the optimisation of water consumption and the energy used to transport it is managed effectively. A smart water system gathers meaningful and actionable data about the flow, pressure and distribution of a city's water. Further, it is critical that the consumption and forecasting of water use is accurate. Water loss management is becoming increasingly important as supplies are stressed by population growth and water scarcity. Smart water system implies transforming wastewater treatment plants into resource recovery facilities, which includes generation of energy.

Smart Water systems also imply engineering alternatives to design of the drainage network. Drains which receive filtered surface run off are designed with permeable edges that in turn help grow riparian vegetation that supports aqua flora and fauna.

MARKET INSIGHTS: INDIA

Water is predicted to become a key part of India's Smart Cities Initiative. Smart Water Networks (SWN) can be developed to help advance the water sector, including to reduce an average non-revenue water (NRW) rate of 60%⁸⁶.

SMART WATER MANAGEMENT BRINGS THE FOLLOWING BENEFITS:

- Distribution networks benefit through improved load management, forecasting, incorporate water storage and by having easy access to data to analyse monitor and manage water quality reliability, losses and outages.
- Commercial units and industry benefit through efficiency gains in meter reading, reduction in billing errors, usable water provision, higher productivity fuelled by fewer disruptions.
- Customers benefit through access to clean water and sanitation.

SCENARIO FOR SMART WATER MANAGEMENT IN INDIA

To an economy heavily reliant upon agriculture, water is an invaluable and critical resource for the new breed of Indian cities and its management poses many challenges for the local government. Across Indian cities where low precipitation is common, compounded by drought, it is essential for smart water conservation management sustainably. However, towards India's extreme South and East, many of its cities face the other side of the coin: copious rainfall which overwhelms a city's infrastructure, housing, basic amenities and acts as a perfect carrier for water borne illnesses.

With most of India's smart cities requiring effective water management technology, both the opportunities and challenges for this sector are immense. The drive to provide better services at an affordable cost is challenging. Entrenched players in the Water utilities industry along with various stakeholders will need to leverage technological innovation to achieve positive strides in this crucial sector.

With both the demand for water and the cost of water treatment on the rise, a simultaneous reduction in the supply of water means most Indian cities are now facing huge challenges in managing and delivering safe supplies

86 Cahn A., Bipin Pradeep K, The Role of Water in India Smart Cities, <http://www.waterworld.com/articles/wwi/print/volume-31/issue-4/technology-case-studies/the-role-of-water-in-india-s-smart-cities.html>

of water to those living and working in cities. The United Nations predicts that global water demand will rise by 40% between now and 2020 and that this will be 50% higher in developing countries - with emphasis on India⁸⁷. These challenges also provide opportunities to those countries and businesses that are ready to exploit them.

Sectors central to developing this market include: smart water meters, smart valves, smart pipes, smart pumps, smart water quality monitors

SMART WASTE MANAGEMENT (OUT OF SCOPE)

MARKET INSIGHTS: INDIA

Smart waste management is defined as:

- i. The collection and dissemination of waste as an economic activity.
- ii. The efficient regulation, monitoring, collection and controlling of waste, from its creation to its recycling stage.
- iii. Maintaining facilities / amenities, which are mandatory required to be observed through the course of these activities to prevent the spread of health and environmental epidemics.

SCENARIO OF SMART WASTE MANAGEMENT IN INDIA

The primary focus of smart technologies and systems dedicated towards managing waste in India's cities seeks to enhance the efficiency and effectiveness of its collection and separation. A chief driver for Indian cities towards the development of effective waste management is the mass levels of urbanisation and population growth across cities. As one of the fastest growing GDP's in the world, waste is an irrefutable byproduct of heightened economic activity. Through smart management of its waste India's new age cities can look towards an improvement in economic productivity, positive externalities and a higher quality of living for its citizens.

With waste collections and disposal being crucial towards establishing an intelligent system. Presently, India has an embryonic waste management sector. Across its urban landscape, 'dumping' is prolific as are enormous landfill sites, along with common practices of burning. The harmful effects on both human life and the environment are tremendous. With growing levels of education and a demand for a better quality of life, India's citizens are appreciating the positive effects stemming from innovative waste management systems. Shedding years of neglect, the Indian government is prioritising the issue and have made in-roads towards the development of small scale biological treatment processes such as anaerobic digestion.

Sectors central to developing this market include: design & engineering services, technology providers (smart bins, infrared bin measures, GPS enabled bin trackers, smart optical sorters, automated collection solutions and providers, operations and management technical capability providers, mechanical collection and separation of waste technologies.

Commercial and industrial enterprises reap rewards from selling recycled waste to secondary markets which were previously overlooked.

87 SENSUS, (2012), Water 20/20 Bringing Smart Water Networks into Focus.

PUNE SMART SANITATION CITY PROJECT

In support of the Indian government's Swachh Bharat sanitation campaign and Smart Cities initiative, on 29 August 2017, the Toilet Board Coalition (TBC) and the Pune Municipal Corporation (PMC) announced a new collaboration towards the world's first Smart Sanitation City.

The Toilet Board Coalition and Pune's governing body, the Pune Municipal Corporation, confirm that they will work together to develop smart sustainable and resilient sanitation systems, delivered through the market, in Pune.

Launching in January 2018, this work is being developed into three main work streams in Pune with the potential to add dedicated work streams for rural and data information management:

1. Community toilets, with a focus on optimising usage at scale and behaviour change;
2. Waste management and resource recovery optimisation;
3. Digital, exploring data use cases for sensing within the sanitation system.
4. A fourth work stream on rural and peri-urban solutions could be added.
5. A data officer has been appointed for information management.

