A VALUE CHAIN ANALYSIS OF NEXT GENERATION SANITATION

D McLean & S Makumbirofa

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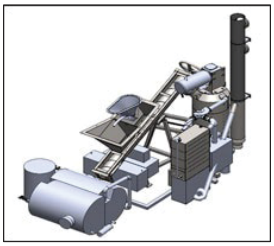

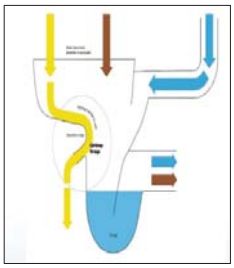


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ABOUT THIS PUBLICATION

This report is one of a series of research projects taking place under a Memorandum of Understanding between the Water Research Commission (WRC), the Department of Trade, Industry and Competition (DTIC) and Trade & Industrial Policy Strategies (TIPS). It is one study informing the National Water and Sanitation Industrial Masterplan.

WRC funded and guided the initiative. TIPS conducted the research. DTIC provides economic policy instruments through which industrial strategy elements can be addressed.

The report is based on inputs and work from numerous individuals, including:

- A Project Steering Committee, including Akin Akinsete and Charmaine Twala (WRC); Gaylor Montmasson-Clair (TIPS); and Gerhard Fourie and Pumla Myeki (DTIC).
- The NGS Value Chain Analysis researchers (Daryl McLean and Sandra Makumbirofa).
- The Water Value Chain researchers (Gillian Chigumira, Gaylor Montmasson-Clair and Elize Hattingh).
- A "core" expert group (Prof Chris Buckley; Neil Macleod; Teddy Gounden; and Prof Lingam Pillay).
- A cross-section of experts from universities (UKZN and Stellenbosch University); municipalities (eThekwini); donors (the Bill and Melinda Gates Foundation); the global Toilet Board Coalition; South African manufacturers; other private sector roleplayers; some manufacturing associations; NGOs; scientific and technical agencies (CSIR); Coega Development Trust; the DBSA; some SETAs (EWSETA and MerSETA); DHET; GreenCape; the WWF-SA Water Desk; professional bodies (SAICE, CBE, SACAP); and some (architectural, civil engineering, plumbing, legal…) consultants.

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EXECUTIVE SUMMARY

The sanitation industry provides user interfaces for excretion; and the safe containment, conveyancing, treatment and disposal/reuse of human excreta. Sanitation is highly interfaced with gender stratification, sociocultural practices, poverty and inequality, public health concerns, environmental impact (water, waste and biodiversity) and infrastructural and economic considerations.

The central strategic arguments in this study are that:

- The sanitation industry is in transition.
- (As yet emergent) Next Generation Sanitation (NGS) technologies are disruptors within the industry. They hold potential to improve efficiencies and circularise the sanitation economy.
- Growing domestic NGS capabilities and unlocking domestic demand for NGS can springboard industrial development and regional and global market share;
- This will require wider coordination and more multi-criteria approaches to planning and budgeting than are common in industrial strategy processes; but
- There are significant health, social, economic and industrial benefits to support such a sustainable development approach.

Industries serving the sanitation sector include mining and chemicals (who provide raw materials); manufacturing (of toilet pedestals, urinals, conveyancing and treatment equipment); the built environment industries (who install and maintain infrastructure); and the finance industries (who provide financial and insurance instruments for infrastructure development and maintenance). Harvesting and re-use of energy, water and biomass from effluence circularises the value chain.

The state provides infrastructure, treatment and sometimes also user interfaces. The post-school education and training (PSET) sector provide scientific research, human capital development and technological innovation. The PSET work has provided a platform for small business development. There is also an emerging role for the community development sector, who facilitate community sanitation dialogues, and who build sanitation “software” such as community capabilities to manage sanitation.

The sanitation sector is in transition. Health and social concerns drive the need to provide improved sanitation to 5.3 billion people globally. Environmental factors (water and energy shortages, waste and biodiversity impacts) are shaping technological responses. Technological innovations (shifts to additive manufacturing, the circularisation of value chains, nanotechnologies and biotechnologies, the emergence of smart houses and smart cities) are responding to these drivers.

Next Generation Sanitation (NGS) is emerging as one field of innovation. NGS is often defined as decentralised and on-site wastewater treatment. This study has adopted a wider conceptualisation, including the various technologies used in such systems but which can also be interfaced with centralised sanitation systems.

South Africa is a global leader in the NGS field. Much of the research and innovation is still a few years from market readiness. This value chain analysis therefore focused on one market-ready pedestal technology (low-flush urine diversion toilets); one decentralised wastewater treatment system (DEWATS); and one membrane technology (sometimes also used in DEWATS systems).

The potential value of the global market by 2030 is forecasted at US$5.2 billion; the African market is estimated at US$447 million; the South African market is estimated at US$56 million. Leveraging the South African markets (through increased and more strategically deployed sanitation infrastructure budgets) can springboard regional and global export growth.

Challenges to unlocking domestic demand lie in the eco-system. Dialogue with key role-players (DTIC, Treasury, DHSWS, COGTA, DPWI) should aim to agree on a coherent and coordinated response. Regulatory frameworks for the certification of NGS technologies needs to be fast-tracked; financing and procurement systems need to be reviewed; and municipal capacity-building should be prioritised. The post-school education and training sector can play a role in building citizen awareness. New financial instruments are needed for NGS. Sustaining, coalescing and leveraging existing scientific and technical expertise should remain a focus.

