THE SANITATION ECONOMY OPPORTUNITY FOR SOUTH AFRICA

SUSTAINABLE SOLUTIONS FOR WATER SECURITY & SANITATION

A Business Perspective

WATER RESEARCH COMMISSION

TOILET BOARD COALITION

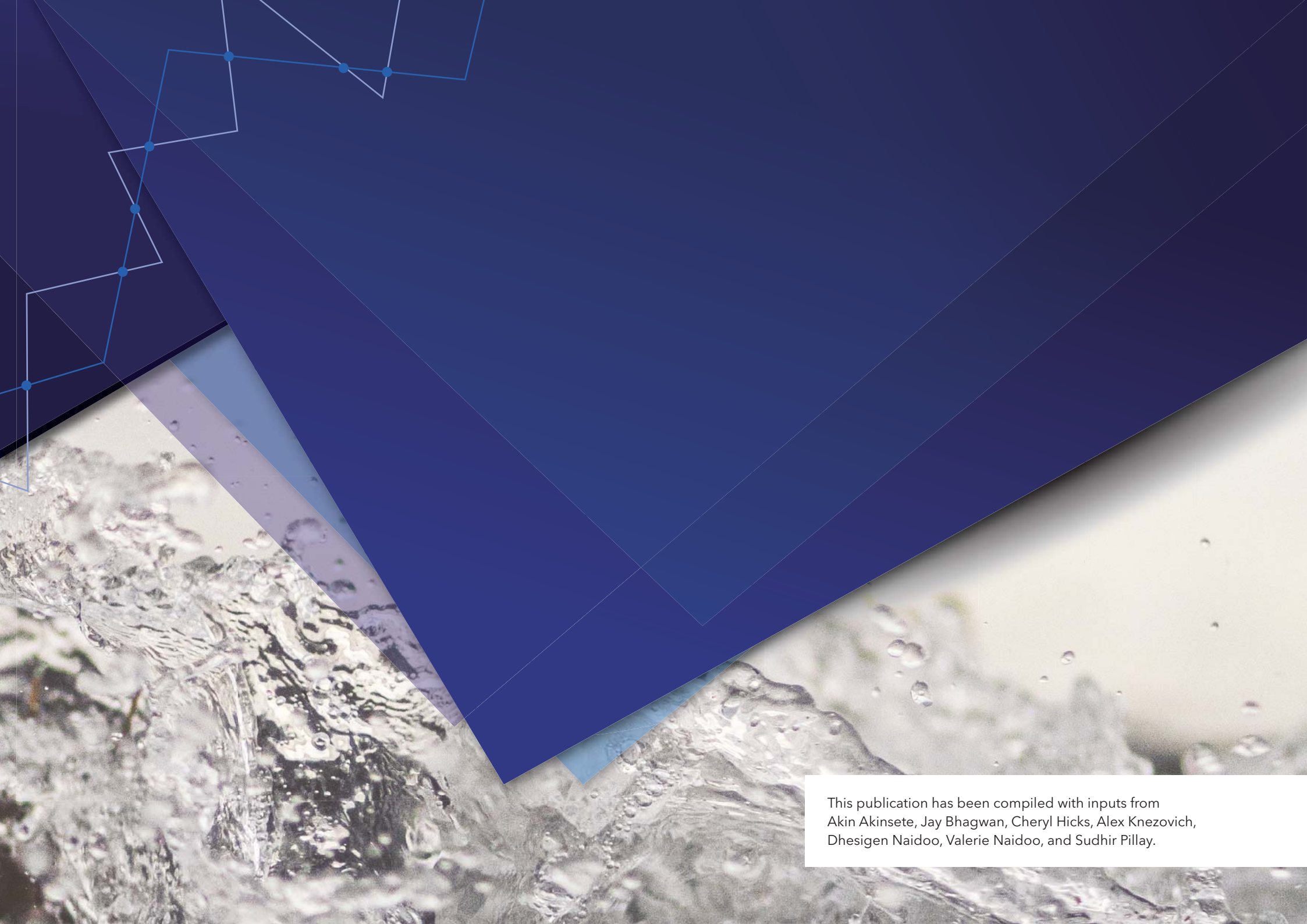

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TABLE OF CONTENTS

"SANICORNS" & RESOURCE SECURITY: Action Plan for Business & Innovation in Sanitation for a Sustainable Future in Africa

The demographic dividend; new production revolution; shifting wealth patterns; accelerated urban transition; and climate change are the mega-trends that will influence this continent's future, claims the latest analysis in the report "Africa's Development Dynamics – Growth, Jobs and Inequalities", compiled by the African Union Commission in partnership with the Organisation for Economic Co-operation and Development (OECD).

By 2063, Africa will constitute 30% of the global population with 3-billion inhabitants, more than doubling the current population of 1.25-billion. More than that, it will be that region of the world with the most youthful population. What we do now will determine whether this computes into a demographic dividend or a demographic burden.

For an already under-serviced continent with respect to the basic needs of water, sanitation, energy, health and nutritional security, the prospect of the population doubling in the next half-century is daunting. We are rapidly reaching, and in some cases exceeding, the planetary boundary conditions on one hand, and have the objective of ensuring universal access to these basic services and facilitating economic growth on the other.
But as Pliny the Elder remarked Ex Africa semper aliquid novi – "There's always something new out of Africa". Africa can pioneer global sustainable development, not despite, but precisely because of its current low industrialisation levels. This means that while the global north has to invest in high-cost retrofitting to switch from the current high-carbon, water-intensive, waste-producing economic model, Africa can leap-frog directly into the sustainable development paradigm.

It already has a wonderful example of this leap-frogging with mobile telephony that has provided access to hundreds of millions of Africans while saving most of connected Africa from the eyesore of millions of kilometres of high maintenance and aesthetically challenging overhead phone wire networks.

Sanitation will bring new Unicorns

Another of the critical domains that has this possibility is sanitation. The current African backlog, which is primarily in Sub-Saharan Africa, is estimated at 570-million people without access to improved sanitation, and if we are to achieve the UN sustainable development goal (SDG) for sanitation, this situation has to reversed by 2030. This is in an environment of increased water scarcity and although the International Monetary Fund (IMF) in its regional economic outlook report pegs a continued recovery, it is still a low growth rates forecast of 3.5% in 2019.
In addition, this is a region with low energy access and security. The International Energy Agency (IEA) in its "Energy Access Outlook 2017" report concluded that 95% of the 1.1-billion people without access to electricity were in Sub-Saharan African countries. These are difficult boundary conditions. It will take high levels of innovation, creativity and ingenuity to meet both the SDG and lay the foundations of sustainable development within this framework.

We mean business

Sanitation systems can also be a solution provider for these challenges. New circular economy approaches and the use of new digital technologies provide new pathways to sustainable and resilient systems for the future via the Sanitation Economy. There is a new role for business to bring cost recovering, resource recovering, and revenue generating solutions to build a new sanitation market.

The Sanitation Economy presents vast potential for economic growth by bringing business solutions for the toilet-water-energy-food nexus. New business models for toilet provision, products and services; re-usable water and nutrients; data and information provide new benefits across the economy and society.

South Africa, with its robust private sector and public outcry for solutions for water security is uniquely positioned to demonstrate a new model. There is a national public commitment to action on water and sanitation. The Department of Water and Sanitation uses the slogan "Water is Life, Sanitation is Dignity". It was at the National Sanitation Summit in 2015, hosted by my Department, where the then Deputy President – Cyril Ramaphosa issued a clarion call "its not all about flushing". This was a call and recognition for transformation and disruptive solutions in the sanitation sector amidst immediate pressure and greater constraints on sanitation and drinking water due to the present effects of climate change.

New technologies and business models are available today that are enabling the shift from sanitation as waste management to sanitation as a delivery system for resources and data. The Toilet Board Coalition has been working with business leaders and entrepreneurs globally to accelerate the new Sanitation Economy.

The benefits this approach offers are significant. This is the result of taking the total system approach of the Sanitation Economy, which fundamentally realigns flows of nutrients, water, energy, data, and finance within the economy, acting as a root cause solution for a number of areas beyond sanitation itself:

- Sanitation solutions for climate change, both mitigation and adaptation, by producing renewable energy and reducing CO2 and methane emissions
- Sanitation solutions for water security, by recovering more, using less, and contaminating less water (The reduced requirements for flushing and conveyance will result in at least 30% freshwater at a domestic level being made available to the system. This also has the upstream benefits such as lower peak demands, means smaller diameter of pipelines - Existing infrastructure capacity and lifespans can be increased, new supply side infrastructure build can be delayed, Chemicals to treat drinking water significantly reduced, Energy and storage requirements reduced)
- Sanitation solutions for food security by improving soil health, agricultural productivity, climate change resilience, and reducing plantation (farm) operating costs.
- Sanitation solutions for the health sector, not only in its traditional (and still important) role in preventing disease transmission, but acting as a data source for preventative health.
- Sanitation solutions for wider initiatives enabling female health and empowerment.
- Sanitation solutions for smart city infrastructure, where it can be integrated with other city systems, such as transport and pollution control, to enhance lives and livelihoods.
- Sanitation solutions for food, consumer goods, and waste sectors, by being implemented within a holistic biological waste system which can process all forms of biological waste, keeping nutrients and energy in valuable use, and enabling substitution of many plastic items with compostable alternatives.

These are beneficial in themselves, with a mix of economic, environmental and social gains not realised by traditional sanitation programmes. They bring a much wider range of companies and other stakeholders into active engagement with sanitation. In effect these all strengthen the business case for sanitation and make it more likely to be widely and sustainably implemented.

Opportunity to lead

Fortunately, we have already achieved some important starting points. The Water Research Commission together with its local and international partners, many working under the banner of the Bill & Melinda Gates Foundation re-invent the toilet programme, have developed a suite of cutting-edge, innovative technologies and solutions that has the potential to revolutionise sanitation. These state-of-the-art technologies share the following characteristics – first, they are designed to use less than a litre of water per flush with some using no water at all. Secondly, the engineering genius at the back end means on-site or decentralised safe and hygienic treatment of the waste.

This means financial savings in construction costs as the kilometres of massive sewerage pipelines as well as large wastewater treatment plants are no longer needed. This goes along with the saving of the vast quantities of water that conveys the human waste vast distances to the treatment works as required by the current model. Add to this the huge energy savings in the treatment works themselves and you have already an amazing trinity of efficiencies – in water, power and money – precisely in the areas of greatest scarcity on the continent.

With this comes the promise of greater economic growth, enterprise development and job creation. This will facilitate our ability as a continent to meet our SDGs and create the mechanisms for our partners in Asia, Latin America and other parts of the global south to be able do the same.

If we manage to achieve this, we will be introducing a model for low-cost, high-beneficiation, low-water, low-energy and, of course, concomitantly low-carbon sanitation. If we go further than the SDGs to making this a pivot point to revolutionise sanitation provision with large scale adoption, meaning the conversion in the global north as well, then we have the bedrock of true sustainable development.

Africa will indeed have brought forth something new – better phrased as former president Thabo Mbeki reminds us as Semper aliquid novi Africa affert (Africa always brings forth something new). Let us in this Africa Month 2019 re-engage the possibility of the African Century in which this continent leads in the shaping of a better Africa and a better world.

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VISION FOR BUSINESS ENGAGEMENT IN SANITATION IN SOUTH AFRICA

Sanitation Systems as a Solution Provider for the Security Nexus: Water, Energy, Food

The toilet-wastewater-energy-pollution nexus is an emerging issue in the developed and developing world. The provision of safe, hygienic and appropriate sanitation solutions is a priority development in the world. Developed nations have followed a linear design approach to achieve to meet their sanitation needs with conventional waterborne systems implemented and continuously improved to meet more stringent control and pollution regulations in order to minimise the overloading of the natural environment.

1. Sanitation & Water Security

South Africa has an arid to semi-arid climate, with an average annual rainfall of 465 mm (half the world average), producing a total annual runoff of approximately 49 000 million m³/a. The current reliable yield of surface water at an acceptable assurance of supply is approximately 10 200 million m³/a nationally. Of this volume, around 70% is stored in the country's 252 largest dams. The total nationally accessible groundwater potential is about 4 500 million m³/a of which between 2 000 and 3 000 million m³/a is currently being utilised. Of the approximately 5 000 registered dams the vast number (3 832) are small dams (less than 12m) serving farms and municipalities. These smaller dams play a critical role in local water security and climate resilience (NWSMP, 2018).