As part of Indian Prime Minister Modi's Smart Cities campaign, there is a focus on efficiency, improved public services, goods and spaces, and modernisation - all driven by new citizen intelligence derived from a web of data captured throughout the city. Smart cities will bring more accessibility of new technologies and applications for more citizens, customers, businesses and public entities.

Project Objective: To demonstrate scalable sanitation business solutions, operating at city scale, and leveraging smart city infrastructure and new technologies.

Project Duration: January 2018 - September 2019

CONCLUSION

There is vast potential for economic growth and the societal benefits of universal access to smart, sustainable sanitation in the Sanitation Economy. These are new markets for new products that will generate wealth, prosperity and dignity.

India provides a formidable test bed for the Sanitation Economy in its perfect storm of political will, consumer demand, innovation and entrepreneurship.

To activate these benefits businesses will need to develop innovative new business models, work with established businesses with scale and disruptive new businesses and technologies, together with public sector officials and experts, to transform sanitation systems for our common future.

Sanitation is no longer just about toilets. It is much much more with US\$ billions on the table. The Toilet Economy, the Circular Sanitation Economy and the Smart Sanitation Economy are robust marketplaces of products, services and innovative new markets that offer a range of opportunities for different sectors.

We hope that more business leaders take up our Call to Action, based on the findings of this report - our first attempt to quantify the Sanitation Economy in India - to join us in Accelerating the Sanitation Economy.

1

Mitigate Sanitation Risks

Understand your company's exposure to the risks of poor sanitation

2

Provide Sanitation Access

Ensure access to sanitation for employees, including supply chains

3

Choose your Sanitation Economy Strategies

Choose the areas of the Sanitation Economy where your company can add value and create new business opportunity

4

Collaborate

Collaborate with the business leaders, entrepreneurs and innovators of the Toilet Board Coalition to create robust ecosystems for your Sanitation Economy strategies

5

Lead

Be an advocate for accelerating the Sanitation Economy with business partners, governments and stakeholders

CALL TO ACTION

APPENDIX A: ASSUMPTIONS

KEY CONSIDERATIONS & ASSUMPTIONS OF TATA STRATEGIC MANAGEMENT GROUP

TOILET ECONOMY

INDIVIDUAL HOUSEHOLD TOILETS

According to the 2011 Census, there were 246 million households in India which increased from 191 million households in the 2001 Census. As per the 2011 Census, urban households constitute only 32%, rural households constitute 68%. 53% of households in India do not have a toilet. While in urban areas 18.6% households do not have toilet, in rural areas the percentage is 69.3%.

Based on the census data, households without toilets was estimated for the year 2017. The figures are projected for years 2018 to 2021 based on the growth rate.

In 2017, out of 99 million urban households, 15 million do not have toilets. Out of 189 million rural households, 122 million do not have toilets.

Market for individual households in rural and urban areas is estimated under following subsegments:

- a. Construction
- b. Repair and maintenance
- c. Cleaning services

CONSTRUCTION OF INDIVIDUAL HOUSEHOLD TOILETS

URBAN

Households without toilets are considered for estimating the market for the construction of toilets. As Swachh Bharat was started on 2nd Oct 2014, the number of toilets built under this mission was also accounted to remove duplicity. Out of the ~99.9 million households, ~84.8 million households already have toilets.

As of 17 Oct'17, ~9 million individual toilets need to be built in urban location. Based on the current pace of construction of toilets under SBM, ~2.2 million toilets still need to be built in 2017 (25% of overall target).

Construction

The market for construction of individual household toilets was based on 2.2 million toilets that would be built in 2017.

The average cost of building one unit basic sanitary toilet in an urban household is estimated to be \$615. The average cost is estimated based on SBM Guidelines and primary research. The cost of building toilets also includes additional fittings (taps, pipes, wash basin etc.) and flooring.

Repair and maintenance

The market for repair and maintenance was considered for ~84.8 million households which had toilets.

Average annual cost of repair and maintenance of one individual household level toilet is estimated to be \$46.

Cleaning

The cleaning market is considered for households which already had toilets and toilets which were built under Swachh Bharat i.e. ~87 million individual household toilets built.

The average cost of cleaning toilets in urban areas is \$4.62 per month (established from primaries). Cleaning of toilets is considered to be carried out by either professional or local maids who get paid for their service.

RURAL

Out of the ~189 million households only ~67 million households have access to a toilet. An alarming number of 122 million households did not have toilets.⁸⁸

As of 17 October 2017, ~58.6 million individual toilets need to be built in rural locations. Based on the current pace of construction of toilets under SBM, ~11.7 million toilets still need to be built in 2017 (20% of overall target).

Construction

The market estimates for construction of individual household toilets was based on ~11.7 million toilets that would be built in 2017.

The average cost of building one unit basic sanitary toilet in an urban household with is estimated to be \$385. The average cost is estimated based on SBM guidelines and primary research. The cost of building a toilet also includes additional fittings (taps, pipes, wash basin etc.) and flooring.

Repair and maintenance

The market for repair and maintenance was considered for ~67 million households which had toilets.

Average cost of repair and maintenance of one individual household level is estimated to be \$31.

Cleaning

The cleaning market is considered for households which already had toilets i.e. ~78.7 million individual households in rural areas having toilets.

Average cost of cleaning toilets in a rural location is \$1.5 per month (established through primary research). Cleaning of toilets is considered to be carried out by either professional or local maids who get paid for their service. The frequency of cleaning toilets is considered to be once per month.