Industrial policy has historically neglected sanitation. This value chain analysis points to a range of possible policy instruments as well as *possible partnerships* to take forward a sanitation industrial development strategy. These include:

- Continued investment in Research, Development and Innovation (through research chairs, student bursaries and innovation funds). *MERSETA, EWSETA and LGSETA have been approached to explore the possibilities for research chairs and student bursaries.*
- Interfacing 4iR interventions with water and sanitation technologies. For example, interfacing water and sanitation sensors and the "internet of things" with SA's regional market share of ICT provision provides efficiencies (currently happening on small scale).
- Leveraging the RDI capabilities and attracting private sector investment through Science and Technology Innovation Parks, Innovation Hubs, business incubators, enterprise development). *UKZN is in the process of establishing a Science and Technology Innovation Park to build on the work of the Pollution Research Group.*
- Tariffs to reduce imports of cheap sanitation components that do not meet local quality standards. *This may be included in the National Water and Sanitation Industrial Masterplan.*
- Public sector infrastructure spend that prioritises NGS due to cost, quality and wider benefits. *The Development Bank of South Africa is exploring how to incorporate NGS as a technology option for WASH development funding.*
- Policy directives to ensure sanitation components are properly specified in public procurement processes.
- NGS infrastructure investments in public higher education, TVET institutions and schools to promote citizen understanding and buy-in to NGS. *DHET has encouraged higher education institutions in water stressed areas to consider NGS in their infrastructure grant applications.*

Challenges and Opportunities in the South African NGS Market

When a municipality puts out a tender to build housing units, they don't specify the sanitation component. They aren't set up to deal with this new approach. They just say a house must be built with a toilet, and this is the kind of toilet people know. So, a building contractor comes in on the lowest price in the tender. Of course they import cheap flush toilets that haven't even been weight-tested, and don't meet quality standards. No one is checking. Then he is paid and goes, and a few months later the toilet breaks. The municipality meets its target. The contractor gets paid.

No one cares that the family doesn't now have a toilet or how the family must now pay for it. No one cares if the toilet was made here. No one cares what happens to the shit, or if there isn't water to flush.

Interview with a South African Next Generation Sanitation Manufacturer.

Never waste a good crisis.

Professor Chris Buckley, Pollution Research Group, UKZN.

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1. Introduction

1.1 Terms of reference for the NGS value chain analysis

The Water Research Commission (WRC), Trade and Industrial Policy Strategies (TIPS) and the Department of Trade, Industry and Competition (DTIC) have a Memorandum of Understanding (MoU) to collaborate around water and sanitation industrial development.

Annexure B to the MoU summarised the rationale for this study:

In light of new technological developments, the need to bridge the sanitation gap presents an opportunity for industrial development, by incorporating locally developed and/or manufactured technologies and products. There is a potential to grow local industries, create much-needed employment, investment and stimulating research and innovation in the sector….

A lot of the market and value chain data for sanitation and especially NGS are anecdotal or are inferred from international data or secondary local data. This study seeks to fill in this gap and provide actual verifiable data.

1.2 The sanitation industry

The sanitation sector provides user interfaces such as toilet pedestals and urinals for people to use (and connects these to containment systems); then ensures the safe storage, conveyancing, treatment and use of excreta. Sanitation components used across these phases are illustratively summarised in Figure 1 below.

Functional group	Description	Examples	System templates
User Interface	The type of toilet, pedestal, pan, or urinal with which the user comes in contact	• Dry Toilet • Urine-Diverting Dry Toilet • Urinal • Pour Flush Toilet • Cistern Flush Toilet • Urine-Diverting Flush Toilet	• Single Pit System • Waterless Pit System without Sludge Production • Pour Flush Pit System without Sludge Production • Waterless System with Urine Diversion (UD) • Biogas System • Blackwater Treatment System with Infiltration • Blackwater Treatment System with Effluent Transport • Blackwater Transport to (Semi-) Centralised Treatment System • Sewerage System with Urine Diversion
Collection and Storage	Collect, store, and sometimes treat the products generated at the User Interface	• Urine Storage Tank/Container • Single Pit • Single Ventilated Improved Pit • Double Ventilated Improved Pit • Twin Pits for Pour Flush • Dehydration Vaults • Composting Chamber • Septic Tank • Anaerobic Baffled Reactor • Anaerobic Filter • Biogas Reactor	
Conveyance	The transport of products from one functional group to another.		
(Semi-) Centralised Treatment	Treatment technologies that are generally appropriate for large user groups		
Use and/or Disposal	The methods by which products are ultimately returned to the environment	• Irrigation; Aquaculture; Macrophyte; Disposal/ Recharge • Sludge: Land Application; Surface Disposal • Soak Pit / Leach Field and Dispose to garden	

Figure 1: Components in the Sanitation Value Chain
Source: Tilley, 2014 cited in Mudombi/TIPS (2018: 9)

1.3 Next Generation Sanitation

Over the past few decades, there has been substantial innovation in the sanitation sector. This has been driven by:

- Health and social issues (provision of safe sanitation to rural communities and urban/peri-urban settlements);
- Environmental concerns (water and energy shortages; environmental degradation due to nutrients being stripped from soil; and waste being unsafely disposed in rivers, oceans and living spaces); and
- Economic considerations (the economic impact of poor sanitation, reducing costs, improving efficiencies in sanitation value chains, circularisation of value chains, using sanitation to create jobs…).

Landscape drivers have stimulated:

- Technological innovation in the sanitation industry (e.g. low-flush toilet pedestals; decentralised waste-water treatment systems; membranes to remove pathogens and harvest nutrients from urine and faeces…);
- Advances in manufacturing (additive manufacturing processes such as 3D printing, nanotechnology, the Internet of Things…);
- Infrastructural reengineering (the emergence of "smart" buildings and cities).
- New financial instruments for providing and servicing sanitation infrastructure.

The term "Next Generation Sanitation" (NGS, sometimes also referred to as "New Generation Sanitation") achieved widespread use through the Bill and Melinda Gates Foundation (2014 and 2016) Reinventing the Toilet Competitions (RTTC 1 and RTTC 2). During RTTC 1, evaluations suggested that some technologies had weaknesses that could be complemented by the strengths of others. RTTC 2 began addressing this, but there is substantial further scientific research and innovation going on. The kinds of design considerations incentivised by RTIC are summarised in Text Box 1 below.

While RTTC conceptualised NGS as "innovative, off the grid, affordable for poor users and sustainable" (Sanitation Matters 2014), ***this report has conceptualised NGS more broadly as any sanitation-related innovations which advance sustainable development goals.*** Many of the NGS technologies (e.g. low-flush urine diversion pedestals and membranes) can also be used in centralized sanitation systems.

Textbox 1

Reinventing the Toilet Competition (RTTC)

Illustrative Design Considerations

"We are looking for innovations in non-conventional technologies with potential to be adopted due to their affordability, durability, convenience, aesthetic design, and effectiveness. Innovations that leverage nutrient capture, energy reuse or industrial usage may make sense as a means of adding income or reducing costs in the sanitation service delivery chain.