If demand continues to grow at current levels, the deficit between water supply and demand could be between 2,7 and 3,8 billion m3/a by 2030, a gap of about 17% of available surface and ground water. (Water RDI Roadmap, 2015, NWRSII, and NWSMP, 2018).

The reuse of wastewater provides a new water resource. Decentralised sanitation systems protect water quality and reduce risk of contamination. Low-flush technologies are a key opportunity for water savings.

2. Sanitation & Climate Change

South Africa's future climate is expected to be warmer with temperature increases of between 1 to 3 degree Celsius and this will impact on both rainfall and evapo-transpiration. Changes in run-off and increased evapo-transpiration will affect water storage and drier parts of the country may record lower dam levels and have reduced storage. Thus, climate change will result in significant changes in future water availability, with major implications for most sectors of the economy like mining, energy, agriculture and forestry. It will also become increasingly difficult for water resources planners to plan effectively. What is clear for the future is that planners and service providers have to become agile at adapting and planning for uncertainty. The northern and eastern regions of the country may get wetter, while the western and southern regions are likely to get drier. The climate models suggest longer droughts which implies that current storage practices will need to change and water use should be reserved for most productive uses rather than for example, flushing water down toilets (NWSMP, 2018).

Organic waste treatment can include faecal sludge management (FSM) to produce renewable energy. New circular sanitation treatment technologies reduce CO2 and methane emissions for a lower carbon economy.

3. Sanitation & Food Security

Sanitation systems have a material impact on agriculture - on the soil, on the water, and on the people who work and live on plantations. Circular sanitation systems have the potential to unlock significant economic social and environmental benefits for agricultural plantations and their local communities. **Systems that capture Toilet Resources can produce feedstock to create organic fertilisers** and energy, leading to cost savings

for operations, cost recovery for initial infrastructure investments, even potentially new sources of revenue. Circular sanitation systems have multiple environmental benefits – reduced carbon emissions and water pollution, and potentially improved soil health and reduced fertiliser. Toilet and treatment choices on farms have differing environmental, social and health impacts.

Pit latrines or on-site sanitation technologies are widely utilised across farms , as sewers are in cities, but neither are universally the optimal solution in the Circular Sanitation Economy. New toilet designs and resource recovery technologies offer farms new choices. The economics are especially favourable considering the triple bottom line of economic, social, and environmental factors. Building Circular Sanitation in from the start will maximise returns by avoiding costly retrofits. Clean, safe, sanitation on farms could improve the livelihoods, and health, of the 78% of the world's poor working in agriculture[1]

Sanitation Systems as a Business Opportunity

The industrial and economic benefits are substantial. Analysis conducted by the Toilet Board Coalition - a private sector platform focused on business solutions for sanitation 2016-2019, identifies the opportunity for transformation of the economics of sanitation - from unaffordable public costs to sustainable business opportunities via the Sanitation Economy. Lower capital and operating costs, together with revenues from toilet services and resource recovery, can reduce the cost of sanitation per person per head to around $6 (ZAR 92), compared with traditional norms of $100-200 (ZAR 1525-3050). This should be seen as a trajectory towards profitable models, sufficient to fund capital and generate a return for commercial investment. The key enabler of profitability is scale.

Poorly managed sanitation has become a business risk that affects all business sectors - including the health of workers and customers, their families and communities, well-being and productivity, environmental contamination of soil and water, and climate change via methane emissions. Businesses are responsible for millions of people via their employees and communities in which they operate. Every company's responsibility must include ensuring safely managed sanitation for all and via Sanitation Economy solutions no longer means an unrecoverable cost for business.

Business initiatives such as the World Business Council for Sustainable Development (WBCSD)'s Water Sanitation & Hygiene (WASH) Pledge cites 50 multi-national companies committing to implementing access to safely managed WASH at the workplace for all employees in all premises under their control within three years of signature. The WASH4WORK initiative which includes business, UNICEF and WaterAid, helps companies to ensure access to sanitation across supply chains and communities where they operate.

Sanitation is a mainstream business issue that goes beyond Corporate Social Responsibility to ensuring sanitation access for employees; to understanding the risks of poorly managed sanitation for business; and to the new business opportunities of the Sanitation Economy.

Leading businesses of the Toilet Board Coalition (Unilever, Kimberly-Clark, LIXIL, Firmenich, Tata, Veolia) and a growing sector of innovators have been building the Sanitation Economy. New economic evidence and business models, product and service providers are now available for scale, providing a pathway to more sustainable and resilient sanitation systems for the future.

There is now a growing pipeline of businesses globally, with significant growth across Africa, creating innovative products for the Sanitation Economy and becoming service providers in rural communities and cities from: Public toilet models; household toilet products & services; on-site circular economy waste management models generating water, energy, fertilisers, and mini grids to feminine care and sanitation health sensors generating new data & insights about human health and behaviour including infectious disease monitoring.

The work of the Toilet Board Coalition and its members has found that, on average per 1 million people served, countries can gain $70 million in increased productivity through the provision of safe sanitation. In addition, for every $1 invested sees a ROI of investment of $5 in positive externalities – including healthcare services and increased attendance at schools. 5x more affordable than sewers, decentralised sanitation solutions demonstrate that waste water management can be done at a much lower cost. Save 2.6 billion L of water per year. Remove 65,000 tons of sanitation waste, or "toilet resources", per year that would have otherwise polluted the environment and caused tremendous public health risk. Produce more than 19,000 tons of animal feed and organic fertiliser combined and help local farmers gain

1 https://www.toiletboard.org/media/48-TBC_2018AgricultureReport_032419_FINAL.pdf

access to increased supply of affordable, agricultural inputs increasing yield & incomes while addressing food security issues.

The management information systems created to track the progress of sanitation against the Sustainable Development Goals is another unique and positive outcome. This information is invaluable for businesses indicating potential new market development areas. Digitising sanitation presents new opportunities to create Sanitation Intelligence, by transforming sanitation systems into smart toilets, smart treatment and smart preventative health in conjunction with Smart City initiatives.

Linking sanitation to smart cities infrastructure - working with research and private sector partners - to deploy sensors in sanitation systems makes toilets, treatment and health smart, enabling a new sanitation intelligence and new information about public health. For example sensor technologies available today can monitor toilet usage and cleanliness; waste treatment operations & maintenance and waste quality for up-cycling; infectious disease circulation for public health - all enabling data-driven sanitation decision-making.

In 2011, The Bill and Melinda Gates Foundation launched the Sanitation Grand Challenge on Reinventing the Toilet, to develop the next generation of sanitation technologies, that work off the grid and provide valuable by-products. Key processes which are determining these pathways are combustion, carbonisation, pyrolysis, electrical conductivity and compression. These developments and directions offer multifold benefits and opportunities for South Africa, both on a social and economic fronts.

Social : South Africa has around 83% coverage of sanitation to date (STATSSA, 2018). Of this, at least 35% have onsite sanitation in the form of Ventilated Improved Pit latrines or septic tanks. Besides the financial constraints for capital and operation, water availability and resulting pollution is a huge concern. Off the grid solutions offer an affordable opportunity to deal with many of our challenges and accelerate service delivery. The potential is much greater, if we are then to extend these systems to all formal residents over time.

Economic: South Africa in recent times has had a limited niche in the technology and industrialisation environment. The potential exists for South Africa to be the one of the front runners in becoming the manufacturing, technology development and innovation hub in the area of new sanitation technology in the developing world. The economic opportunities these offer are:

- International competitiveness and export
- Job creation in manufacturing but a large component on servicing (off the grid means more specialist plumbers and technicians)
- Greater leverage to the social case.

Introducing the Sanitation Economy [2]

Business solutions for smart, sustainable and resilient sanitation systems that go beyond corporate social responsibility and contribute to a shift from a system of mounting costs to a system abound with business opportunity and new markets.

Sanitation is every business's business. The Sanitation Economy presents vast potential for global economic growth while addressing one of the most urgent grand challenges of our time, achieving universal access to improved safely-managed sanitation (SDG6). It monetises toilet provision, products and services, biological resources, data and information to provide benefits across the economy and society.

As a market opportunity example, studies from the Toilet Board Coalition estimate that The Sanitation Economy is a $31 billion market today in India alone, and is set to double to over $62 billion annually by 2021.

This is the biggest opportunity in a century to transform sanitation systems into a smart, sustainable and revenue generating economy. By accelerating the Sanitation Economy, we can create a robust marketplace of new market opportunity that has been virtually untapped. We can do this while improving lives of the 2.1 billion currently without toilets, and ensuring the capture, safe treatment and use of 3.8 trillion litres (500 Lpp/a x 7.6 billion global population 2017) of toilet resources which is currently lost and untreated; and by leveraging smart technologies to drive efficiency in sanitation systems, while capturing extensive amounts of data to inform business, policy, and health decision making.

The Sanitation Economy offers new ways of looking at sanitation systems: as a solution provider for sectors and governments facing constraints on essential resources such as water, nutrients, energy and proteins; as a reservoir of information about human health and behaviour; and as a test bed for innovation and new technologies that reinvent the toilet and its ecosystems. It leverages new business models and disruptive technologies together with established technologies and businesses with scale to transform sanitation systems. The economic case for the Sanitation Economy

What is the Sanitation Economy

The Sanitation Economy links 3 distinct areas for business and societal benefit.

1. 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, planned and unplanned (informal) settlements. Toilet designs apply the Circular Sanitation Economy principals to minimise waste and greenhouse gas (GHG), and capture data to feed the Smart Sanitation Economy.

2. THE CIRCULAR SANITATION ECONOMY

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

3. THE SMART SANITATION ECONOMY

Digitised sanitation systems that optimise data for operating efficiencies, maintenance, plus consumer use and health information insights. Sanitation is included in smart cities architecture monitoring public toilet usage, sewage treatment, health indicators, and detects needs for maintenance and repair throughout the system.

1 http://www.toiletboard.org/media/30-Sanitation_Economy_Final.pdf

2 http://www.toiletboard.org/media/38-The_Sanitation_Economy_in_India.pdf

THE SANITATION ECONOMY

MARKETPLACE

Sanitation as a business opportunity instead of an unaffordable cost

Sanitation as a solution provider, offering not only sanitation, but cost savings and environmental improvements to food/agriculture, consumer goods, energy, health, waste, water and other industries

PREVENTATIVE HEALTH

HEALTH DATA
Nutrition & health data can inform public officials, the healthcare and pharmaceutical community and individual users

TOILET ECONOMY

HOUSEHOLD
- TOILET SHELTER
- CONTAINER TOILETS
- PAN/TOILET FIXTURE

PUBLIC
- BIO TOILETS
- PUBLIC & COMMUNITY TOILET BLOCKS
- PORTABLE TOILETS

- LAUNDRY SERVICES
- MAINTENANCE AND REPAIR
- CLEANING
- PERSONAL HYGIENE PRODUCTS
- FEMININE CARE PRODUCTS

BIOLOGICAL WASTE INPUTS

Consumer biological waste
- toilet waste
- kitchen waste
- animal waste
- compostable packaging & other items

Industrial biological waste
- toilet waste,
- food / market waste,
- agricultural & food waste
- farm waste
- compostable packaging & other items

CIRCULAR SANITATION ECONOMY

COLLECTION & TRANSPORT OF BIOLOGICAL WASTE

PROCESSING
Resource recovery plants process and refine the collected waste through various technologies to produce safe valuable products

HOMES, BUSINESSES, FARMERS, MANUFACTURERS, CITIES
Upcycled products from Toilet Resources are sold back to businesses, cities and individuals to complete the loop

SMART SANITATION ECONOMY

DISTRIBUTION
Relevant data is communicated back to the user through mobile applications and services

SOFTWARE/DATA PROCESSING & ANALYTICS
Sensor sends molecular characterisation data to cloud based cognitive computing platform where data is analysed and organised

SENSORS & DATA CAPTURE
Sensors in household, business, community and public toilets capture molecular characterisations of waste and transmit data through connected networks and devices

CONSUMER USE DATA

Consumer insights data related to consumer behaviour & product usage. Customer relationship management, marketing, advertising & product decisions

TOILETS & PRODUCTS DESIGNED FOR REUSE OF RESOURCES

SYSTEM OPERATIONS DATA

Manufacturers, operators, and service companies can access status information to inform the need for maintenance, repair, cleaning, waste collection, etc.