INDIVIDUAL TOILETS

PARTICULARS	KEY CONSIDERATIONS	
	URBAN	RURAL
INDIVIDUAL TOILETS	A toilet which is available within the premises of a family household	
GENERAL	<ul style="list-style-type: none"> Nos. of HHs and HHs without a toilet taken from 2011 Census 80% of HHs not having toilets would go for an individual toilet while 20% of households would go for community toilets (SBM guideline) 6% inflation 	<ul style="list-style-type: none"> Nos. of HHs and HHs without a toilet taken from 2011 Census 90% of households would go for an individual toilet and the rest would opt for community toilets 6% inflation

88 Office of the Registrar General & Census Commissioner, (2011), Census 2011, India

PARTICULARS	KEY CONSIDERATIONS	
	URBAN	RURAL
CONSTRUCTION	<ul style="list-style-type: none"> Total no. of toilets constructed under SBM (from October 2014 to October 2017) – 3,074,229, considered Average cost of building one unit basic sanitary toilet or that with a septic tank \$615 (SBM guideline and primary research) The cost also includes additional fittings (taps, pipes, wash basin etc.) and flooring 	<ul style="list-style-type: none"> Total no. of toilets constructed under SBM (from October 2014 to October 2017) – 51,274,299 considered Average cost of building one unit of basic toilet with twin/leach pit tank \$385 considered Cost of building a toilet in rural India is \$185, however during our primary research cost of building a decent toilet is \$385
MAINTENANCE/REPAIR	Annual maintenance/repair cost as \$46 with an assumption that 10% of existing toilets would incur this annual cost	Annual maintenance/repair cost at \$30.8 with an assumption that 10% of existing toilets would incur this annual cost
CLEANING	Average annual cleaning cost at \$4.6 per month for all toilets (existing & newly built). The cost includes cost of consumables ~\$1.5 and service fee of a professional ~\$3 engaged for cleaning	Average annual cleaning cost at \$1.5 per month for all toilets (existing & newly built). The cost includes cost of consumables as in rural areas HHs typically do the cleaning by themselves

COMMUNITY TOILETS

As per the 2011 Census, 62 million population live in slums from 52 million⁸⁹ as per 2001 Census. Based on the census data it is estimated for the year 2017 that India has over 75 million in slum population living in 16.4 million houses. The figures are projected for 2018 to 2021 based on growth of 2.2% in slum population.

Slum population was considered for estimating the requirement of community toilets. Number of toilets for men and women was estimated based on Swachh Bharat Mission-Urban guidelines which sets standards for 'one seat per 35 men and one seat per 25 women'⁹⁰. Based on the slum population (including men and women) Tata Strategic estimated 358,188 community toilets are required in 2017. Based on primary research, it was

89 Rukmini S. - The Hindu, (2013), Slum population up, from 52 million to 65 million, <http://www.thehindu.com/news/national/slum-population-up-from-52-million-to-65-million/article5187166.ece>

90 Ministry of Housing and Urban affairs, 'Guidelines for Swachh Bharat mission-Urban', p.43

estimated that 68,625 community toilets⁹¹ are already available. Around 26,435 community toilets would be built in 2017⁹². Effectively the total number of community toilets available in 2017 is estimated to be 95,060.

Primary research was conducted to establish the number of community toilets available in India. The cost of cleaning, maintenance and repair were established based on primary interaction with Mr. Swapnil Chaturvedi (Samagra- TBC Toilet Accelerator).

The market for community toilets is estimated under following sub-segments:

- a. Construction
- b. Cleaning services
- c. Maintenance & repairs

Construction

Construction market includes:

- Construction of a community toilet
- Supplies for building a community toilet

The market for construction of community toilets was considered based on the toilets that are in 2017 (i.e. 26,435). The cost of building one unit of community toilet is \$6,692 which is established based on the Swachh Bharat guidelines⁹³ and secondary research.

Cost of supplies for construction of one community toilet is estimated to be \$1000 based on primary research. Supplies for construction of a community toilet includes brick, building materials, pipes, flooring etc.

Cleaning services

The market for cleaning is estimated based on the total number of community toilets available in 2017 which need periodic cleaning i.e. for 95,060 community toilets (26,435 which will be built in 2017 and 68,625 already available).

The cost of cleaning services includes salary for one person who is employed for each community, consumables and tools required for cleaning. The estimated cost for cleaning a community toilet each month is ~\$185 (which includes \$138 for salary for one person and \$46 for consumables & tools).

Thus market size is calculated based on the number of toilets which require cleaning i.e. 93,085 multiplied by monthly cost for cleaning services for community toilets i.e. \$185.

Maintenance & repairs

The market for maintenance is estimated based on the effective number of community toilets which will be available in 2017 and which will need periodic maintenance & repairs i.e. for 95,060 (26,435 which will be built in 2017 and 68,625 already available).

Cost of the maintenance and repair of a community toilet is considered based on the primary research. Maintenance and repair include regular services, tools and consumables. Based on this it is estimated the cost of maintenance and repair for one community toilet is ~\$523.

91 Primary interactions with Government Municipal department officials of Pune, Mumbai and Madhya Pradesh. Primary interaction were also conducted with professional working in sanitation sector

92 1,22,302 community toilet seats were built when accessed from Swachh Bharat Urban dashboard in the month of August 2017

93 Ministry of Housing and Urban affairs, 'Guidelines for Swachh Bharat mission-Urban', p.43

The cost of maintenance includes salary (salary of ~\$230 for one person) for two people who would work in two shifts in one community toilet and tools and consumables which are required for maintenance and repairs (~\$62 per month).