Efficiency considerations:

- Low lifecycle costs;
- Long-lived and easy to use, maintain and service during productive life;
- Safety / backup mechanism in the case of system failure;
- Minimal water, energy, space requirements;
- Aesthetically appealing: absence of smell / flies, and appealing user/worker interface are key;
- Appealing across different cultural contexts (privacy, dignity, ease of use are key).

Health and safety considerations:

- Lower pathogen load of materials to enable safer servicing/removals;

- Minimal or no user involvement in operation and maintenance of containment facilities;
- Technologies that are useable in a wide variety of contexts
- No use of chemicals/materials that are potentially dangerous to the environment and human health).

Advances in transport:

- Treatment and/or water separation that commences during transport;
- Increased ability to extract solids as part of extraction from pit latrines and other containment devices;
- Durability in unstable and unpaved roads situated in densely populated urban environments;
- Increased personnel safety during extraction and/or transport.

Advancements in decentralized treatment technology for use at community, apartment block, town, and/or city scales:

- Decreased time requirements to reduce the mass or volume of fecal sludge / sewage;
- An ability to site and maintain the system directly in communities;
- Pre-fabricated / off the shelf sale possible for community or apartment block level use;
- Remote sensing capacity for centralized monitoring / controls".

Bill and Melinda Gates Foundation (2016: 1)

The technologies developed through the RTTC Programme "incorporate new processes to the field of sanitation including: pyrolysis, the thermal decomposition of human solid waste in an oxygen-free environment to produce biochar, electrolysis; using electrical currents to break down the chemicals in human liquid-waste; pasteurisation, a heat treating process which thermally sterilises human waste; plasma gasification, using microwave technology to gasify human waste; hydrocyclone toilet bowl technology, for separation of solid and liquid wastes; and on-site membrane technology, to purify liquid waste through filtration" (Sanitation Matters 2014).

Behind any sanitation technology innovation lies an extensive architecture of scientific research. For example, some membrane technologies can harvest fertiliser from urine (this is one economic argument for urine diversion toilet pedestals). Yet a high percentage of the SA population is on medication for TB and HIV. The safety of harvesting and using fertilizer infused with such pharmaceuticals is still under investigation.

Technology Readiness Levels are measured on a scale of 1 to 8. Level 8 means that they qualify as "actual systems completed and qualified through test and demonstration" (Zhou et al., 2018). Most NGS technologies are not yet at this stage. Experts interviewed for this study agreed that many NGS technologies are about 3-4 years away from market readiness.

Some "alternative" sanitation technologies such as "composting, anaerobic digestion and storage are reliable but still face challenges in addressing the links between the political, social, institutional, cultural and educational aspects of sanitation" (ibid).

Other Next Generation technologies, such as "Microbial Fuel Cells (MFCs), Microbial Electrolysis Cells (MECs), and struvite precipitation, are at technology readiness level 8" (ibid). Even when at this level,

technologies can run foul of changing climatic conditions (as in the case of black soldier fly larvae experiment in eThekwini).

Technology readiness levels cascade into industrial development prospects. For heuristic purposes – and at the suggestion of sanitation experts – this NGS value chain analysis therefore focused on only three Technology Level Readiness 8 technologies:

- an NGS pedestal technology (low-flush urine diversion pedestals);
- a decentralised waste water treatment (DEWATS) system;
- a membrane technology.

Conveyancing equipment is also included, although this is not specific to NGS.

1.4 The Next Generation Sanitation Value Chain

Mudombi provided a rigorous initial conceptualisation of the sanitation value chain (including Next Generation Sanitation) in his report *A Forward-Looking Approach to Next Generation Sanitation and Industrial Development in South Africa* (TIPS 2018). This study adopts Mudombi's conceptualisation, but proposes some refinements that have implications for how the sanitation industrial value chain and markets are analysed.

Mudombi also summarised the difference between conventional and NGS value chains, as in Figure 2 below. "NGS technologies differ from conventional sanitation solutions in three main ways. They do not require conveyance, require no (or minimal) water usage, and the on-site treatment produces pathogen-free outputs. NGS are transformative technologies that offer non-sewered sanitation solutions, thereby eliminating the need for a piped sanitation collection system" (ibid: 10).

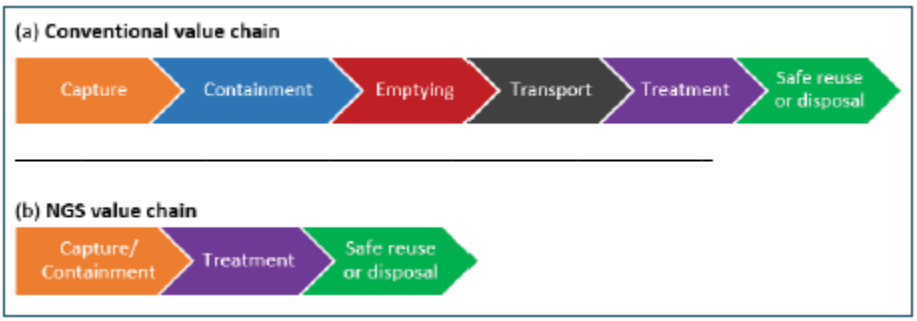


Figure 2: Conventional verses NGS Value Chain
Source: Mudombi/TIPS (2018: 9)

This report proposes a few refinements to Mudombi's foundational work.

First, it disaggregates NGS waste disposal systems (where on-site treatment has significant economic, social and environmental benefits) and NGS pedestal technologies (which save water and can also be interfaced with existing sewage conveyancing and disposal systems).

Interviews conducted for this study suggest that many people in the middle market segment (and "almost all" in the high-end market segment) would prefer to pay less for water and move "off grid" (due to high levels of distrust in municipal services and/or environmental sensitivity). User concerns regarding smell (which UKZN studies have demonstrated are not prevalent once users experience the technologies) and poor design are key factors to address in opening these markets. Two interviews also suggested that as NGS technologies are implemented in middle- and high-end markets, user preferences for high-flush toilets will cease to be the "gold standard" for low-end markets. "Does Bill Gates have these in his own house?" asked one respondent.

This refinement impacts on the analysis of potential markets for NGS technologies. There are good reasons why providing access to "improved" sanitation should remain the primary focus. But NGS should not be seen as a solution only for impoverished communities. Retrofitting low-flush toilets to existing buildings that connect to centralised sanitation systems in water-stressed areas, and incentivising low-flush pedestals (and DEWAT systems in new builds in rural and peri-urban areas) provide other potential markets, and a platform for industrial diversification. Design intensification will enable penetration of all markets.