TOILET ACCELERATOR
SMART SUSTAINABLE SANITATION FOR ALL

SENSORS

- IN TOILETS
- TOILET ADJACENT
- IN BATHROOM
- INFRASTRUCTURE

PRODUCTS

ENERGY PRODUCTS
Fuel, electricity, heat
- Biogas for local factories & electricity to the grid
- Bio diesel for transport
- Bio charcoal to replace wood/coal

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

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TOILET BOARD COALITION

Key Drivers for Business Engagement in the Sanitation Economy

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 billion according to the World Bank.
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.

By accelerating the Sanitation Economy, businesses can capture significant benefits:

1. Access to the growing emerging market customer base (2.1 billion people globally that need basic sanitation. 61% of the global population do not yet have access to improved sanitation including waste management).
2. Competitive advantage and innovation, creating smart, sustainable sanitation systems for the future.
3. Contribution to sustainability targets - addressing resource scarcity (such as water for manufacturing and nutrients in agriculture), climate change and zero waste policies.
4. Reducing costs and accessing new resources through the Circular Sanitation Economy - valuing sanitation waste as "Toilet Resources" and generating new revenue from valuable products derived from Toilet Resources such as energy and fuel, nutrients, proteins, water, information and more.
5. Access to new data and information for operational decision-making and potentially new market opportunities by leveraging the mobile, digital, big data and smart mega-trends for sanitation.

Benefits

There are immediate opportunities for business and governments to build demand for the Sanitation Economy and realise significant benefits:

- Opportunity for businesses across sectors to ensure sanitation access for employees and communities where they operate
- 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
- Opportunity for operators to leverage new business models to enable benefits faster and at lower cost
- Opportunity for smart cities solution providers to integrate sanitation systems into smart infrastructure and information architecture.
- 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.

Our national percentage of households with access to improved sanitation facilities from 62% in 2002 to 83% in 2017, reaffirming Government's commitment to provide access to this basic human right. Though significant progress has been made since the democratic dispensation from 1994, many new challenges have emerged with a growing aspiration for better solutions. The binary model, of gold standard in the form of full flush toilet vs hole standard in the form of pit latrines, for rich and poor areas respectively has not closed the gap, but reared a myriad of new operational challenges. Compounding this is the fact that South Africa is a water scarce country and the universal access to waterborne sanitation may not be realized due to the prohibitive costs and the availability of water. The deeper problem is that there is no sanitation market, especially for the poor – it happens to be a monopolized public good with minimal innovation uptake.

According to the National Water and Sanitation Masterplan (2018), the total requirements in the country will increase due to population and associated economic growth, but individual users' requirements should be reduced by improving efficiency, adopting new technologies, and reducing losses, especially in the agricultural and municipal sectors, through water awareness, and strict regulation, cost recovery and incentives.

The provision of waterborne sanitation is unsustainable and South Africa must adopt water-less, low water or full recycle sanitation technology where appropriate

Water availability and raw water quality will decline further if the degradation of aquatic ecosystems (including wetlands), poor land use practices, and high levels of water pollution from agriculture, industry and sanitation practices continue. Faecal contamination, eutrophication (growth of algae in rivers and dams), increasing salinity and sediment wash off to surface waters will continue to have widespread impacts, while radioactive contamination, heavy metals and persistent organic pesticides (POPs) have had more localized impacts linked to industrial practices. Poor water quality increases the cost of treating water to potable standards, and in future will increase the cost of water to industry and users or lead to an unsustainable business case for the water sector. The full cost of pollution from poor sanitation on human health is not fully reconciled in terms of the growing demand on the fiscus nor the quality of life.

It is estimated that South Africa has lost over 50% of its wetlands, and of the remaining 3.2 million ha (less than 5% of SA land cover) of which a third are already compromised limiting their ability to perform vital ecological services such as regulating water flows and purifying water, recreational services and economic services.

South Africa aims to transform the sanitation environment towards a smart sanitation technology solutions environment which will see sanitation going off the grid, and associated with this a new sanitation services market for relevant settlement types.. To achieve all of this at the scale it is envisaged that smarter management systems and user behaviour change will be necessary. This approach offers opportunities for stimulating the development of a new industries which will potentially meet several national objectives of job creation, SMME development, micro and macro enterprise development etc. while turning this challenge into an opportunity towards a circular economy for sanitation.

The circular economy of sanitation sees human wastes as resource, which allows a new ecosystem approach with benefits to be derived from processing, by-products and servicing models which support self-sustaining businesses. It has a catalytic effect on stimulating and developing a series and variety of logistics and supply chain models which brings greater convenience to the user/customer and the much needed capacity which is a weakness in the public model. There are several initiatives, where human wastes are being turned into valuable products such as biochar, oil, protein and fertilisers. This resource approach opens up these new opportunities for a Sanitation Economy.

To enable these new sanitation markets, requires political and public sector leadership. It is also about transforming a very entrenched public supply model which will have to evolve if we are to be successful. The following is already in progress:

- **PLATFORM - SASTEP** (South African Sanitation Evaluation Programme) - The WRC has created a co-ordinating national platform with Department of Science and Innovation (DSI) and the Bill and Melinda Gates Foundation to enable 3 critical areas in the new sanitation industry viz: demonstration with commercial partners, localization and industrialization. The programme provides a common platform for all national public and private partners through which the new sanitation economy can be discussed.

- **POLICY** -The new sanitation industry opportunities are included in our new Department of Human Settlements, Water and Sanitation policy positions and in the National Sanitation White paper (in draft publication). This formally sets Government impetus and commitment in this direction.

- **INDUSTRY** - The dti (Department of Trade and Industry, DSI (Department of Science and Innovation) and WRC have included new off grid sanitation in a dti Industrial Policy Action Plan of 2017 (IPAP, 2017). TIPS (trade and industrial policy strategies), the research policy arm of dti has done a study which estimates that there is a case for non-sewered sanitation with a local SA market opportunity of R17 billion annually to meet the SDG targets while the opportunity is significantly greater globally. Transforming the sanitation space requires a strong industrial and innovation base for solutions and production. Localisation (assembly and manufacturing), the establishment of value chains and critical linkages with the potential future global value chains also stimulates and creates a new industry with products and services and many new jobs.

- **STANDARDS** – The South African Bureau of Standards (SABS) has adopted the ISO 30500 Standards on non-sewered sanitation In May 2019. These are very important elements in this new sanitation economy stimulating competitiveness and international trade.

- **REGULATIONS** – The Department of Human Settlements, and Water and Sanitation (DHS& WS) is working on new regulations, however one of the key instruments undergoing revisions is the National Building Regulations to include the new off grid sanitation solutions. This will further incentivize both state and public institutions to ensure quick uptake of solutions.

- **INNOVATION STIMULATING GROWTH** - In his recent speeches in response to challenges to school sanitation, the President Mr Cyril Ramaphosa, highlighted and recommended the introduction of new innovative solutions to the school sanitation system. (SAFE 2018)

- **COHORT OF NEW SKILLS AND CAPACITY** – To meet the requirements of this new sanitation economy, the appropriate sets of skills and competencies will be needed to support the technology, servicing, marketing and customer management.

Through the use of innovative technical products, South African can shift the paradigm in which she serves her towns and cities towards more responsible use of scarce water resources, energy and nutrients while achieving the main aim of sanitation: protecting public health and the environment. There is an opportunity to grow resource recovery industry, the service industry (inclusive of operation and maintenance) through the use of innovative products and business models which result in smart supply chain management.

The Sanitation Transformation Initiative) – known under the acronym SaniTI – is an approach conceptualised and visioned by the WRC which aims to disrupt the current sanitation paradigm by presenting a new pathway that incorporates the elements described above:

- Off-the-grid sanitation that meets user needs and expectations
- Circular economy principles in which products in the value chain are recycled or re-used with the addition of other revenue streams
- Establishing market needs and demands.
- Presenting a R&D pathway to achieve technical, policy and procurement targets in line with our vision.
- Reskilling and training professionals and businesses

SaniTI presents a national strategic direction for the South African sanitation industry for various partners and stakeholders to break away from the current engineering and economic paradigm. A new paradigm for sanitation which is proposed is based on technology disrupters which can safely treat human excreta and matches user preferences without the need for sewers, and reliance for external water and energy supply. Through innovation and smart chain supply, universal access can be achieved sustainably and linked to water security and business opportunities.

The opportunity opens up for leapfrogging these solutions into the new developments of growing cities of the developing world, reducing water consumption and eliminating pollutant pathways. This alone can free up nearly 30 to 40% treated water in the system. On the back of this transformative initiative is the opportunity for the digital platform which offers the opportunity for behaviour change and service credibility. The WRC continues to work with all its partners, DSI, dti, DHS&WS, eThekwini municipality, South African Bureau of Standards (SABS) amongst others towards this outcome.

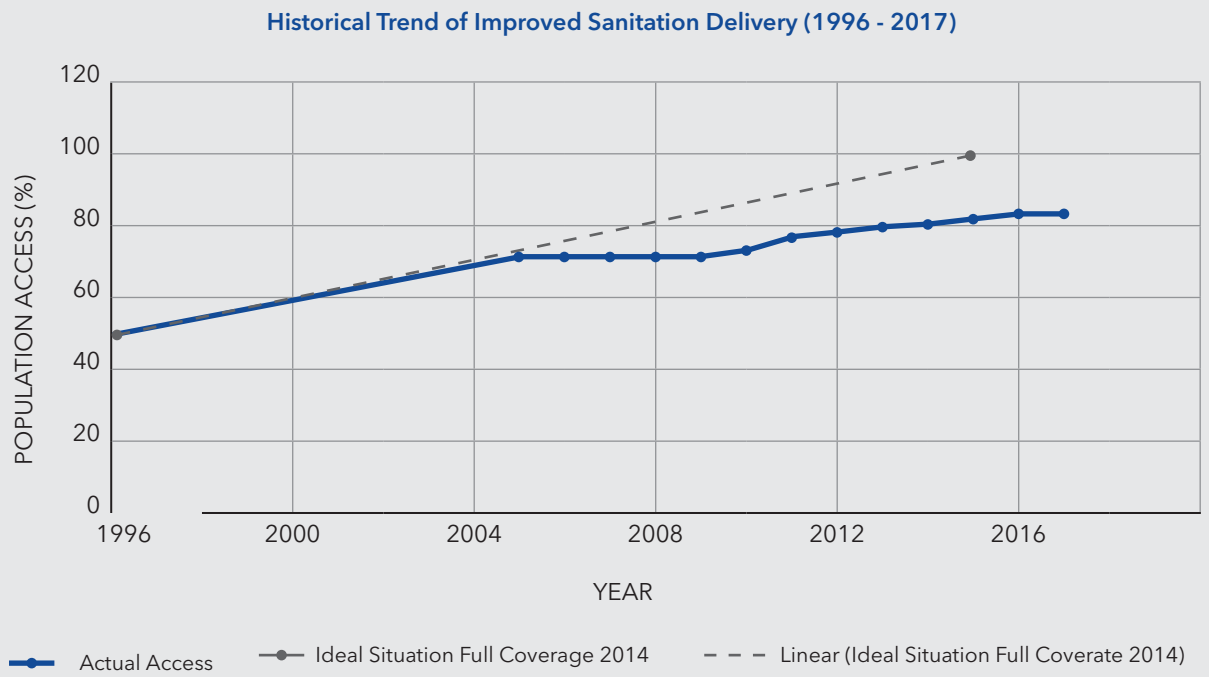
In summary, the public sector must stimulate and invest more in the water innovations space if we want to build a water secure world. It is upon all of us to advocate for this sanitation revolution; however, it is important to prepare our people for such a revolution; lest we become a group of sanitation rebels. We need a shared vision and a common message that resonates and is amplified. The sanitation evolution has taken us only so far, now is the time for the sanitation revolution to disrupt and set us on a more strategic and sustainable trajectory into the future.