PARTICULARS	KEY ASSUMPTIONS & CONSIDERATION
GENERAL	<ul style="list-style-type: none"> Community toilet block is a shared facility provided for a group of residents or an entire settlement. Community toilet blocks are used primarily in low income informal settlements where space and/or land are constrained Out of the total slum population that do not have access to a toilet, 30% would build their own toilet and 70% would use community toilets One seat per 35 men and one seat for 25 women are based on the norms of the number of toilet seats required As Swachh Bharat is currently targeting Open Defecation Free (ODF) status, only the no. of existing community toilets have been estimated based on the current availability in tier 1, 2 & 3 cities
CONSTRUCTION	<ul style="list-style-type: none"> Community toilet 5 seats per community toilet unit was considered based on the budget allocation for construction released to urban local bodies Target for construction under SBM is considered as market Cost per unit: <ul style="list-style-type: none"> Supplies - \$1000 Complete construction - \$6692 Supplies would include fittings (pan, tap, overhead tank, pipe etc.) for the toilet Complete construction includes civil work & furnishing CTs are mains connected (connected with sewage line/provision)
MAINTENANCE/REPAIR	<ul style="list-style-type: none"> Cost per unit: <ul style="list-style-type: none"> Two human resourced for 24 hrs functional toilet @ \$461 per month Repair @ \$62 per month
CLEANING	<ul style="list-style-type: none"> Cost per unit: <ul style="list-style-type: none"> One full time (8 hrs) human resourced for 24 hrs functional toilet @ \$138 per month Repair at \$46 per month if the toilet is cleaned two times a day

PORTABLE TOILETS

Portable toilets are used as an accessible solution to bridge the lack of sanitary facilities and sewage systems in urban slums. Portable toilets would be applicable where community toilets could not be built in the slums. The study has considered one portable toilet having 5 seats.

Potential number of portable toilets required in slums is estimated based on the number of community toilets still required to be built which is 263,128.

Out of the gap in requirement of community toilets, it is assumed that only 80% of them could be addressed by portable toilets (i.e. 210,503). It is also assumed that 20% of existing community toilets i.e. 13,725, would be portable toilets. Hence, the number of portable toilets required is calculated based on the number of portable toilets required (210,503) deducted with portable toilets already available (13,725 available portable toilets). It was estimated that 196,778 nos. of portable toilets are required as of year 2017.

Assuming that 10% of the requirement would be addressed in year 2017, an estimate of 19,678 portable toilets was considered as addressable market for portable toilets in year 2017.

The market for portable toilets is estimated for following sub-segments:

- a. Deployment
- b. Cleaning services
- c. Maintenance & repairs

Deployment

Market for deployment includes 10% of number portable toilets which would be installed in 2017 i.e. 19,678 portable toilets.

Cost of deploying one portable toilet is estimated to be \$3,077 which is established based on primary research with sanitary ware vendors.

Cleaning

Market for cleaning services is estimated for portable toilets that would be installed in 2017 (19,678) and which are already available (portable toilets which are already available 13,725) i.e. 33,403 portable toilets would require cleaning services. Cost of cleaning one portable toilet is estimated to be similar to cleaning services cost for one community toilet i.e. \$185 per month.

Maintenance & repairs

The market for maintenance is estimated based on the effective number of portable toilets which will be available in 2017 which will need periodic cleaning i.e. for 33,403 (19,678 which will be installed in 2017 and 13,725 already available).

Cost of maintenance and repair of a portable toilet is considered similar to community toilet i.e. ~\$522.

The cost of maintenance includes salary (salary of ~\$230 for one people) for two people who would work in two shifts in one community toilet, tools and consumables (~\$62 per month).

CIRCULAR SANITATION ECONOMY

Products derived from biological waste – key consideration & assumptions for the input material

The following table shows input materials which are considered for four target products under portfolio no.2

TARGET PRODUCTS	INPUT MATERIAL
ELECTRICITY FROM BIOGAS	Organic content in MSW, non-hazardous industrial waste, agricultural waste & faecal sludge
COMPOST	Organic content in MSW, non-hazardous industrial waste, faecal sludge, agricultural waste
BIOCHARCOAL	Faecal sludge
PROTEIN FOR AQUA & POULTRY FEED	Faecal sludge
WASTEWATER	Sewage

The table below summarises estimated numbers for all input materials; more detail follows this table:

KEY CONSIDERATION	FY 17	FY 21	DESCRIPTION
MSW (BIOLOGICAL CONTENT) [MILLION TONES]	11.5	12.8	Total MSW generated in 2017 is estimated to be 54 million tonnes. Out of which 43% of MSW would contain biological content i.e. 23.22 million tonnes. Now considering that this biological content of MSW would be equally utilised for compost and generating biogas; 11.5 million tonnes has been taken as input for biogas and compost respectively.
FAECAL SLUDGE [MILLION TONES]	11.4	12.8	Total faecal sludge generated in 2017 is estimated to be 45.8 million tonnes. Faecal sludge is equally utilised for compost, biochar, protein feed and biogas; 25% of 45.8 million tonnes i.e. ~11.4 million tonnes has been taken as input for all the four products.
AGRICULTURE WASTE [MILLION TONES]	81	95	Total agriculture waste generated in 2017 is estimated to be 163 million tonnes which is calculated based on 2015 data. Agriculture waste is equally utilized in generating compost and biogas; hence 50% of 163 million tonnes i.e. 81 million tonnes of agriculture waste is considered as input for biogas and biochar each.