Second, a clear distinction a made between sanitation "hardware" (infrastructure components) and sanitation "software" (socio-culturally embedded perspectives and practices). Mudombi flagged software issues as central – "the main barrier to [NGS] adoption is the behaviour of users, and their acceptance of the technologies" (ibid:22). These issues are reflected in recent conceptualisations of the sanitation value chain, illustrated in Box 2 below:

Box 2: Recent Conceptualisations of The Sanitation Value Chain

…Sanitation Value Chain has the following basic policies:

- *Put values of people and community in the centre of the discussion, and prepare sanitation system to drive this value chain*
- *Design the sanitation system by focusing on incentives for individual users and community;*
- *Recognise a sanitation system as an integrated system with social and technical systems;*
- *Design the sanitation system by making a good matching between social characteristics and pre-requisites of the technologies.*

(Funamizu, N., 2017:1).

Software issues are also reflected in sanitation *industrial* strategy conceptualisations. Hence, the eco-systems analysis is located within this paradigm.

Third, the sanitation industrial value chain analysis is located within the wider, transitional landscape of climate change, technological shifts (coded as the "fourth industrial revolution" or 4iR) and post-pandemic responses. This is because the sector is undergoing major shifts, for example:

- Climate change is causing water scarcity in many parts of South Africa and the world. A major argument for NGS is that it minimizes water consumption in sanitation processes and has scope for water reclamation.
- Technology changes in manufacturing include the emergence of additive manufacturing, through nano-technologies and 3D printing.
- Most data and forecasts for the industrial value chain are pre-pandemic. They do not adequately reflect the impact of the pandemic on production, sales or other economic factors. Post-pandemic economic stimulus packages globally and in South Africa are foregrounding the greening of infrastructure. Mudombi and Montmasson-Clair (2020) have made the case that a post-pandemic stimulus package focused on water and sanitation could open possibilities for import substitution; small business development; job creation; circularisation of the economy; improved efficiencies; and saving water-dependent jobs.

These refinements to Mudombi's initial conceptualisation impact on the analysis of markets and the sanitation industrial value chains.

2. Sanitation markets

2.1 Conceptualising sanitation markets

Sanitation markets can be conceptualised in relation to:

- User interfaces (safe, basic, limited, unimproved, open defecation);
- Design of sanitation system (centralised, decentralised);
- Who pays and how (state or donor funded, private or mixed);
- Geographic factors (urban, peri-urban, rural or developed/developing world); and
- Climatic conditions (water stressed or not).

Each of these provides different perspectives on existing or future markets. For example, low-flush user interfaces can be provided in both centralised and decentralised systems – thus opening markets in centralised systems. There is a stronger business case for NGS sanitation systems in water-stressed areas as opposed to non-water stressed areas. Peri-urban and rural provision has a stronger cost-benefit ratio than urban provision.

2.2 Decision-making for sanitation system design

Hattingh (2020) reports factors informing how decisions regarding sanitation provision are made, based on roughly 200 interviews:

- End user problem: Currently, sanitation infrastructure in South African peri-urban informal settlements (ventilated and un-ventilated pit latrines, as well as chemical toilets) is unsafe for the low-income vulnerable (women, children and the disabled), and often inconveniently located for users.

- Environmental problem: Pit latrines fill up with sludge that contaminates groundwater and living spaces, is unhygienic, smells bad and are sometimes dangerous.

- Project context problem: Informal settlements toilets are serviced between once and twice a week, but disruptions lead to overflow, contamination, community safety and health issues. Toilets are poorly monitored.

- Channel logistics-costs and service problem: logistics costs increased by 158% since 2015 (and escalating), leading to a squeeze in profit (Hattingh, 2020). Service is also constrained by the distances to the service areas. Reducing logistics costs allows expansion of informal community service envelope.

- Service delivery: Municipalities are productivity constrained, as they can't keep up with land grabs (leading to rapid urbanisation), which results in a lack of sanitation service delivery. There is little real-time monitoring of infrastructure, which means servicing is delayed.

These factors point to the constraints that undermine current NGS provision in South Africa and more widely, and inform some of the policy recommendations.

2.3 Aggregate market size and structure

The sanitation ladder is helpful in understanding the sanitation markets:

Safely managed	Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site	*Improved facilities include: flush/pour flush to piped sewer system, septic tank or pit latrine; ventilated improved pit latrine, composting toilet or pit latrine with slab.*
Basic	Use of improved facilities which are not shared with other households	
Limited	Use of improved facilities shared between two or more households	
Unimproved	Use of pit latrines without a slab or platform, hanging latrines and bucket latrines	
Open defecation	Disposal of human faeces in fields, forest, bushes, open bodies of water, beaches or other open spaces or with solid waste	

Figure 3: The Sanitation Ladder
Source: Mudombi/TIPS (2018: 11)

In 2010, the UN General Assembly "recognised access to safe and clean drinking water and sanitation as a human right" (WHO, 2019). Sustainable Development Goal 6.2 calls for "adequate and equitable sanitation for all and is tracked with the indicator of 'safely managed sanitation services'" (WHO, 2019). While only 3 of the SADC member states have the right to water and sanitation enshrined in their constitution, the SADC Protocol has been interpreted from a socioeconomic rights perspective to include these. Also, various African Charters more explicitly provide for such rights (Matchaya et al 2018). Clauses in the South African Constitution have been interpreted as implying the right to adequate sanitation. These have been cascaded through legislation such as the Water Services Act of 1997, the Municipal Systems Act of 2000, the National Sanitation Strategy (2005) and the Free Basic Sanitation Strategy (2009). (SERI, 2011: 19). State obligations have also been affirmed in recent court cases (ibid).

NGS technologies provide safe, cost-effective, environmentally friendly and socially responsive solutions to sanitation needs. Providing sanitation to those who have unsafe, unimproved and open defecation sanitation is a global, continental, regional and domestic policy priority. TIPS 2018 correctly assessed these as the primary markets for NGS technologies.

The global markets for providing NGS to end open defecation by 2030 was estimated at 1.1 billion people (see Figure 4). About 3.4 billion people would need access to basic sanitation. About 5.3 billion

people would need to be provided with safely managed sanitation services. About US$120 billion would be required annually to meet the 2030 sanitation targets.