THE PROBLEM TO SOLVE: CURRENT TRENDS IN SANITATION IN SOUTH AFRICA

Current Situation of Sanitation in South Africa

Our sanitation challenge in South Africa is a continuous one. Dealing with the inequities of the past, coupled with a dichotomy in society through apartheid spatial planning and the new perils of nature in the form of climate change puts a huge pressure on how we roll out sanitation in the future. We do not see the current norms in sanitation technology in the form of high flush toilets sustaining in the future in terms of both water and sanitation security. It was at the National Sanitation Summit in 2015, hosted by my Department, where the then Deputy President – Cyril Ramaphosa issued a clarion call "its not all about flushing".

This was a call and recognition for serious Sanitation Transformation in the sector. This was a call to tackle the binary problem of gold standards for rich and hole standard for the poor. This was a call that our destiny on sanitation should not be attached to the flushing of human wastes. This on the recognition that climate change will put greater constraints on sanitation than drinking water, and disrupting this sanitation environment with smart sanitation solutions and service models is the kind of transformation which was required.



Data Sources: Stats SA 2018 (1996, 2017), WHO?UNICEF JMP 2018 (2005 - 2016)

Figure 1: Historical trends in Sanitation Delivery

The sanitation nexus (water-wastewater-pollution), is now becoming a greater concern and issue for the following reasons:

- Climate variability will have an impact on both water quantity and quality
- Most countries , including South Africa are reaching the point of complete allocation and utilisation of all water resources
- Water Efficiency and demand management will become critical but what follows when this is done
- Quality of used water will become more complex to manage due to emerging contaminants
- Greater competition for water use

South Africa has made large strides in eradicating sanitation backlogs. The households with access to improved sanitation, as defined by the WHO and UNICEF (WHO and UNICEF, 2012), increased from 49% in 1996 to 77% in 2013, and currently sits at 83% (a further 16 million households with « improved sanitation ») as at 2017 (STATS SA, 2018). However, there is still a significant percentage of the population that do not have access to improved sanitation. In 2017, there were 2.8 million households in South Africa that utilised unimproved sanitation including 280,791 households which practised open defecation (STATS SA, 2018). This remaining 17% of households that still use unimproved sanitation facilities and including the households that still practise open defecation needs to be addressed. Bold action needs to be taken now to achieve a national target of sustainable sanitation for all by 2030 (NSIP, 2019).

In terms of technical options used, 61% out of 83 % of all households with access to improved sanitation are served with waterborne toilets which are connected via sewers to Wastewater Treatment Works (WWTW). Waterborne or full flush toilets depend on the availability of water to flush human excreta and transport it to a WWTW where it is treated and discharge or disposed into the environment. Typically, urbanised areas make use of flush toilets connected to a WWTW via a network of sewers.

A significant proportion of the population (36%) rely on on-site sanitation alternatives for their sanitation needs. This includes both improved (22%) and unimproved sanitation (14%) facilities. A large percentage of the improved on-site sanitation facilities are comprised of dry sanitation options, with VIP latrines representing the largest percentage of the population served by this technology amongst dry sanitation options and second largest percentage overall. The decision for the choice of VIP and other dry systems is largely determined by cost (no sewers) and the non-requirement of water for functioning. Due to backlogs never disappearing at the municipal level and at schools it has become clearer that the VIP options will continue to be unsustainable.

The numbers above are sanitation provision needs as determined in terms of local government provision. The historical trends suggest that South Africa is at a cross roads and delivery has levelled off. Some of the reasons could be associated with water supply and the constraints thereof, the lack of appropriate technology and delivery models for capacity constrained municipalities. (Figure 1,2 &3)

Sanitation provision in South Africa also falls within Department of Basic Education (DBE) and Public Works for schools and public facilities like hospitals. A situational analysis carried out by DBE (DBE (2019) unpublished) characterized the state of sanitation facilities in schools into categories:

1. Schools with rudimentary pit toilets and unacceptable sanitation
2. Schools with sanitation but with undemolished pit toilets
3. Schools with no age appropriate sanitation (no sanitation facilities for Grade R learners)
4. Schools with insufficient sanitation

The Department of Basic Education has identified ca. 3900 schools that would require new sanitation facilities to address the shortfall and inadequacy of facilities. This falls within the ambit of the SAFE (Safe and Appropriate Sanitation for Education) initiative and it plans to address the sanitation shortfall within the next three years. However, there is a need to add more sanitation facilities to cater for increasing demand at existing schools.

Sanitation Infrastructure

Despite significant strides made in increasing sanitation coverage, there is still a challenge in maintaining existing infrastructure and implications of rapidly extending sanitation services. A large component of the challenges experienced in sanitation service provision relate to technical limitations that affect the way we approach sanitation service provision. Full flush connected to sewers and WWTWs is not affordable for the entire country and there is an uneven and climatically-induced constrained water supply. As an alternative, waterless (dry) latrines

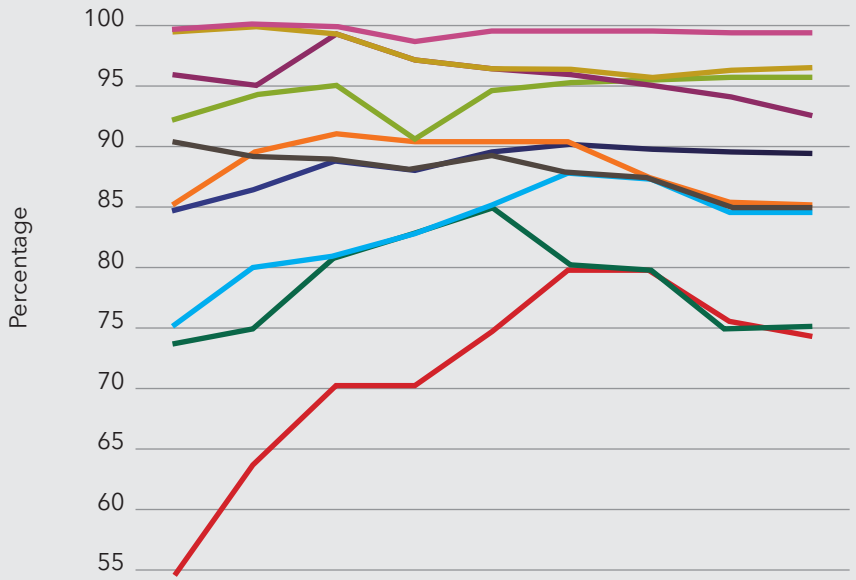
are provided to unserved, indigent populations. Our technical approaches are therefore limited to extremes: a complex, high-capex and high-opex full flush system connected to WWTWs via sewers or a dry system which is essentially a storage hole for human excreta. The limitations in both of these approaches have resulted in severe sanitation post-infrastructure implementation challenges linked to affordability, operations & maintenance, pollution, disease and tragically fatalities at primary schools.

A third of the South African population relies on waterless VIP latrines and their variants. These technologies offer the technical advantage of not requiring water for effective functioning. The National Education Infrastructure Management System (NEIMS) Report dated January 2018 had already indicated that 8,702 schools in the country have pit latrines which did not meet Norms and Standards for School Infrastructure regulations published in November 2013 (Department of Basic Education, 2018). It was concerning that there are few alternative sanitation technologies implemented in rural areas and schools in provinces which have the highest number of latrine facilities, namely, Eastern Cape, Limpopo and KwaZulu Natal provinces. Latrines have a limited lifespan and require periodic emptying and servicing to function as a safe and hygienic sanitation option.

Operations and Maintenance

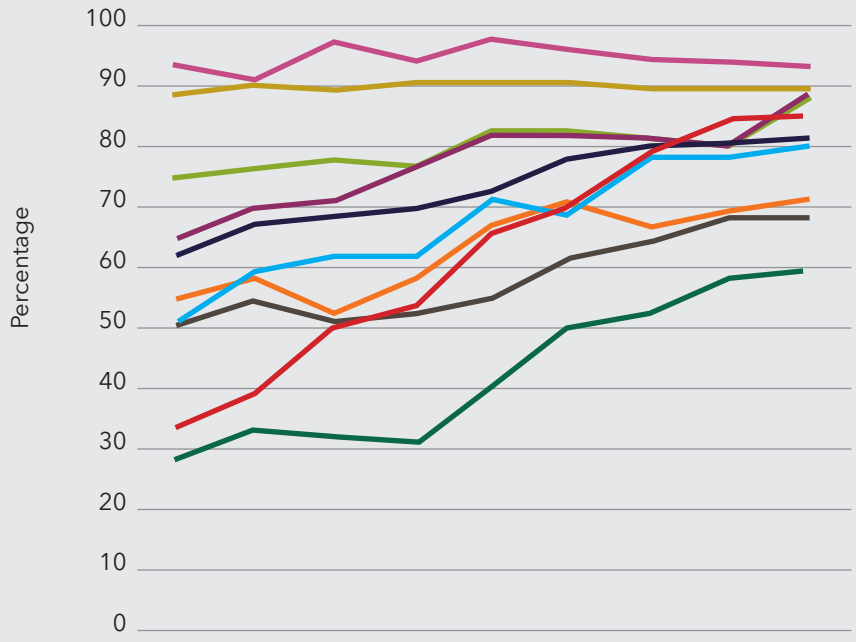
The lack of focus on an operation and maintenance (O&M) strategy was highlighted by WRC with regards to the sustainability of the all sanitation initiatives. O&M costs represent more than 80% of the lifecycle cost of a toilet and simply constructing toilets is a short-term solution and without a long-term O&M strategy, the problem would undoubtedly resurface. Past experiences show that the O&M budgets are either inadequate or diverted to other pressing needs. A similar scenario exists in various municipalities where the incorrect budgets are allocated to operate and maintain toilets in order to increase their lifespan resulting in "backlogs of backlogs". Similarly, O&M is a neglected budget item for waterborne sanitation. Despite waterborne sanitation serving nearly two-thirds of the South African population, South Africa is experiencing challenges with maintaining its WWTW infrastructure. The Green Drop Certification Programme for Wastewater Quality Management in 2013 released the results of WWTW performance indicating that out of 824 municipal WWTWs, 800 WWTWs are in poor or critical condition (DWS, 2014). The privately-owned WWTWs were assessed and 1 out of 5 WWTWs were found to be in poor condition.

An innovation synergised water industry that is able to deploy new solutions through efficient manufacturing support and effective water sector businesses that work in collaboration with the public sector.



		2002	2004	2006	2008	2010	2012	2014	2016	2017
	WC	98.9	99.2	99.4	98.6	98.8	98.9	98.9	98.7	98.7
	EC	56.1	63.4	70.4	70.8	74.9	79.2	78.7	76.4	74.2
	NC	92.5	93.2	95.4	90.7	94.1	95.7	96.0	96.0	96.0
	FS	95.6	95.0	97.4	97.6	96.9	96.6	95.2	93.2	92.8
	KZN	75.4	79.4	81.4	82.1	84.1	87.8	87.0	84.2	84.5
	NW	85.6	88.5	90.8	90.0	91.0	91.2	87.2	86.7	85.8
	GP	98.7	98.8	98.0	97.1	97.2	97.2	96.5	97.5	97.1
	MP	90.5	88.1	88.9	88.3	88.1	87.6	87.2	85.4	85.5
	LP	7.8	75.4	80.7	82.5	84.0	80.1	79.6	75.1	74.7
	RSA	84.4	86.5	88.8	88.7	90.0	90.9	90.1	89.0	88.6

Figure 2: Access to water supply (STATSSA, 2019)



		2002	2004	2006	2008	2010	2012	2014	2016	2017
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	NC	92.5	93.2	95.4	90.7	94.1	95.7	96.0	96.0	96.0
	FS	95.6	95.0	97.4	97.6	96.9	96.6	95.2	93.2	92.8
	KZN	75.4	79.4	81.4	82.1	84.1	87.8	87.0	84.2	84.5
	NW	85.6	88.5	90.8	90.0	91.0	91.2	87.2	86.7	85.8
	GP	98.7	98.8	98.0	97.1	97.2	97.2	96.5	97.5	97.1
	MP	90.5	88.1	88.9	88.3	88.1	87.6	87.2	85.4	85.5
	LP	7.8	75.4	80.7	82.5	84.0	80.1	79.6	75.1	74.7
	RSA	84.4	86.5	88.8	88.7	90.0	90.9	90.1	89.0	88.6

Figure 3: Access to sanitation (2002 to 2017) (STATSSA, 2019)

BUSINESS APPLICATIONS & TECHNOLOGIES

The Toilet Economy

The toilet economy goes beyond facilities and traditional treatment methods and stretches the innovation challenge to develop off grid sanitation models with appropriate business models.