KEY CONSIDERATION	FY 17	FY 21	DESCRIPTION
INDUSTRIAL WASTE (NON-HAZARDOUS) [MILLION TONES]	16	18	Industrial waste (non-hazardous) generated in 2017 is estimated to be 32 tonnes based on FY 15 data. Industrial non-hazardous waste is considered to be equally utilised for compost and biogas. Hence, 50% of 32 million tonnes i.e. 16 million tonnes of non-hazardous industrial waste is considered as input for both products.
WATER FROM SEWAGE [BILLION LITRES]	10,039	14,695	Based on the data of sewage generation reported in year 2015, figures for the year 2017 were estimated as follows: Generation - 25,586 billion liters, collected - 23,028 billion liters and treatment capacity of 10,039 billion liters. Out of this 10,039 billion liters, 80% of treated water i.e. 8,031 billion liters; could be used for industrial purpose.

The numbers and calculations have been detailed out in the section below:

MSW

Total Municipal Solid Waste (MSW) generated in FY 13 is 133,760 metric tonnes per day⁹⁴ while in FY 15 is 141,064 metric tonnes per day⁹⁵. Based on these figures, MSW for the year 2017 to 2021 was projected.

In India biological content in MSW is in the range of 30% to 55%. An average of 43% biological content in MSW is considered.

Total MSW generated in 2017 is 54 million tonnes⁹⁶. Out of which 43% of MSW contains biological content that is 23.22 million tonnes. Now considering that this biological content of MSW would be equally utilized for compost and generating biogas; 50% of 23.22 million tonnes i.e. 11.5 million tonnes is input for biogas generation and compost.

Faecal sludge

The current population of India is 1.34 billion⁹⁷. As per NSSO survey 2012, 48.3% of population defecated in the open⁹⁸. Based on this, 37.7% of the population defecating in open was estimated for the year 2017. The figure was further validated with other reported figures in a news article⁹⁹. As 62.3% of population have access to a toilet, faecal matter of 0.84 billion people (62.3% of 1.34 billion) is collected in the system (septic tank, litch pit or sewage line). Considering that a person produces around 0.15 kg per day of faecal matter¹⁰⁰, 45.8 million tonnes of faecal matter is collected in this system.

94 The Energy and Resources Institute (TERI), (2014) Waste to Resources: A Waste Management Handbook, p.4.

95 Ministry of Environment, Forest & Climate Change - Central Pollution Control Board (CPCB), (2015), Annual Report 2014-2015, Chandu Press, p.61, New Delhi.

96 Estimated based on figures of year 2013 (133760 metric tonne per day, Source: TERI, A Waste Management Handbook, p4. as well as SPCB report & year 2015 (141064 metric ton per day, Source: Green tribunal- [http://www.greentribunal.gov.in/Writereaddata/Downloads/199-2014\(PB-I-Judg\)_OA22-12-2016.pdf](http://www.greentribunal.gov.in/Writereaddata/Downloads/199-2014(PB-I-Judg)_OA22-12-2016.pdf), pg.39.)

97 United Nations, (2017), World Population Prospects 2017 revision, p. 29

98 The Hindu, (2016), What numbers tell us about open defecation in India, <http://www.thehindu.com/data/What-numbers-tell-us-about-Open-Defecation-in-India/article15422326.ece>

99 The Economic Times, (2017), Over 62 percent households in rural India have access to toilets: Survey, <http://economictimes.indiatimes.com/news/economy/infrastructure/over-62-per-cent-households-in-rural-india-have-access-to-toilets-survey/article-show/59972669.cms>

100 Established on primary & secondary research

Faecal sludge is considered to be input for four target products – biocharcoal, feed proteins, compost and biogas. Thus only 25% of total faecal sludge or 11.4 million tonnes (total faecal in a year is 45.8 million tonnes) is considered for each of the four products.

Agriculture waste

Agriculture waste generated in India was 150 million tonnes in 2015. As per the reports¹⁰¹ agriculture waste growth rate is 4%. Based on this growth rate, 163 million tonnes of agriculture are estimated for the year 2017. Agriculture waste is considered as input for biogas and compost products. Thus, only 50% of total 163 million tonnes of agriculture waste i.e. 81 million tonnes are considered for biogas and compost.

Industrial waste (non-hazardous)

Industrial waste (non-hazardous) generated in 2017 is estimated to be 32 million tonnes based on FY 15¹⁰² data. Industrial non-hazardous waste is equally utilized in generating compost and biogas. Thus only 50% of total 32 million tonnes of non-hazardous industrial waste i.e. 16 million tonnes of industrial waste (non-hazardous) are considered as input for producing biogas & compost.

Sewage

According to the Ministry of Environment, Forests & Climate change sewage generation in India¹⁰³ in 2015 was 61,754 MLD and 38,254 MLD in 2013. Based on this figures, annual numbers for sewage generation and treatment capacity was estimated for year the 2017. Sewage generation and collection is estimated to be 25,845 billion liters and 23,261 billion liters respectively. The treatment capacity is estimated to be 10,141 billion liters.

Wastewater

As per primary research with industry expert, 99% of sewage contains water. Hence 25,586 billion liters (99% of 25,845 billion liters) of wastewater is considered for treatment. With India having a limited treatment capacity; 10,039 billion liters of wastewater was estimated as input for treated water.

Treated water was classified into five different grades based on treatment process and its usage applicability¹⁰⁴. The wastewater grades are classified by the wastewater treatment companies¹⁰⁵. Grade III treatment technology is membrane-based reverse osmosis process which removes dissolved solids in water and grade IV treatment technology is ultraviolet treatment which involves disinfection process to inactivate bacteria and microbial pathogens.

Electricity from biogas

Biological content (43%) in Municipal Solid Waste (MSW), agriculture waste, faecal sludge and industrial waste (non-hazardous) and faecal sludge are considered as inputs for generating biogas which in turn generate electricity.