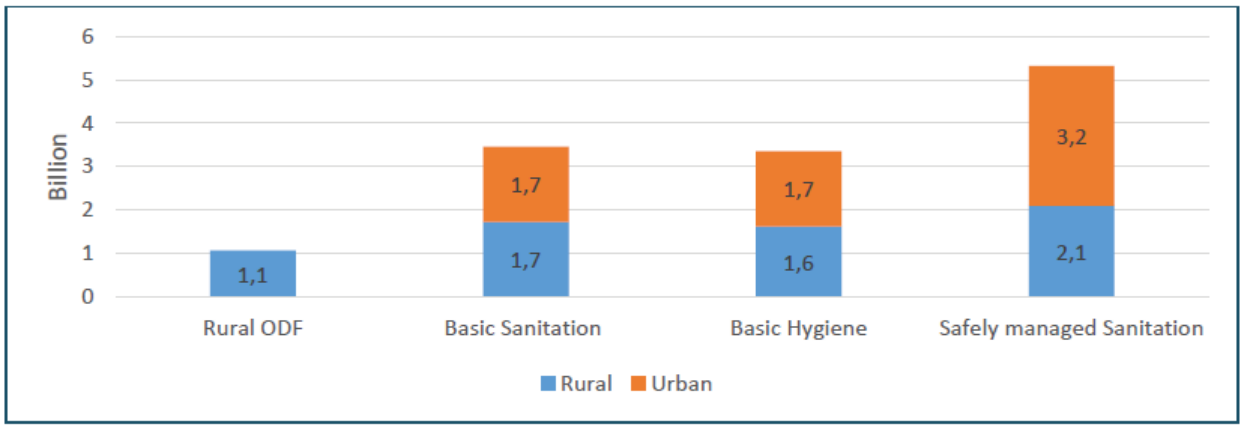


Figure 4: Global Markets for Providing Safely Managed Basic Sanitation in Urban and Rural Areas
Source: Mudombi/TIPS (2018: 12)

These NGS markets are heavily concentrated in developing world environments, as illustrated in Figure 5 below:

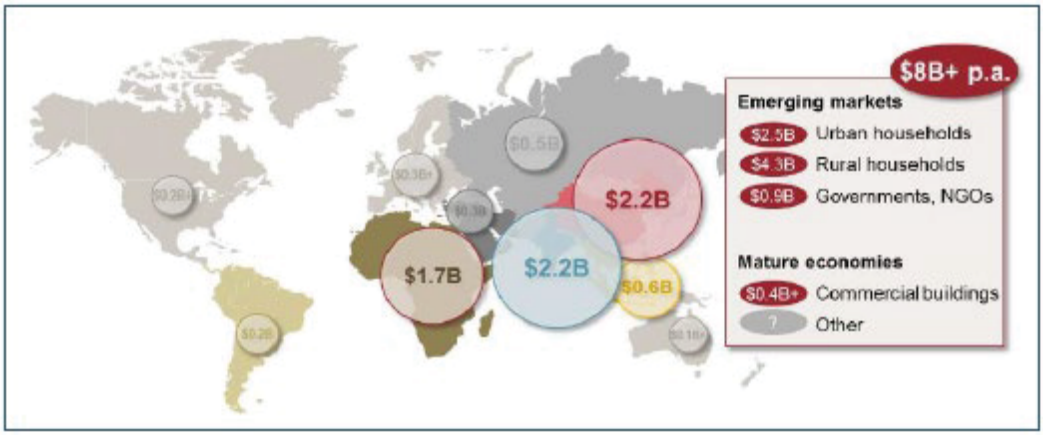


Figure 5: Global Distribution of NGS Markets for Safely Managed Basic Sanitation
Source: Mudombi/TIPS (2018: 12, drawn from BCG)

Analysis conducted for this value chain analysis disaggregated the projections from the Reinventing the Toilet Competition (RTTC) model projections to include South Africa.

Box 4:

Summary of RTTC Model Projections for Global, African and South African Markets

Reinvented Toilets (RT) can be used in residential and non-residential settings. For both settings, the RT model is divided into two types: the single unit RT (SURT) for stand-alone houses and the multiple unit RT (MURT) for apartments. The RTTC model presents an upside scenario and base scenario for comparison of the potential of RTs. The upside scenario assumes that RT market share will increase and be realised sooner; and the costs of doing business will be minimised and maintained. The baseline scenario assumes a more conservative current potential of RTs. Both scenarios assume a mature market of RT, with no price elasticities, no financing schemes or subsidies. Selected countries were used to extrapolate market assumptions to Rest of the World based on similarities across national landscapes.

The overall forecast is as follows:

World

On the upside scenario, the global estimated potential revenue for 2030 is $5.2 billion, where the SURT revenue will contribute 36% ($1.9 billion) and the MURT revenue will contribute 64% ($3.3 billion). On the baseline scenario, the estimated potential revenue for 2030 is $1.9 billion.

Africa

Africa's estimated total revenue for 2030 is US$447 million, where the SURT revenue will contribute 46% (US$207 million) and the MURT revenue will contribute 54% (US$239 million). On the baseline scenario, the estimated total revenue for 2030 is US$201 million.

South Africa

South Africa's estimated total revenue for 2030 is US$56 million, where the SURT revenue will contribute 58% (US$32 million) and the MURT revenue will contribute 42% (US$24 million). On the baseline scenario, the estimated total revenue for 2030 is US$25 million. Of the US$56 million potential revenue, there is a significant opportunity of 93% of it concentrated in residential areas and 7% of it in non-residential areas.

Meeting the health and social justice imperatives of providing adequate sanitation – in South Africa and elsewhere – provides an opportunity for industrial development of the local Next Generation Sanitation sector.

Provision of cost-effective rural sanitation; the emergence of smart buildings and smart cities; infrastructure investments as components of post-pandemic stimulus packages; the greening of infrastructure in response to climate change; and the wider circularisation of value chains mean that those who already have adequate sanitation are also potential markets.

This study follows the analysis that providing safely managed basic or improved sanitation to those who currently do not have access represents the primary markets. However, those who already have safe and basic sanitation but who live in highly or moderately stressed water areas represent a major potential market for retro-fitting of existing pedestals, to reduce water consumption. This is true in South Africa, but also across many parts of the world.