SOME OF THE KEY CONSIDERATIONS FOR THE TOILET SYSTEM OF THE FUTURE:

1. Technical and process design

a. Single units but with a modular design for full transformation of waste
b. Multi-units for commercial buildings but with planned variability
c. Multi-unit for informal settlements (high variability design and in situ design)
d. Peak and variable flows
e. Treat blackwater

2. Cost

a. Affordable
b. Innovative business model to offset infrastructure cost

3. Product Design

a. Aspirational
b. Low energy or renewable energy
c. Low (<2 L per flush) or no water
d. Full recycle
e. Sustainable
f. Product storage
g. Product recovery
h. Gender intentional

4. Manufacturing

a. Mass production
b. Scale

5. Regulations/Standards

a. Full or improved recovery in order to shift from effluent and sludge regulations to product specifications
b. Standards based eg SANS 30500 certification

TECHNOLOGIES & INNOVATION

This section shows some of the research done and innovation tested and planned to be tested in SA and the reasons for its development.

Types of Toilets

1. Waterless Toilets

The principle approach was to test other dry toilet options for South Africa due to lack of water in certain regions. There are various dry systems that have been tested for user acceptability but acceptance is low. South Africa has also tested a global technology called the earth auger and under the engineering field testing platform in eThekwini the nano-membrane toilet was evaluated to improve development. Commercial companies like SATO have also tested the SATOPAN.

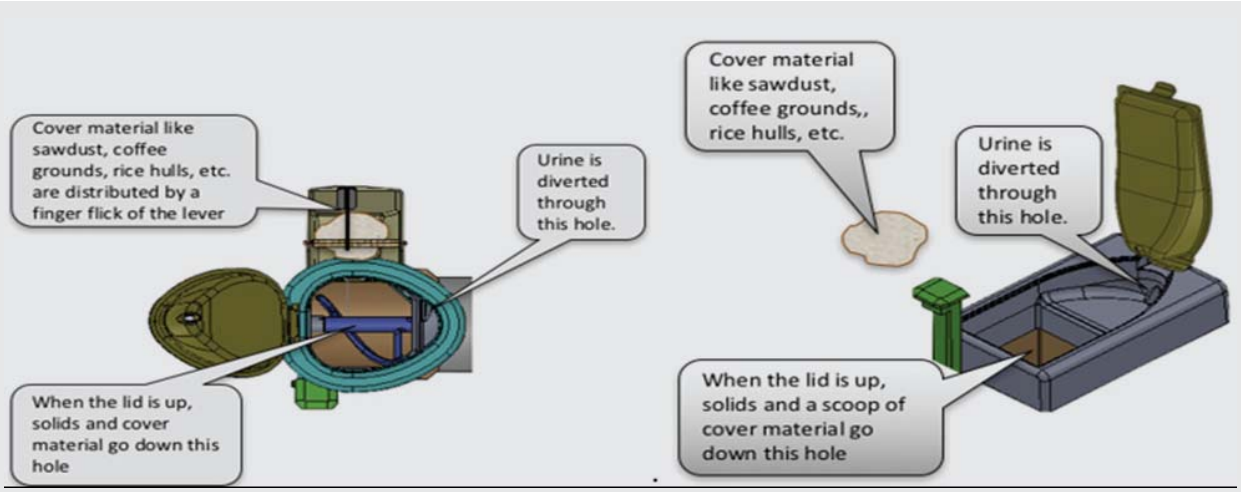

Figure 4: Earth Auger toilet with cylindrical auger and vent pipe in Eastern Cape

Figure 5: Pour Flush pedestal

Case Study: Earth Auger

In February 2016, about two hundred (200) units of the Earth Auger Sanitation technology (Thailand design) were implemented as a demonstration at Ida Farms Community under Emalahleni Local Municipality in the Chris Hani District municipality, Eastern Cape Province, South Africa. The toilets were implemented to provide sanitation to inhabitants who were using open defecation. The study found user acceptance and uptake was not high and this was due to institutional training and communication failures. Typically, we have seen that communities are reluctant to perform additional services to maintain their toilets. These technologies may have resonance in communities that value sustainability and ecological living and believe self-reliance.

2. Low flush Toilet (piloted as low and pourflush systems)

Due to the poor ownership shown by communities around dry toilets, WRC shifted its research strategy to look at hybrid toilet systems that used "alternate sources of water eg greywater or very limited amounts of water to increase the user acceptability and sustainability of sanitation implementation in the country.

Case Study: The Pour Flush toilets

The Pour Flush toilets are suitable in areas where there is a limited water supply because it only uses one to two litres of greywater compared to a standard flushing toilet. The pour flush latrines have a water seal between toilet bowl and sludge that eliminates smells and flies. It looks like a standard flush toilet because the user does not see human waste and the leach pit where the faecal waste that accumulates, is not directly under the pedestal which also makes it safe to be used by children. The project started in 2015 and around 800 units have been completed in the following municipalities: Mkhondo Municipality: 129 completed; Chief Albert Luthuli: 130 completed; Amathole DM: 150 completed; Chris Hani DM: 150 completed; Joe Gqabi DM: 122 completed; !Kheis LM: 120 completed ; The project also provided 360 jobs for the community.

3. Arumloo (low flush toilet)

The Arumloo is a South African design that was originally patented by the Water Research Commissioner but has since released the patent to the developer for commercialization purposes. The Arumloo is an innovative microflush toilet capable of flushing on less than two litres of water.

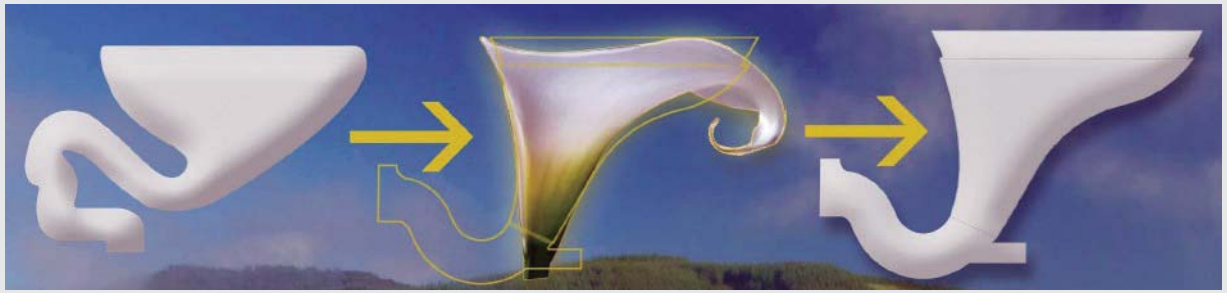

Figure 6: Arumloo low (micro) flush toilet

The product mimics the Arum Lily flower and the vortex created by innovative bowl design allows higher efficiencies for flushing (less than 2 litres) compared to a conventional full flush (9 to 12 litres).

4. **Urine diversion** (UDDT)

UD Toilets have been tested as a smart technology of the future. Urine forms a small part of wastewater but through the presence of nitrogen and phosphorus is a key contributor to pollution in the environment. Pilots have been conducted in eThekwini and Stellenbosch and showed 3 critical components needed for success viz: community acceptance was critical, the design was not ideal, and once urine is separated there is no toolbox of options to deal with the urine in a cost-effective way with viable market routes. The recent design of the EOOS toilet from the BMGF RTT technology toolbox seems to have some promise and will be tested in South Africa. In addition, studies funded by University of Cape Town by the WRC has shown that a possibility exists to use urine as a fertiliser in the agriculture sector in South Africa but more work needs to be done.

Figure 7: UD Toilet in Stellenbosch

Mobile Sanitation Facilities

In the major cities of South Africa informal settlements are common due to urbanization. The provision of sanitation has proved difficult and, in many instances, mobile and temporary facilities like chemical toilets are used which incur significant costs. This is not considered a sustainable long term solution for informal settlements which can exist indefinitely due to seasonal job opportunities and the inability of social housing to keep abreast of urbanization rates. The BMGF RTT technology toolbox offers some opportunities to test innovative mobile and communal toilets facilities

Treatment

1. **Back-end Toilet treatment technologies**

South Africa is currently looking at demonstrating 5 to 6 RTT technologies in various environments to evaluate robustness, user acceptance and ultimately cost/affordability of the capex and opex. Full recycle units using either smart MBR systems or electrochemical technologies are available for testing in several environments like schools and in communities as well as in green buildings in South Africa. These modular systems may offer potential manufacturing and scale up opportunities in the South African market. Other systems like solar septic and zyclone and USF may be appropriate in certain South African environments. In addition, SASTEP will evaluate the opportunity to demonstrate the sanitation solutions for wider initiatives enabling female health and empowerment. This incubation and demonstration process is aimed to stimulate thinking around localization, industrialization and export, thereby changing the current sanitation industry trajectory.

2. **Adapted Treatment technologie**s

Adaptation of front-end and back-end systems: The new sanitation industry also allows for adaption of new toilets designs like EOOS or Arumloo with tested low end technologies like DEWATS which adds circular economy advantage at local level. to more simpler technologies:

Figure 8: Range of RTT technologies (photos courtesy of Bill and Melinda Gates Foundation)

DEWATS systems comprise a primary biodigester, a secondary anerobic filter and a tertiary wetlands design for polishing and are typically designed for a maximum of 1000 households. These systems were typically designed for low desludging and reuse of treated effluent for agriculture (community gardens or household gardens) for lower income communities.

Applications:
The toilet economy could be implemented in various environments in South Africa and the incubation of this new industry will probably require important first adopters like the schools programme and busineses. The opportunity for this industry ranges from schools that are located in peri-urban and rural areas, to healthcare facilities like clinics as well as driving future sustainable developments

Figure 9: Pilot DEWATS system in eThekwini

via the property sector and developers. The latter is stimulated by government policy from the Department of Environment and Department of Human Settlements and through the Green Buildings Council of South Africa (GBCSA) the opportunity exists to test many of these solutions in new developments and commercial buildings.

Informal Settlements

Informal Settlements pose a particularly wicked challenge for South Africa and other growing developing countries. South Africa can be considered as a young urban nation; with an urbanisation rate of around 64% but is higher than that experienced in other developing countries such as India at 32%, Nigeria at 47%, China at 54%) (de Kock and Petersen, 2016 Brand South Africa). The urban migration trend has exacerbated challenges of sanitation provision in cities in: (1) informal areas without formalised planning and (2) government subsidized housing areas with an ever increasing backlog. The laying of sewers in unplanned housing sites limits the municipalities technical approach. Temporary options such as chemical toilets can be provided but are expensive to implement and require frequent emptying cycles in areas not conductive to such a task.

Figure 10: Dichotomy of SA society with informal settlements in the middle of planned settlements (photo: courtesy of eThekwini)

The National Development Plan (2011) calls for new spatial norms and standards to deal with urbanisation and informal areas, interventions to ensure environmental sustainability and resilience, mechanisms which would make markets work more effectively for the poor supporting rural and urban livelihoods and reforms to current planning for improved co-ordination. The technical core at the municipalities are calling for more appropriate and affordable technologies for implementation.

Business Models:
Operations and maintenance remain a key challenge for on-site sanitation and WRC research shows that the reasons include lack of O&M budget, poor revenue collection and limited capacity to manage toilet facilitiies. Competing needs from other sectors such as tertiary education, the social grant systems etc. and the low economic growth currently being experienced in South Africa has placed tremendous strain allocation of budgets for sanitation infrastructure. The quality of O&M varies across the country due to lack of skills in some places as well as the diversion of resources to more pressing needs. These have led to varying quality of tap water, sanitation, treatment works effluent, and other water products and services across the country. Based on anecdotal evidences it seems the current O&M model is not working, and alternative models may be required.