Compost

Municipal Solid Waste, faecal sludge, agriculture and non-hazardous industrial waste are inputs for producing compost. 50% of biological content is MSW, 25% of faecal sludge, 50% of agriculture waste and 50% non-hazardous industrial waste are considered. Chemical fertilisers consumption includes urea (\$82 per MT), DAP (\$386 per MT), Complex (\$357 per MT), SSP (\$55 per MT) and MOP (\$337) and price varies for each one of them.

101 The Times of India, (June 2015), Farmers must learn to managing agro waste: Experts, 150 million tons of agri waste generate in India, estimated based on growth for 2017 to 2021, <https://timesofindia.indiatimes.com/city/nagpur/Farmers-must-learn-to-managing-agro-waste-Experts/articleshow/47569956.cms>

102 European Business & Technology Centre (EBTC), (2011), Waste Management in India, p.2, New Delhi.

103 ENVIS Centre on Hygiene, Sanitation, Sewage Treatment Systems and Technology, (2016), National Status of Waste water generation and treatment, http://www.sulabhenviis.nic.in/Database/STST_wastewater_2090.aspx

104 PwC, (2016), Closing the water loop: Reuse of treated wastewater in urban India, p.12., India

105 PwC, (2016), Closing the water loop: Reuse of treated wastewater in urban India, p.10., India

Faecal sludge

Faecal sludge produces biochar (40% is derived from faecal waste).

Faecal sludge is considered as the input for producing protein from larvae (black soldier fly). One tonne of waste produces 0.33 tonnes of larvae. Protein is extracted from larvae and used to produce protein content for aqua and poultry feed.

Estimated market price for poultry feed in India is \$0.46 (Rs. 30/Kg¹⁰⁶) while aqua feed market price is estimated at \$1.35 (Rs. 88/Kg¹⁰⁷).

Water

87% of the water in India is consumed by agriculture followed by the industrial sector (8%) and domestic use (5%)¹⁰⁸. Currently wastewater applicability in agriculture has low scope as it requires nutrition values for different crops. Thus it was not considered for agriculture.

Industrial water consumption in India is estimated to be 40 billion meters. Thermal power plants are major industry which consume ~88% of water¹⁰⁹. Other industries like pulp & paper (2.2 %), textiles (2%), steel, (1.3%), sugar (0.5%), fertiliser (0.2%) have less than 5% overall water consumption only thermal industries were considered.

Treated wastewater is classified into five different grades for reuse for various applications. The treatment stages and their specific uses depend on factors such as quality of the influent (concentration of minerals, etc.) and treatment technology used at previous levels

The wastewater grades are classified by the wastewater treatment companies¹¹⁰. Grade III treatment technology is membrane-based reverse osmosis process removes dissolved solids in water and grade IV treatment technology is ultraviolet treatment which involves disinfection process to inactivate bacteria and microbial pathogens.

106 Ashish Kulshrestha - The Economic Times, (2017), Low feed prices take poultry industry's profits to four year high, <http://economictimes.indiatimes.com/industry/cons-products/food/low-feed-prices-take-poultry-industrys-profits-to-four-year-high/article-show/57378694.cms>

107 New India Express, (2017), CIBA's shrimp feed proves an instant hit among farmers, <http://www.newindianexpress.com/states/tamil-nadu/2017/feb/09/cibas-shrimp-feed-proves-an-instant-hit-among-farmers-1568581.html>

108 Ajay Jindal, Shama Kamat, (2011), Water Recycling and Reuse for Domestic and Industrial Sectors, https://www.chemtech-online.com/WAT/Ajay_Shama_july11.html

109 Chandra Bhushan, Centre for Science & Environment, (2013), Industrial Water Challenges, p.5, New Delhi

110 PwC, (2016), Closing the water loop: Reuse of treated wastewater in urban India, p.10., India

SMART SANITATION ECONOMY

KEY CONSIDERATIONS FOR HEALTH DATA

Two major markets for health data are identified:

- Pathology tests for monitoring health as part of wellness and preventive care
- Government spending on disease surveillance

Pathology test

- Market for pathology test was taken from market estimates published by India Brand Equity Foundation in August 2015
- 8%¹¹¹ of this market was finally considered as addressable market for test/screening that could be undertaken with the help of smart toilets

Government spending on disease surveillance

70% (programme cost) of estimate for government expenditure of \$1.4 billion¹¹² for disease surveillance programme was considered as an addressable market.

TRANSPORTATION OF WASTE

Total MSW collected in FY17 is taken to be 49 mn tonnes. This is estimated based on established figures taken for year 2013 & 2015 (total MSW generated and collected in FY 13 was 49 million tonnes¹¹³ and 33 million tonnes. In 2015, MSW generated and collected was 51 million tonnes¹¹⁴ and 47 million tonnes. Based on these figures, total MSW generated in 2017 is estimated to be 54 million tonnes and 49 million tonnes, as collected). It is assumed that 49 million tonnes of MSW is distributed among tier 1, 2 & 3 cities in ratio of 7:2:1. The following table shows the distributed figures.