In 2017, 45% of the global population (3.4 billion people) had access to a safely managed sanitation system. 31% (2.4 billion people) used private sanitation facilities connected to sewers from which waste water was treated. However, the "safety" of such sanitation systems depends on the efficacy of waste water treatment; is water-intensive; does not always harvest biomass or reclaim water; and sometimes has negative environmental impacts.

Even those currently provided with adequate sanitation therefore represent a major market for next generation sanitation products, as countries grapple with the impact of climate change and environmental degradation.

3. A Multi-Criteria Analysis of the Business Case for NGS

NGS pedestals are not cheaper than conventional technologies (and in some cases are more expensive). Decentralised Waste Water Treatment Systems (DEWATS) are usually cheaper than centralised systems, especially where clustered and especially in peri-urban and rural areas.

The business case for a shift to NGS however relies on a multi-criteria analysis which has implications for financial planning and transversal coordination. Key aspects of a multi-criteria business case are sketched here (even though some benefits cannot be monetised).

Examples of benefits that cannot be monetised include

- **"Access Time** is the time saved to access the improved sanitation, such as access time to a private toilet compared to finding an appropriate place for open defecation. The economic value of time is based on the same values as health-related time savings.

- **Intangibles** include comfort, privacy, convenience, safety, status, respect and prestige. These are difficult to measure in monetary terms, but they often play an important role to the demand of improved sanitation and the willingness to pay for it" (UN 2015: 14)

Policy decisions regarding the rollout of NGS systems should explore a wider lens than cost-benefit analysis. Interviews conducted for this research suggested that a more delicate (multi-criteria) funding and financing model is required.

3.1 Cost Considerations

Comparing the cost of centralised and decentralised wastewater treatment depends on factors such as location, length of piping required, water pollution levels, treatment costs, etc. Various studies have demonstrated the cost advantages of providing DEWATS solutions in rural and peri-urban areas (Jung et al., 2018, UNESCAP, Hutton, 2012).

A series of World Bank Cost-Benefit case studies demonstrated that:

DEWATS can be seen to provide good market opportunities for households and small industries in urban and peri-urban areas where there is no access to centralized sanitation services, especially in climate risk zones. The market includes the different segments of the value chain, starting from the stimulation of demand and proceeding to the supply of hardware facilities (e.g. latrines and septic tanks), and the collection and transport of waste. It also includes opportunities to recover costs from reuse of wastewater…

…the CBA from the World Bank studies shows the return on investments of different sanitation solutions for three selected countries, compared to other countries. The studies indicate that the return on investments can be as high as 10 USD per 1 USD of investment, but also as low as 10 US cents

South African data on costing provided a strikingly different analysis. One participant reported that for every R1 on new build in a rural area such as Lusikisiki, the funders would have been required to spend R29 to connect to municipal services. NGS is more cost-effective in many SA contexts.

Moreover, the advantage of DEWATS systems is that they do not require the major upfront capital injection required by centralized systems. Also, DEWATS value chains and sanitation services – using an inter-sectoral and cross industry approach – "may benefit from shared resource productivity, inter-linking synergies between supply chains and consumption nodes, while tapping into unused local resources. This then allows them to realise compounding effects through synergistic linkages and material symbiosis through the principle of circular economy in order to reap multiplier effects" (ibid: 10).

The UN study argues for a careful financial modelling of the sanitation system policy options, as one input into strategy-making. A financial economist interviewed for this study independently argued the same.

3.2 Health Benefits

Health benefits include the reduction in diseases caused by improved sanitation. "The economic savings used to measure this are: 1) the averted health care cost 2) the economic cost of time lost due to illness and 3) the cost of premature deaths avoided" (UN, 2015:15).

At least 10% of the world's population is thought to consume food irrigated by unsafe wastewater (WHO, 2019a). Unsafe sanitation is estimated to cause 432 000 diarrhoeal deaths annually and is a major factor in other diseases. Some impacts are difficult to monetise, but estimates are that "every US$1 invested in sanitation yields a return of more than US$6.6 in sub-Saharan Africa" (ibid: 3). Between 1-5% of GDP in Africa is lost due to inadequate sanitation (ibid: 2), due to "morbidity, mortality, productivity and access time" (ibid:2).

Economic losses as a result of poor sanitation and inadequate water supply have been documented in a global study, and have been shown to vary between developing regions from 0.7 percent to 4.3 percent of gross domestic product (GDP), or 1.5 percent globally, with the highest impact in Sub-Saharan Africa (Hutton, 2012). Economic studies conducted at country level by the World Bank over the past 10 years have shown that poor sanitation and hygiene alone cost countries between 0.5 percent and 7.2 percent of their GDP (World Bank, 2017: 8).

Not providing improved sanitation has measurable downstream costs on the healthcare system and the economy that should be taken into consideration in policy deliberations.

3.3 Water

In South Africa, there is a projected 17% gap between the supply and demand of water by 2030. The shortages are projected in the same geographic areas where formal employment is heavily concentrated. Some 3.2 million jobs are moderately or heavily dependent on water. Therefore,

promoting NGS as a water-efficient technology would impact on sustaining employment in these areas (TIPS 2017a).

The cost of sustaining such jobs through water-efficient sanitation strategies should be seen against the challenges and costs of creating new businesses and jobs. More delicate water user-payment models may assist in funding water and sanitation infrastructure to address the challenges.

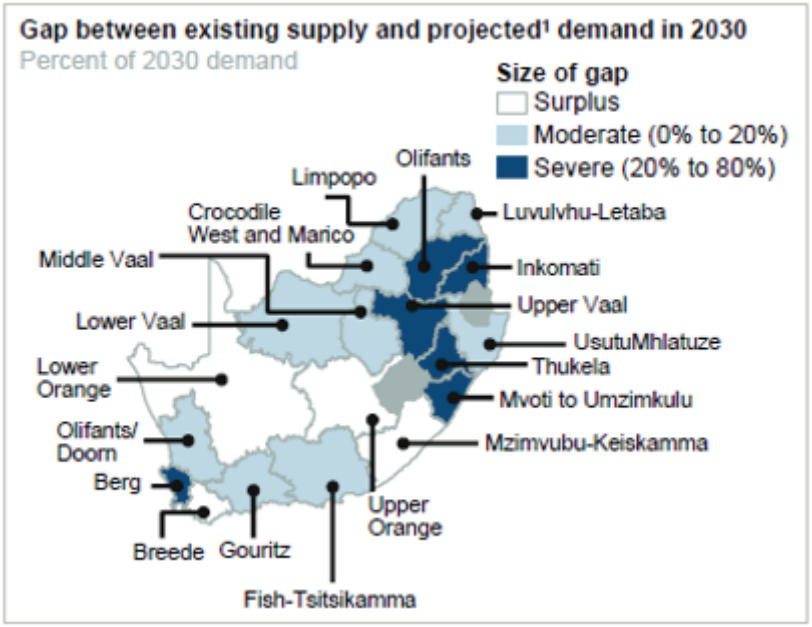


Figure 6: Projected Gaps between Supply and Demand of Water in South Africa
Source: TIPS (2017b)