Social Franchising Model as O&M Sustainability model

The Council for Scientific and Industrial Research (CSIR), the Water Research Commission (WRC) and Amanz' abantu Services, undertook studies of selected institutional options which could assist in the improvement of operation and maintenance (O&M) of water and sanitation services infrastructure. The outcome of the studies hypothesized that if conventional franchising principles, found in other business sectors such as food services, could be correctly implemented, it would enable consistent quality of products and services and this would ensure consistent and satisfactory quality sanitation and water services.

The social franchising model in this context entailed business-to-business partnerships, whereby small locally based enterprises entered into a business partnership with a larger established enterprise for the purpose of utilising a "tried and tested" approach for undertaking the activities required to ensure the sanitation and water facilities and systems are operating in a reliable manner and in accordance with suitable hygienic standards. This innovative proposal was then piloted, using a grant received from IrishAid, in Butterworth Education District in the Eastern Cape.

The pilot was a resounding success with the following outcomes:

- Improved water and sanitation services to the schools in the district (400 schools).
- Six emergent franchisee micro-entrepreneurs were established and supported.
- A training programme has been developed, consisting of formal training, onsite mentoring, regular get-togethers, report backs and sharing of experience, and ad hoc training.
- Operational methodologies for school and household situations were developed.
- More than 20 sustainable jobs and more than 50 part-time informal employment opportunities have been created.
- A public-private partnership, supporting job creation and the establishment and nurturing of emergent micro-entrepreneurs, was created.
- Proof of social franchising partnerships concept in the operation and/or maintenance of water services infrastructure was shown to be a viable and workable model

Services provided through this partnership included: leak detection, borehole management, management of municipal treatment works, management of treatment package plants, meter reading, pit-emptying services, laboratory services, data management, demand and pressure control management, and site and property management.

The Circular Sanitation Economy closes the loop of the biological and water cycles. Polluting waste with multiple costs becomes a renewable resource with a value. This should mean ultimately that biological waste, from throughout the production and consumption of food, flows back into agriculture as nutrients and clean water, being used safely for producing food crops and energy recovery for industrial applications such as manufacturing.

TECHNOLOGIES & INNOVATION

This section shows some of the research done and innovation tested and planned to be tested in SA and the reasons for its development.

1. Waterborne Systems

South African Sanitation Policy describes sanitation services as the collection, removal, treatment and/or disposal of human excreta and domestic wastewater, and the collection, treatment and disposal of industrial wastewater. This includes all the organizational arrangements necessary to ensure the provision of sanitation services including, amongst others, appropriate health, hygiene and sanitation related awareness, the ongoing operation and maintenance of the systems, the measurement of the quantity and quality of discharges where appropriate, and the associated billing, collection of revenue and consumer care. This in general falls under the responsibilities of municipalities that have been authorized as Water Services Authorities.

Waterborne systems are currently managed as end of pipe systems but research shows that they have the potential to stimulate the circular sanitation economy as well through:

a. Phosphorus Recovery (Struvite formation)
b. Energy generation
c. Carbon recovery

Processing:
Phosphorus recovery from centralised waterborne systems

Human excreta are the largest source of phosphorus in urban areas, with humans typically excreting 1.6 – 1.7 g phosphorus per day mostly found in urine. However, in developing countries, the organic fraction of municipal solid waste may become an even larger sink. In this regard, within biological wastewater treatment plants, up to 90% of the phosphorus load maybe incorporated in the sewage sludge. Considering that natural phosphorus reserves are on the decline and are expected to deplete by 2033, the use of sewage waste has the potential to be a major source of new phosphorus. This source of phosphorus is argued by some to simultaneously alleviate the challenges facing developing countries in terms of sanitation and offer a "low cost source of phosphorus in the form of struvite", a magnesium ammonium phosphate-based fertilizer. Figure xxx illustrates how future demands for phosphorus can be meet through efficiency in use, changes in demand and recovery from waste streams.

Studies by the WRC indicate that a concentration of 50-60 mg/L of orthophosphates is required for economically feasible recovery from the liquid phase. Source separated urine contains 300-900 mg/L and together with sludge liquor and the anaerobic digestion side streams (20-100 mg/L), have been demonstrated to be economically feasible for phosphate recovery. Phosphate recovery technologies include physical,

TOILETS

- **Container toilets** with urine diversion
- **Dry-composting toilets**
- Toilets with on-site small **biogas reactors**
- Toilets with **automated cleaning systems**

TREATMENT AND REUSE

- **Collection trucks with built-in dewatering system**
- **Anaerobic digestion producing biogas** plus residual soil conditioner or organic fertiliser
- **Gas engines converting biogas to electricity**
- Solar-powered conversion of **Toilet Resource into fuel briquettes**
- Air drying of **compost in windrows**
- Struvite reactors **producing fertiliser from urine**
- Community-Scale production of **compost and clean water using tiger worms**
- **Production of proteins (animal feed)** and oil using black soldier fly larvae
- **Pyrolysis suitable for contaminated waste** yet still yielding water and biochar

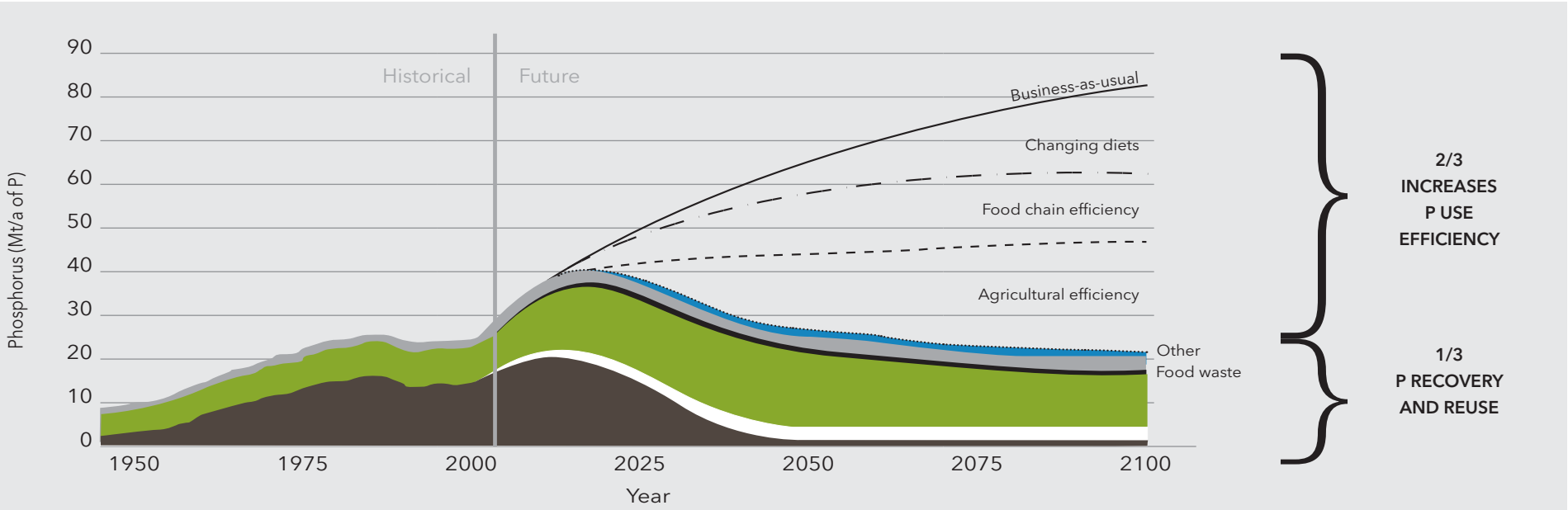

Figure 11: Illustration of future demands for phosphorus

biological, chemical and physical-chemical procedures. Of all technologies available the Crystalactor® is the most advanced crystallization method that achieves a recovery of > 90% and an EPC of 0.3-1 mg/L. Industrial crystallization technologies are common due to their ability to produce high purity, water free and marketable final products such as struvite and calcium phosphates.

2. Energy recovery

To unlock the energy potential from wastewater, the major technologies or approaches that could be used include, conventional anaerobic digestion, advanced anaerobic digestion and enhanced hydrothermal carbonization technologies.

Conventional Anaerobic digestion of municipal wastewater sludge is well established and is the most implemented technology in South Africa. It is a mature technology which has been applied widely both internationally and nationally at various scales. In South Africa there are several large scale conventional anaerobic digesters within municipalities using the technology for sludge stabilization. These municipalities use the biogas to heat up the digesters when required and the remaining biogas is flared. This practice has been typical in South Africa since it is often easier to flare the gas than acquire the required CAPEX funding for the Combined Heat and Power turbines to generate both heat and electricity.

Currently, the status of anaerobic digestion in South Africa is well understood, with 108 WWTW of the identified 217 WWTW confirmed to use anaerobic digestion for stabilisation and treatment of sludge. Furthermore, 46 water services authorities out of 152 have approximately 420 anaerobic digesters, which are spread across the 108 WWTW (out of 824) across 9 Provinces. This means that approximately 13.1% of all plants have had investment made in anaerobic digesters, with a corresponding total design volume of 1 367 Ml, with WWTW in Gauteng have substantially invested in anaerobic digestion, and therefore present a localised opportunity for energy recovery from wastewater sludge digestion. The potential for energy recovery from the 108 wastewater treatment plants currently operating 420 anaerobic digesters have been estimated. The total biogas production is therefore estimated at 282 671 m3/day, based on status quo conditions and process configurations. This biogas production translates to electrical energy of 657 765 kWh/day with an estimated

saving (at 60 cents per kWh electricity) of R144 million per annum.

3. Carbon recovery

Latest technology developments by PCS Biofuels™ have advanced the hydrothermal carbonization process through the development of patented catalysts and proprietary processing methods. Labelled as hydrothermal polymerization, this enhanced process allows any type of low value waste biomass with moisture content from near 0 to 60% or more to be efficiently and effectively utilized. Hydro-thermal polymerization also improves the speed, safety, quality and control of solid fuel production over pre-existing methods. The result is a tailored polycarbon solid fuel suitable as replacement for coal in power plants, cement plants and iron smelters. Having an energy content of up to 29 GJ per tonne (if produced from woodchips), polycarbon solid fuel can be mixed with coal to lower the overall carbon intensity of existing coal-burning facilities or completely replace the use of coal altogether. Hydrothermal polymerization technology offers several advantages that include the following;

- Carbon dioxide neutral process with no methane production
- Wet process – biomass can be used without expensive pre-drying
- Accepts a wide range of biomass types, and is thus an effective waste management technology
- Can safely process problematic wastes that currently require expensive disposal
- Self-contained process with little odour or noise emissions
- Low investment and operating costs due to moderate temperature and pressure
- Straightforward technical operation with no specialist skills needed in the production process

APPLICATIONS

Beneficial agricultural use of sewage sludge is a well-known practice globally. The benefits include; a source of essential crop nutrients, improvement in soil structure and minimization of soil erosion and runoff. However, sludge applied above crop nutrient requirements can be detrimental to plant growth and will ultimately pollute water bodies.

1. Agriculture

a. Fertiliser (sludge)

Generally, sludge with acceptable quality for agricultural use is applied according to crop N requirements. A large fraction of the N in sewage sludge is in organic form. Crops, however, utilize N in the form of NH_4^+ and NO_3^-. It is, therefore, essential that the organic N is mineralized before it can be utilized by plants. The mineralization of organic N is influenced to a large extent by the availability of water and soil temperature. The synchronisation of sludge application rates to farming system crop nutrient requirement and agro-ecological zones has therefore been demonstrated as the way forward for resilient beneficial agricultural use of treated wastewater sludge through the WRC-supported projects. In all South African agro-ecological zones, irrigated systems have been observed to have higher crop nutrient requirements than rain-fed. Under rain-fed cropping systems, areas which receive higher rainfall have been shown to have higher crop nutrient requirements. A simple model (SARA) has been developed in South Africa to manage sludge use.