CITY/TOWN CATEGORIES	TRANSPORTATION COST PER TONNE OF MSW (IN USD)	%AGE CONTRIBUTION IN MSW (E)	MSW COLLECTED (IN MN TONNES)
TIER 1	46	70	34.3
TIER 2	26	20	9.8
TIER 3	20	10	4.9

Tier 1 cities – Cities with population 1 million and above;

Tier 2 cities – Cities with population 0.1 million and above;

Tier 3 cities – Cities with population below 0.1 million

Source: Ministry of Housing & Urban affairs

111 Shiras S., Gopalakrishnam S., Parihar N., Chauhan A, Mehjabin S., (2016), Research report – Pathology Industry, p.4., <https://www.slideshare.net/SalmanShiras/pathology-labs-research-report>

112 Health Care India, India's spend on preventive health is 9% of health care expenditure, <http://healthcare-in-india.net/public-health-2/indias-spend-on-preventive-health-is-9-of-healthcare-expenditure/> and <http://www.mohfw.nic.in/sites/default/files/89498311221471416058.pdf>, p37

113 The Energy and Resources Institute (TERI), (2014) Waste to Resources: A Waste Management Handbook, p.4. as well as SPCB report & year 2015 (141064 metric ton per day, Source: Green tribunal- [http://www.greentribunal.gov.in/Writereaddata/Downloads/199-2014\(PB-I-Judg\)_OA22-12-2016.pdf](http://www.greentribunal.gov.in/Writereaddata/Downloads/199-2014(PB-I-Judg)_OA22-12-2016.pdf), pg.39.)

114 Ministry of Environment, Forest & Climate Change - Central Pollution Control Board (CPCB), (2015), Annual Report 2014-2015, Chandu Press, New Delhi.

APPENDIX B: SOURCES

Ajay Jindal, Shama Kamat, (2011), Water Recycling and Reuse for Domestic and Industrial Sectors, https://www.chemtech-online.com/WAT/Ajay_Shama_july11.html

Anushree P., Poorvaja P., Richa M., Dakshini B., (2016), CSR in Water, Sanitation & Hygiene (WASH) What are India's Top Companies up to?, Samitha & India Sanitation Coalition.

Ashish Kulshrestha - The Economic Times, (2017), Low feed prices take poultry industry's profits to four year high, <http://economictimes.indiatimes.com/industry/cons-products/food/low-feed-prices-take-poultry-industrys-profits-to-four-year-high/articleshow/57378694.cms>

Bill and Melinda Gates Foundation, (2013), Water, Sanitation & Hygiene: Reinvent the Toilet Challenge, Seattle, USA.

BMI Research, (2015) India Pharmaceuticals and Healthcare report.

British Biochar Foundation, http://www.britishbiocharfoundation.org/?page_id=52

Cahn A., Bipin Pradeep K, The Role of Water in India Smart Cities, <http://www.waterworld.com/articles/wwi/print/volume-31/issue-4/technology-case-studies/the-role-of-water-in-india-s-smart-cities.html>

Capital Market – Live news, (2016), Report Mapping the CSR trends in Water Sanitation and Hygiene in India, http://www.business-standard.com/article/news-cm/report-mapping-the-csr-trends-in-water-sanitation-and-hygiene-in-india-116052700437_1.html

Chandra Bhushan, Centre for Science & Environment, (2013), Industrial Water Challenges, p.5, New Delhi.

Dr Indrani Chandrasekharan, Planning commission, (2015), Task Force Recommendations on Waste Management, p.3, Hyderabad, AP, India.

Ellen MacArthur Foundation, (2015), Towards the Circular Economy - Economic and business rationale for an accelerated transition.

Ellen MacArthur Foundation, (2016), Circular Economy in India: Rethinking growth for long-term prosperity, <http://www.ellenmacarthurfoundation.org/publications/>.

Ellen MacArthur Foundation, (2017), Urban-Biocycles, EU.

ENVIS Centre on Hygiene, Sanitation, Sewage Treatment Systems and Tecnology, (2016), National Status of Waste water generation and treatment, http://www.sulabhenvi.nic.in/Database/STST_wastewater_2090.aspx

European Business & Technology Centre (EBTC), (2011), Waste Management in India, p.2, New Delhi.

Health Care India, India's spend on preventive health is 9% of health care expenditure, <http://healthcare-in-india.net/public-health-2/indias-spend-on-preventive-health-is-9-of-healthcare-expenditure/>

"Healthcare." Indian Brand Equity Foundation download, accessed January 25, 2017. January 2017. <http://www.ibef.org/download/Healthcare-January-2017.pdf>

Healthcare IoT market to grow at a CAGR of 43% to 2022 says a global report available at ReportsWeb.com. (2016, Feb 18). <http://www.mohfw.nic.in/sites/default/files/89498311221471416058.pdf>, p37

IBM Institute for Business Value India Healthcare Survey 2016

Indiamart website, Natural Wood Charcoal price, <https://www.indiamart.com/proddetail/natural-wood-charcoal-15503070655.html>

Indian Institute for Forest Management (IIFM), (2016), The Feasibility of wood based charcoal in industrial processes, India.

Infoholic Research LLP, a global market research and consulting organization, (2016), Smart Cities Market in India (By Applications: Smart Governance, Smart Building, Smart Security, Smart Energy, Smart Infrastructure, Smart Mobility, Smart Healthcare and Smart Education; By Cities: Tier 1, Tier 2, and Others) Forecast to 2023.

Interview with Shelter associates CEO, 9 October 2017, Pune, India.

J.S. Kamyotra and R.M. Bhardwaj, (2011), India Infrastructure Report 2011 - Municipal Wastewater Management in India, Oxford University Press, p. 299, India.

Kulak M., Unger N., King H., (2017), Technology choices in scaling up sanitation can significantly affect greenhouse gas emissions and the fertiliser gap in India, Unilever Safety and Environmental Assessment Council (SEAC). <http://washdev.iwaponline.com/content/early/2017/06/22/washdev.2017.005>

Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation and Farmers, (2016), State of Indian Agriculture 2015-16, p.80, New Delhi

Ministry of Chemicals & Fertilizers, (2016), Policy on promotion of City compost, New Delhi

Ministry of Environment, Forest & Climate Change - Central Pollution Control Board (CPCB), (2015), Annual Report 2014-2015, Chandu Press, New Delhi.