Water has a price. Municipalities set their own tariffs which differ between user categories. Pricing varies during periods of water scarcity and according to consumption levels. Illustratively:

		Cape Town L1		Cape Town L5		eThekwini		Tshwane L1		Ekurhuleni		Johannesburg	
		Monthly use (kl)	R/kl	Monthly use (kl)	R/kl	Monthly use (kl)	R/kl	Monthly use (kl)	R/kl	Monthly use (kl)	R/kl	Monthly use (kl)	R/kl
Residential	Step 1	0-6	12.85	0-6	21.19	0-6	18.63	0-6	10.55	0-6	10.21	0-6	8.28
	Step 2	6-10.5	17.13	6-10.5	34.43	6-25	22.01	7-12	15.05	7-15	16.82	6-10	8.79
	Step 3	10.5-35	22.78	10.5-35	52.39	25-30	29.30	13-18	19.77	16-30	20.60	10-15	15.00
	Step 4	>35	39.39	>35	300.00	30-45	45.21	19-24	22.87	31-45	25.63	15-20	21.83
	Step 5					>45	49.73	25-30	26.14	>45	31.60	20-30	29.98
	Step 6							31-42	28.25			30-40	33.22
	Step 7							43-72	30.23			40-50	42.42
	Step 8							>72	32.37			>50	45.19
Commercial & Industrial	Step 1	Not stepped	22.78	Not stepped	37.50	Not stepped	29.12	0-100000	22.28	0-5000	22.06	0-200	38.39
	Step 2							10001-100000	21.14	5001-25000	22.41	>200	40.49
	Step 3							>100000	19.70	>25000	23.38		

Figure 7: Water Tariffs for Selected Municipalities
Source: Green Cape Water Market Intelligence Report 2020

The price of water in water-stressed areas makes retrofitting of existing sanitation pedestals viable on a user-payback model, but the financial instruments for this are still under development. Incentive schemes for new build are similarly required.

3.4 Faecal Sludge Reuse

Part of the argument for urine-diversion pedestals is that they are able to separate urine from faeces for treatment purposes, and thereby harvest waste, water and energy. Currently, the safety of fertilizer harvested from urine has been demonstrated only at household level (Buckley, 2020, pers comm).

Estimating the value of faecal sludge reuse depends on a variety of factors. Mallory et al. (2020) provides a comprehensive review of studies. They suggest that the maximum value of products to be derived from faecal sludge review is about US$5 per person a year:

"This review suggests that a maximum value of products derived from FS is US$5/p/y. In the one study where the operating costs along the whole chain from containment to reuse have been published along with reuse revenues, they only cover 10% of operating costs. In another business practicing CBS reuse revenues only cover 8% of operating costs. Higher value products often rely on smaller markets or subsidies from government allowing the value to be effectively inflated….

This is unlikely to scale up when selling products from the treated waste of millions of people instead of tens of thousands, and no businesses are operating at that scale yet. The main benefits of sanitation are hard to monetise, most specifically reduced health spending. Resource recovery provides a new stream of revenue to mobilise businesses to enter into the market, but it still does not provide a huge financial incentive for organisations to start sanitation businesses or to invest in sanitation. For environmental, health and social reasons, CE [Circular Economy] systems of sanitation are worth pursuing, as they drive better waste management with all the associated health benefits. Unfortunately, most of these valuable contributions to society and the SDGs cannot currently be monetised. Carbon credits for electricity from biogas and subsidies for organic fertilisers are examples of interventions that help to shift the value proposition of CE sanitation. The state may need to intervene to create an enabling environment for CE sanitation" (ibid).

The poor financial returns on faecal sludge reuse is not the only challenge. As Moya et al. (2019: 1) argue:

"regulations on the use of fertilizers derived from source-separated excreta, undeveloped markets for organic fertilizers, difficulties in securing secondary sources of organic matter for composting as well as complex transport and distribution logistics. The findings of this study emphasized the need for clear policies with respect to human excreta derived fertilizer, as well as institutional involvement in order to incentivize the sale and use of human excreta derived fertilizer locally to ensure that sustainable and safely managed sanitation systems are available in urban areas".

Faecal sludge treatment and reuse has had mixed results in South Africa. The Water Research Commission led a series of studies to develop a Water Franchising model, then funded the piloting of this. The model has proved successful in creating a set of small enterprises (franchisees) who are trained, resourced, supported and managed by a franchisor. Versions of this model are also in place in eThekwini, successfully sustaining 1200 small service providers (but there are labour relations contestations currently). One private company that had a faecal sludge reuse component along the same lines has subsequently abandoned it due to poor financial viability.

Faecal sludge reuse is however only one component in the financial model behind water franchising.

Faecal sludge reuse has limited financial returns. However, when linked to wider operations and maintenance budgets and interventions, local small and micro-enterprise development is possible.

3.5 Soil Degradation

Assessing the economic impact of soil degradation is a contested and difficult challenge (Robinson et al., 2014). Soil is central to human life – "apart from providing food, biomass and raw materials and serving as a habitat and gene pool, soil also performs storing, filtering and transformation, as well as social and cultural, functions" (Gorlach et al., 2004). Soil degradation has therefore become a major policy issue, with specifications included in the System of Environmental-Economic Accounting (Robinson et al., 2014: 696). Eco-services payment models are being explored as one component of land conservation and restoration processes, and faecal sludge reuse is a potential element of this.