Further work carried out at the University of Cape Town, investigated the on-site production of fertilizer directly from urinals. So far, a temporary urinal that houses calcium hydroxide, which produces calcium phosphate (a type of fertilizer) when urine collects in the container. A variant of the technology was recently incorporated into the design of Growthpoint Properties' new corporate headquarters for Exxaro in Centurion. The R600 million property was installed with waterless and low flush urinals for the collection of urine for further processing into fertilizer. This provides a model for other commercial buildings as well as other commercial locations such as malls, taxi ranks, stadiums etc. In a separate energy to waste study, it was shown that fertilizer from urine can be used through different certification processes approved by retailers and the agriculture sector in South Africa.

b. Animal feed

eThekwini is currently supporting the research of black soldier fly (BSF) which lays its eggs on faecal sludge. This organism provides several opportunities

Figure 12: Black soldier fly and the production of oils from larvae (photo courtesy of eThekwini municipality and BMGF)

whereby their larvae are able to be harvested for poultry and other associated feed. In addition, the BSF model offers the opportunity to develop oil products which could offer the correct business model with the agriculture sector and the FMCG companies in future.

2. Energy from Industry

Research studies by the WRC and partners have identified three major classes of wastewater with the greatest potential for energy recovery to be (i) sewage (both for centralized and decentralized systems), (ii) animal husbandry wastewaters, and (iii) food and beverage processing wastewaters. This is based on the loads and volumes typically present in South Africa and the energy determined to be potentially available from them (Table 1).

In this regard, an estimated 10 000 MWth can be recovered from the wastewaters generated in South Africa, representing approximately 7% of the national energy distributor's electrical power supply. These estimated energy values highlight the need for on-site smaller energy generation grids which will remove demand from the national grid.

Business Models

CASE STUDY: Hathikuli Plantation, Assam, India

Tata Global Beverages and Amalgamated Plantation, in association with the TBC and ETP, have completed a feasibility study in July 2018 to understand the benefits of implementing a Circular Sanitation Economy system in a tea plantation. This study addressed the social, environmental and economic components of implementing new sanitation infrastructure and technology that would collect Toilet Resources and convert them into new valuable resources for the plantation.

Located in North India in the state of Assam, Hathikuli is an organic tea plantation operated by 4330 workers. The estate provides residential houses for its permanent workers and their families, each provided with a toilet shelter and pit latrine. The plantation management are committed to improving the sustainability of the plantation and quality of life for its workers.

The study methodology is detailed later in this report, as a step by step toolbox. This was created to collect and analyse the information needed to implement a Circular Sanitation Economy approach. This assessed the feasibility and potential for resource recovery, and evaluated a range of toilet, collection, and treatment options. The toolbox is adaptable to quantifying the broad benefits to agriculture described previously. However, this initial study was focused on the specific needs of Hathikuli.

Key findings:

- Current methods of emptying pit latrines could be improved.
- Re-use products that come in contact with food or have to be handled by hand (i.e. compost, biogas and water) have large social taboos preventing their use.
- Only electricity derived from Toilet Resources could be accepted for use in the home.

Wastewater Types	MWth	%
Sewage (municipal + sewage)	850	9.79
animal husbandry	7500	86.39
Olive production	4	0.05
Fruit processing	68	0.78
Winery	3	0.03
Distillery	70	0.81
Brewery	17	0.20
Textile	22	0.25
Pulp and paper	100	1.15
Petrochemical	48	0.55

Table 1: Energy potential from various wastewater sources in South Africa

- The desire to be better informed about an individual's own health was seen as a huge benefit by the community, and could increase the usage of toilets if used as a behaviour change incentive.
- There are widely varying capital costs associated with each treatment technology.
- Re-use products utilised for industrial processes on the plantation can potentially cover the operational and maintenance costs of the collection and treatment and in some cases the capital is recoverable over the lifespan of the technology.
- There is high demand for the energy products such as biogas or briquettes.
- Technologies that offset combustion of solid fuels have the most significant impact on the reduction in carbon emissions. • Environmental benefits should not be considered in isolation – for example, the use of cleaner sources of fuel may improve health by reducing exposure to smoke.

Smart Sanitation Economy (new area)

Smart Sanitation is a new way of looking at sanitation designed for cost recovery, revenue generating business opportunities, and future system resilience.

It leverages the innovative technologies based on the collection and monitoring of real- time data that are already reshaping most industrial sectors. Sanitation is no different – it too can be transformed by technologies such as the Internet of Things (IoT), and Artificial Intelligence (AI). The Smart Sanitation Economy – part of the Toilet Board Coalition's transformative vision of the Sanitation Economy - puts sanitation systems at the centre of a reservoir of data and information that has been virtually untapped. And that could unlock new insights about human health and behaviour.

TECHNOLOGIES & INNOVATION

New digital sensing technologies are being tested in a pilot selection of public toilets, enabling the collection of new data, feeding new insights, and creating Sanitation Intelligence. The following chart outlines early insights of what can be deployed today, and what it can tell us.

	Available Data Collection Technologies	New Data	New Insights
Smart Public & Community Toilets	• Footfall Sensors • Heat / Moisture Senors	• Users per day • Temperature & moisture levels hourly	• Peak usage • Operations & maintenance needs • Cleanliness
Smart Toilet Resource Treatment & Management	• Sensors / Robots in sewer lines & water ways	• Flow of sewage, breakage, leakage • Quality of sewage • Water quality	• Operations & maintenance needs. • Sewage value for upcycling • Pathogen levels in rivers
Smart Preventative Healthcare	• Sensors within the toilet	• Detection of instances of Diharrea • Monitoring of bacteria, DNA	• Safely managed sanitation • Infectious disease monitoring

The Smart Sanitation City produces new intelligence for individuals, businesses and city authorities for data-driven decision-making. Reliable data has been lacking in sanitation systems. The chart below indicates the intelligence that can be generated from data available today on Pune's sanitation system

	Smart Public & Community Toilets	Smart Toilet Resource Treatment & Management	Smart Preventative Healthcare
Citizen Intelligence	• Toilet locations & usage • Cleanliness • User reviews of toilets • Other services available at toilets or via WiFi	• Pollution levels • Oversight of the city's service provision	• Community health information & advice
Business Intelligence	• Scheduling maintenance Customer usage patterns • Consumer insights (products and usage) • Demographics of users Advertising seen by user	• Efficient operations and preventative maintenance of collection and treatment • Ability to more easily manage decentralised systems • Quality of Toilet Resources • Transport optimization • Market demand for re-use products	• Individual/community health insights • Feedback on medical trials • Potential medical product/service needs • Sanitation market insights
City Intelligence	• Operational status of toilets triggering maintenance and cleaning • Increasing toilet usage • Increasing Toilet Resource collection efficiency for the city	• Increasing Toilet Resource management efficiency • Overview of treatment plant operations and performance • Pollution levels • Location of road transport and roving maintenance staff	• Community health indicators • Early warning of disease outbreaks • Public health information including toilet use, handwashing, nutrition, immunisations

APPLICATIONS

Ti: Toilets for Her

Old buses become smart toilets for women

Toilet Integration (Ti): Toilets for Her is a new connected hygiene centre business model concept introduced by the PMC with the help of Saraplast to provide public toilets for women throughout Pune. The Ti Bus is a converted out-of-service city bus that provides a clean and safe pay-per-use facility for women to use in public areas. The Ti business model generates revenue by providing additional services at the public toilet such as laundry and a café as well as selling goods such as sanitary pads and products that provide health information. The Ti bus has proved an insightful new base for consumer research, informing potential new product and service innovation. Ti Bus is beginning to implement sensors with the vision to integrate digital heath and personal care services to provide ongoing value added information to their consumers. Launched in 2017, there are currently ten operational buses in Pune, serving approximately 275 people per day.

Suvidha, a Community Hygiene Centre

Laundry services help the finances of community toilets

Developed through local consumer insights, Unilever, with the support of Municipal Corporation of Greater Mumbai and Pratha Samajik Sanstha, built the Suvidha Centre in Mumbai in 2016. It is a pay-per-use toilet facility. The centre also offers a laundry facility, which has been one of

the main revenue drivers, while releasing time for women in the community to pursue productive tasks. Grey water from the laundry is treated and used for toilet flushing, reducing the overall water footprint. Users can also utilise shower facilities, and safe drinking water through vending machines. The Centre also provides job opportunities to the local community, employing eight people.

Applying the learnings from Pune Smart Sanitation City, a Suvidha Centre could be enhanced with additional data collection, optimising the operations and revealing further consumer insights.

Smart Cities

Sanitation can be included in Smart Cities' architecture through data monitoring of public and community toilet usage, sewage treatment operations, infectious disease circulation and other health indicators. It is the vision of the Smart Sanitation City that enhanced data collection will enable more efficient decision-making that will lead to cost savings for the city and revenue generating opportunities in partnership with the private sector.

At the centre of a Smart Sanitation City is the citizen. Smart sanitation is designed to provide information to make a citizen's daily life not only easier, but healthier as well. As a government and city optimises current sanitation solutions and builds new ones, and the citizen has access to real-time data on all aspects of the system, the citizen benefits from an environment that is clean, safe and sustainable.

Data from toilets informs the users, operators, and other businesses, improving the user experience and operating efficiency, and widening the range of potential services.

With the addition of digital technology, not only can Sewage Treatment Plants (STPs) increase their operational efficiency and yields of usable products, but also efficiently access markets for these products.

With access to more information, such as footfall traffic of public toilets or nutrient levels within Toilet Resources, each group of stakeholders can make more informed data-driven decisions.

GARV Toilets

Efficient Management of Smart Toilets

Smart toilets, in terms of self-cleaning, are becoming more popular throughout India. Located in Delhi, GARV Toilets are stainless steel portable smart public bio-toilets equipped with an RFID-IoT powered mobile app that can tell how many people have used a toilet, the amount of water available and how often the toilet has been cleaned. It is equipped with smart technologies like sensor based flushing systems, which clean the toilet floor and lavatory pan, depending on requirement-post every usage. While GARV Toilets has traditionally been a toilet production and sales company, it is now transforming into a sanitation service company that seeks to provide a rich sanitary experience to urban slum communities through its vandal-proof fabrication and smart design.

Smart preventative healthcare

19th and 20th century Sanitation – still a vital preventative health tool 21st century Smart Sanitation - the new early warning system for health

Emerging technologies can detect diseases and other health conditions in the sanitation system, and this data could drive cheaper, more effective healthcare. Business models which place value on health data could then help fund the sanitation system itself.

Effective Affordable Healthcare

A key priority of any clean, safe and Smart City would be the health of its citizens – longer and more productive lives without disease. While cities strive towards this goal, it remains a challenge especially in areas that have a high concentration of informal settlements. In traditional health systems, the municipal government's health department takes either curative steps (post an event) or performs routine health measures to keep a tab on communities' health. This proves to be an expensive and inefficient way to address community health challenges. Health systems are at full stretch financially, while the provision of traditional sanitation itself is expensive, so this is not working as an economic model for a healthy city. A new model is needed.

Rapidly emerging technologies can detect diseases and indicators of other health conditions, by sensing and sampling the waste in the sanitation systems. This can be done for communities from street-level to the whole city, and even individuals - with proper safeguards. With early accurate detection, this preventative health approach is potentially better than traditional healthcare – both more effective (reducing incidence of health problems) and more efficient (fewer people get sick and they are diagnosed sooner, so less medical care is needed).

Excerpt from WASH in Health Care Facilities Global Baseline Report by WHO & UNICEF 2019

No one goes to a health care facility to get sick. People go to get better, to deliver babies or to get vaccinated. Yet hundreds of millions of people face an increased risk of infection by seeking care in health facilities that lack basic necessities, including water, sanitation, hygiene,

health care waste management and cleaning (WASH) services. Not only does the lack of WASH services in health care facilities compromise patient safety and dignity, it also has the potential to exacerbate the spread of antimicrobial-resistant infections and undermines efforts to improve child and maternal health. New figures from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) indicate that WASH services in health care facilities are sub-standard in every region. An estimated 896 million people use health care facilities with no water service and 1.5 billion use facilities with no sanitation service. It is likely that many more people are served by health care facilities lacking hand hygiene facilities and safe waste management. WASH services are more likely to be available in hospitals than in other types of other health care facilities, and in urban areas than in rural areas.