Ministry of Environment, Forests & Climate Change, (2016), National status of waste water generation & treatment.

Ministry of Housing and Urban Affairs, (2015) Pradhan Mantri Awas Yojana-Housing for All (URBAN) 2015-2022, <http://pmaymis.gov.in/>

Ministry of Housing and Urban affairs, (2017), Guidelines for Swachh Bharat Mission –Urban, India.

MIT underworlds , (2015), A vast reservoir of information on human health and behavior lives in our sewage, <http://underworlds.mit.edu/>

New India Express,(2017),CIBA's shrimp feed proves an instant hit among farmers, <http://www.newindianexpress.com/states/tamil-nadu/2017/feb/09/cibas-shrimp-feed-proves-an-instant-hit-among-farmers-1568581.html>

Office of the Registrar General & Census Commissioner, (2011), Census 2011, India

Panagariya, Ashok. "The Challenges and innovative solutions to rural health dilemma." National Center for Biotechnology Information. Annals of Neurosciences. October 2014. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4248476/>

PwC, (2016), Closing the water loop: Reuse of treated wastewater in urban India, India

- Ramprasad S – Ideas for India, (2013), Renewable energy and India's future, http://www.ideasforindia.in/article.aspx?article_id=127
- Raviprasad Kamila, The Hindu, (2015), Compost from city waste ready for sale, <http://www.thehindu.com/news/cities/Mangalore/compost-from-city-waste-ready-for-sale/article6863732.ece>
- Rukmini S. – The Hindu, (2013), Slum population up, from 52 million to 65 million, <http://www.thehindu.com/news/national/slum-population-up-from-52-million-to-65-million/article5187166.ece>
- SENSUS, (2012), Water 20/20 Bringing Smart Water Networks into Focus,
- Shiras S., Gopalakrishnam S., Parihar N., Chauhan A, Mehjabin S., (2016), Research report – Pathology Industry, p.4., <https://www.slideshare.net/SalmanShiras/pathology-labs-research-report>
- Strucker A.(2016), Amsterdam water and waste in transition to a circular economy, Green Ribbon Mission, p.13, Amsterdam.
- Suparna Goswami – Forbes, (2017), These 3 Healthcare Startups are tapping into India's soon-to-be booming IoT Market, <https://www.forbes.com/sites/suparnagoswami/2017/02/22/3-healthcare-startups-tapping-into-indias-soon-to-be-booming-iot-market/#b6ce7d050402>
- The Economic Times, (2017), Over 62 percent households in rural India have access to toilets: Survey, <http://economictimes.indiatimes.com/news/economy/infrastructure/over-62-per-cent-households-in-rural-india-have-access-to-toilets-survey/articleshow/59972669.cms>
- The Energy and Resources Institute (TERI), (2014) Waste to Resources: A Waste Management Handbook, p.4.
- The Hindu, (2016), What numbers tell us about open defecation in India, <http://www.thehindu.com/data/What-numbers-tell-us-about-Open-Defecation-in-India/article15422326.ece>
- The Times of India, (June 2015), Farmers must learn to managing agro waste: Experts, 150 million tons of agri waste generate in India, estimated basis on growth for 2017 to 2021, <https://timesofindia.indiatimes.com/city/nagpur/Farmers-must-learn-to-managing-agro-waste-Experts/articleshow/47569956.cms>
- Theresa Kern – Digitalhealth.careers, interview of Adrian Gomez Campos, Co-Founder of S-There (2017), Digital Health Champions: Smart sanitation solutions that flush up health data, <https://digitalhealth.careers/digital-health-champions-smart-sanitation/#.WfLyHmioOM8>
- United Nations, (2016), World Water Development report – Water and Jobs, <http://www.unwater.org/publications/world-water-development-report-2016/>
- United Nations, (2017), World Population Prospects2017 revision, p. 29
- USAID Factsheet, (2015), <http://populationfoundation.in/wp-content/uploads/2015/09/Water-For-Health-and-CSR.pdf>
- Water and Sanitation program (WSP), (2011), The Economic impacts of Inadequate Sanitation in India, Marc P.DeFrancis, India.
- WHO/UNICEF joint Monitoring Program (JMP), (2017), Progress on Drinking Water, Sanitation and Hygiene 2017 – update and SDG Baselines, Anna Grojec, Switzerland

World Bank (2013), WB confronts US\$260 Billion a year in Global Economic Losses from lack of Sanitation, Washington, <http://www.worldbank.org/en/news/press-release/2013/04/19/wb-confronts-us-260-billion-a-year-in-global-economic-losses-from-lack-of-sanitation>

World Bank Group – Water and Sanitation Program (WSP), (2010), The Economic Impacts of Inadequate sanitation in India, <https://www.wsp.org/sites/wsp.org/files/publications/wsp-esi-india.pdf>

World health organisation, (2010), factsheet 2010, Tony Waddell.

Yes bank – Food and Agribusiness Strategic Advisory and Research (FASAR) Team, (2015), Indian feed industry: revitalizing Nutritional Security, Gurgaon

Zeeuw H. and Dreschel P., (2015), Cities and Agriculture: Developing Resilient Urban Food Systems, ed. RAUF Foundation & International Water Management Institute (IWMI), Earthscan by Routledge, New York.



Address: Rue Fendt 1, 1201 Geneva, Switzerland

Enquiries: secretariat@toiletboard.org

www.toiletboard.org

Twitter: [@TheToiletBoard](https://twitter.com/TheToiletBoard)

Linkedin: www.linkedin.com/company/toilet-board-coalition