According to the WHO and UNICEF's 2019 Global Baseline Report on WASH in Health Care Facilities, 1.5 billion people have no sanitation services in their health care facility.

Sanitation and antimicrobial resistance in health care facilities

Antimicrobial resistance (AMR) among human pathogens has been identified by the World Health Organization as one of the greatest global threats to human health. Environmental reservoirs are the most important source of antibiotic resistance genes. Wastewater and faecal sludge from health care facilities pose a particular risk because they contain high levels of antibiotics, resistant pathogens and resistance genes. Open defecation, the discharge of untreated wastewater, and leakage from on-site sanitation systems at health care facilities can all lead to the release of antibiotics, resistant pathogens and resistance genes into environmental reservoirs, and therefore increases in antimicrobial resistance.

World Health Organization, Guidelines on Sanitation and Health, WHO, Geneva, 2018,

The Toilet Board Coalition sees even greater potential in WASH in health care facilities through the deployment of sanitation systems that could also, at low cost, feed data back to the health care facility and the patient. Disease detection and passive monitoring of health indicators, without the need for increased staffing could help primary care facilities operate more efficiently and provide increased services to citizens.

BUSINESS SOLUTIONS AVAILABLE TODAY: GLOBAL CASE STUDIES

Tiger Toilet provides a low maintenance biodigester, using worms to neutralize the waste (vermidigester) on-site. The biodigester provids a safe and affordable solution for low-income families in both rural and urban settings. Biodigester arrays have also been used successfully to create community level sewage treatment plants.

Efficient biorefinery that cleanly processes high moisture biogenic resources while generating capital in the form of tipping fees, service contracts, thermal energy, electrical energy, water and biochar. **The Biomass Controls** sanitation innovation is the ability to add toilet resources to the bio-refinery and outut products such as thermal energy and biochar. It is designed for communities of 500-10,000 peple.

India-based company **Saathi** manufactures biodegradable and compostable sanitary pads made from banana tree fiber to provide a rash-free sustainable experience and reduce pad and plastic waste. Saathi biodegradable pads degrade within 6 months of disposal - 1200 times faster than plastic pads. Each woman purchasing Saathi pads on e-commerce saves 60kg of pad waste over her lifetime and subsidises pads for low-income women.

Garv Toilets is an Indian company that provides community sanitation services in India through vandal-proof stainless steel toilet cabins equipped with RFID, IoT sensors and are self-cleaning. The solar panels enable sustainability in terms of energy usage. The models include sanitary-pad vending machines and incinerators and are disabled-friendly.

ATEC produces, sells and distributes small-scale pre-fabricated biodigesters turning kitchen, farm and human waste into biogas for rural farming households across Cambodia. The ATEC Biodigester is designed to withstand the challenging conditions of flooding, high groundwater and earthquakes, that developing countries face.

Through social entrepreneurship and by taking into account the comples environment of the slums, **Eau et Vie (Water and Life)** builds secured runing water networks and develops innovative, sustainable communal toilet blocks comprising of Biofil toilets and showers, each serving 3 families, in the slums of Bhashantek (Dhaka), Bangladesh.

Svadha stablishes organised ICT enabled sanitation e-commerce platform for rural customers in India. Svadha's model delivers tailored solutions from toilets to waste management to rural households via a network of entrepreneurs providing last-mile logistics and transaction support.

Lootel is a smart toilet café providing clean washroom services using a Pay, Use and Redeem concept. Customers pay for the use of the toilet and redeem a voucher at the Lootel Café. Lootel is an inovative public washroom service based in Indore, India.

Toilet Integration (Ti) provide women in Pune, India, with a sanitation kiosk that includes clean and safe toilets, as well as sale and disposal of female hygiene products, laundry systems, breastfeeding spas, etc. They are created by refurbishing old busses into integrated sanitation hubs.

Laguna Water is a joint venture between private utility and provincial government in the Philippines, which decided in 2014 to explore how to replicate a portable toilet service in its concession area to reach last mile consumers - building on the success of similar model for water access to the same last mile consumers.

BUSINESS SOLUTIONS AVAILABLE TODAY: LOCAL CASE STUDIES

Joelex makes sanitation accessible and affordable for the urban poor, especially women, children and the youth in Kampala, Uganda, by building toilets, showers and waste to water treatment plants within slums and markets. Joelex has designed waste treatment plants to provide various byproducts such as domestic and drinkable water, biogas and fertiliser.

Clean Team is a Ghanaian company that provides dry toilets to lowincome households and collects the waste for an affordable monthly fee. It currently operates in four service areas, with an estimated resident population of 450,000.

SAFI SANA offers the installation of turn-key factories for waste re-use and sale of power, fertiliser and seedlings, currently in Ghana. It fills an existing gap or replaces traditional utilities as an economically sustainable solution for governments to manage waste while roviding improved sanitation, energy and agro input material for the local community.

The Biocycle is located in Durban, South Africa, and is developing commercially viable and scalable processes for the bio-conversion of human feacal waste into valuable products, using the Black Soldier Fly (BSF) larvae technology: larvae meal, oils, and biochar.

Based in Kenya, **Sanergy** takes an innovative systems-based approach to build out the entire sanitation value chain, using a network of franchised micro-entrepreneurs and landlords, who operate low-cost waterless toilets as small businesses or as value-add services to tenants. Sanergy safely collects the waste, which is then treated and converted into organic fertiliser and high-protein animal feed, which are then sold on to farmers.

Sanivation sells non-sewered waste processing services to cieties and towns in Kenya. Sanivation installs container-based toilets in people's homes and charge a small monthly fee to service them. The waste is then ollected and transformed into charcoal briquettes or a firewood substitute briquette. The sale of their briquettes subsidises the cost of fecal sludge treatment, making Sanivation's model one of the most cost-effective faeces treatment systems in the world.

Live Clean (EFlush) provides access to public toilet and shower facilities that are clean, safe and affordable in peri-urban areas of Lusaka, Zambia. Live Clean toilets are built from cargo containers. The waste from the toilets is pushed into water recycling Biodigestion systems that make the water reusable for showers and toilets through membrane filters. The solid waste is converted into bio-gas and fertiliser. All lighting and water pumps are powered with solar energy.

CALL TO ACTION:
A 5 POINT ACTION PLAN

Launching a National effort to build the Sanitation Economy in South Africa 2020-2025

Inspired by the success factors of the SBM program, of the 'Waste to Resource' paradigm and of Citywide Inclusive Sanitation, we propose stimulating a global effort to help scale up the Sanitation Economy in countries around the world by, among other things:

01

Disrupting the status quo – and creating demand for Sanitation Economy solutions;

02

Rethinking approaches to the provision of urban sanitation services, encouraging private sector companies and their public sector counterparts to raise the bar on providing safely managed sanitation at scale;

03

Considering wastewater and faecal sludge as a valued resource to be recovered and reused;

04

Identifying quick wins in the scaling of business solutions in the sector.

05

Unleashing the influencers who can help in the financing of sustainable and resilient sanitation systems,

We **invite you to join us in our work to scale up of the Sanitation Economy** and these related initiatives in order to help close the resource loop, to promote sustainable service delivery, to grow the sanitation products market and, ultimately, to achieve the SDG of safely managed sanitation for all.

ABOUT WATER RESEARCH COMMISSION

The South African Water Research Commission (a public entity) is a national science council whose mandate is to create new knowledge which amongst other strategic goals contributes to the development of goods and services for economic development.

The WRC advocates for SANiTI (Sanitation Transformative Initiative) which aims to disrupt the current sanitation paradigm with innovative technologies, business models and approaches and accelerate equitable and sustainable access to sanitation provision.

The WRC runs SASTEP, the South African Sanitation Technology Evaluation Programme (funded by Department of Science and Innovation and the Bill and Melinda Gates Foundation) which plays a national co-ordination and technical advisory role on technology demonstration, localization and industrialization.

Find out more at www.wrc.org.za

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ABOUT THE TOILET BOARD COALITION (TBC)

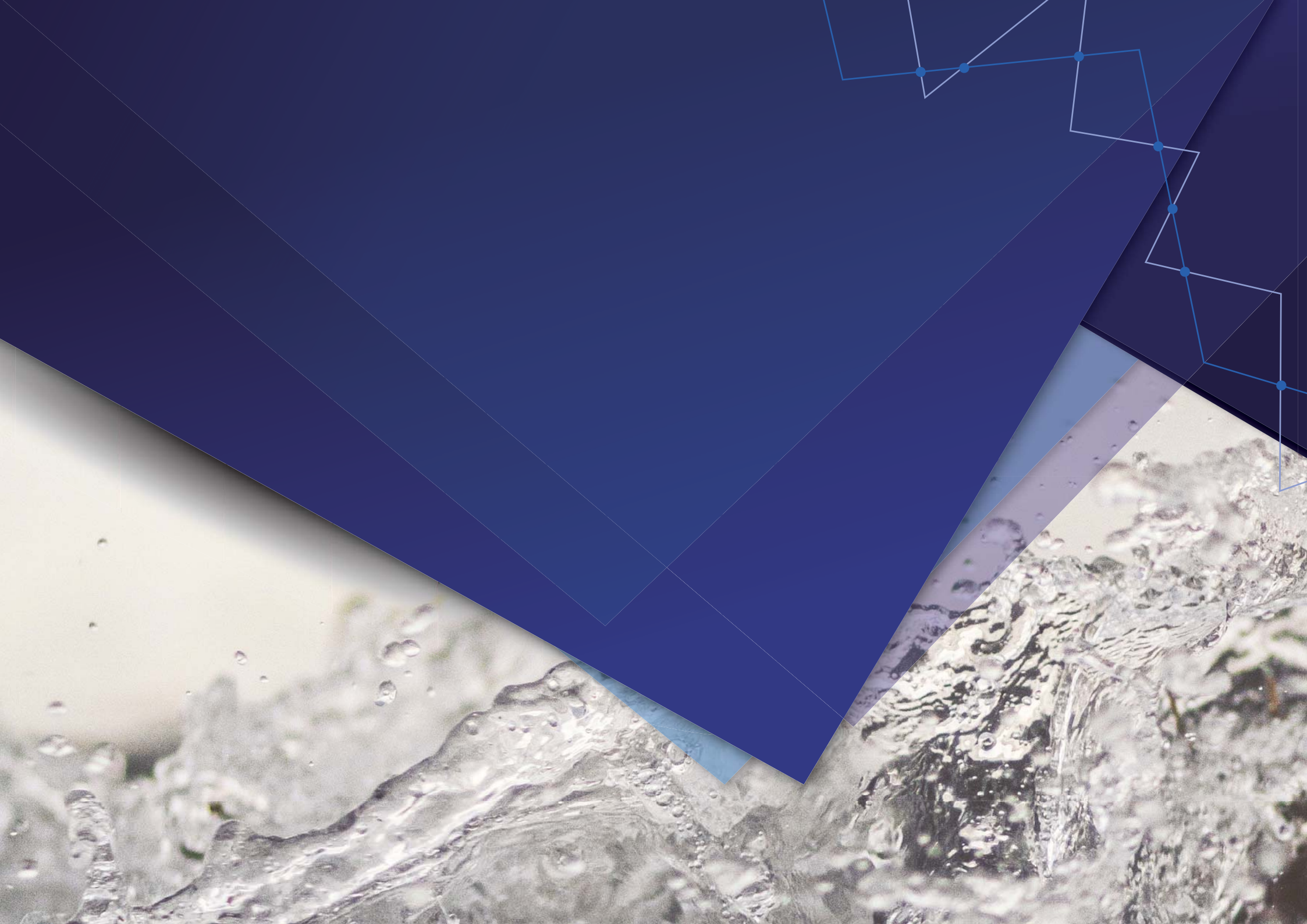
The TBC is a business-led partnership with the ambition to address the global sanitation crisis by accelerating the Sanitation Economy.

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 program dedicated to sanitation entrepreneurs in low-income markets.

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

Find out more at www.toiletboard.org




TOILET
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