Research on the economics of soil degradation suggests that

> *"the total cost of soil degradation is indeed significant. Estimates of the total, nation-wide or state-wide cost from Australia, Canada, New Mexico and Spain have produced results between €200 million and €1.9 billion per year (expressed in 1999 €). While these numbers should not be compared directly, they illustrate that the potential economic impact of soil degradation can reach a significant order of magnitude, even if viewed on a macroeconomic scale".*

NGS impacts on soil degradation by mitigating contamination of soil and water; and by returning nutrients to soil. The wider benefits of faecal sludge reuse are not reflected in the current low financial returns reported under D above. Eco-service payment models are required to further incentivise uptake.

3.6 Employment Impact

Since NGS is an alternative to traditional sanitation, it is likely that NGS employment will displace some existing sanitation sector jobs (rather than create significant numbers of new jobs). However, using NGS to deliver sanitation needs in South Africa will support jobs in manufacturing, construction and operations/maintenance. It will have the added value of supporting downstream water-dependent jobs.

To illustrate this, this study estimated the employment impact of delivering improved sanitation (using NGS) to all households in highly water stressed areas in South Africa:

- The calculations focused on the 10 municipal districts in the most highly stressed water areas in South Africa, and selected those with the highest number of people who need improved sanitation.

- The affected population was calculated by multiplying the number of households without adequate sanitation (i.e. those using pit latrines, buckets or open defecation) by the average household size.
- Wastewater volume was calculated by using an unpublished "Household Water estimation", using the "mixed use population model". Non-resident employees and customers were not included.
- Provision of DEWATS was calculated by using the total costs of 2 DEWATS plants (R16.2 million for 3448 people). The pedestal costs were calculated on the assumptions of pedestals costing R500 each; labour for installation costing R750 per pedestal; and R150 per metre cost x 5 metres to connect each household).
- This figure was then multiplied by the total affected population in each municipality.
- Jobs supported was calculated using the national employment multiplier for construction of 1.94 construction jobs supported after a R1m investment.

Table 1: Employment Impact of Providing Adequate Sanitation to Households in Severely Water Stressed Municipalities
Source: Authors own calculations

Municipalities	Affected population	Cost of NGS	Jobs supported
eThekwini Metropolitan	835 174	R4.26 billion	8 264
City of Mbombela Local	498 906	R2.54 billion	4 937
Bushbuckridge Local	492 364	R2.51 billion	4 872
City of Ekurhuleni Metropolitan	318 989	R1.63 billion	3 157
Nkomazi Local	298 104	R1.52 billion	2 950
City of Johannesburg Metropolitan	183 697	R0.94 billion	1 818
Msunduzi Local	253 582	R1.29 billion	2 509
Dr JS Moroka Local	202 831	R1.04 billion	2 007
Chief Albert Luthuli Local	127 617	R0.65 billion	1 263
City of Cape Town Metropolitan	110 704	R0.56 billion	1 095

As illustrated in Table 1 above, 32 871 jobs could be supported through delivering improved sanitation to about 3,3 million people across 10 municipal districts. The total cost would be around R16 billion (slightly higher than the current Treasury budget allocation of 2021 R14 billion for the country as a whole). Investing in NGS sanitation can also support or create employment.

4. Value Chain Analysis of Pedestal Manufacturing

4.1 South African pedestal manufacturers

There are only two South African-based manufacturers of traditional sanitary ware (Vaal Potteries and Betta). Both are now subsidiaries of multinationals. Betta claims 50% of regional market share, Vaal Potteries claims 30%. Price-competitive but poor-quality sanitary ware is increasingly imported from China, Vietnam and South Korea (this accounts for some of the increase in imports). High quality but more expensive traditional sanitary ware is imported from Europe due to design intensivity or brand competitiveness (this accounts for the remaining increase in imports). All raw materials used in local manufacturing are locally sourced.

Envirosan (with three factories) is the largest South African NGS pedestal manufacturer. They have innovated a range of products that address SA and regional sanitation challenges – for example, child-friendly toilet seats as well as low-flush urinals. South African NGS pedestal manufacturing is highly price-competitive with EU manufacturing, and only slightly less price-competitive than Chinese manufacturers. For example, a Swiss manufactured urine-diversion pedestal costs around 1500 Euros whereas SA urine diversion toilets cost roughly R500. (Chinese manufactured pedestals cost roughly R450). However, the Swiss pedestals are high-quality ceramics whereas the SA and Chinese pedestals are injection-moulded plastic (although SA NGS manufacturers are also moving into the ceramic pedestal market). The Swiss pedestals are also design-intensive and have strong brand appeal. Design intensification and brand development are needed to penetrate the middle and high-end NGS markets. The Chinese pedestals often do not meet quality standards (they have reportedly not been weight-tested, for example).

Savvyloo is currently at Technology Readiness Level 7, on the verge of TRL 8. They currently operate in the portable container ablution facility market, aimed at saving portable providers costs. (For example, their products save 80% of water costs as well as transport and logistics costs). They have patents in 3 countries, for a zero-flush facility which uses solar panels to dehydrate and decontaminate effluence. In response to initial challenges with overflow, they have integrated sensors in the containers and connected these using satellite connectivity (which both expands satellite reception and incentivises use of the portable toilets).

Savvyloo are currently small scale, employing only 4 people. However, they are about to go global. Based on local off-take orders, they intend opening 2 factories each employing 130 employees and producing 2000 toilets per month. They are in discussion with DTIC around grant funding under the Black Industrialists scheme. Should their offtake orders in Brazil be confirmed, they intend building a further two factories and increasing employment by another 400.

There is a complex ecology in the relationships between domestic traditional and NGS pedestal manufacturers. The small NGS pedestal manufacturers have invested heavily in product development, and continue to do so. They commission larger manufacturers to produce components. Some product innovation is being taken forward via international partnerships. For example, there is a partnership with Samsung around miniaturisation of components for emerging technologies.

Key challenges reported by the NGS manufacturers include:

- The basic NGS technologies are open-source. Product development/product differentiation is required to customise these to specific niche markets. South African innovations include, for example, a child-friendly toilet lid and membranes that remove pathogens from waste-water.
- Product development takes 3-4 years and substantial investment to take new products from design through testing, remodification, patenting, certification and production to market.
- Despite having patents, NGS pedestal manufacturers experience challenges when their designs are copied. Contesting patent infringement is expensive (and the legal system is still evolving to deal with these issues – SA has specialised patent lawyers but no specialised patent judges for example).
- Because NGS pedestal orders are low-volume, the large manufacturers will only produce these when they have redundant capacity. This leads to long lead times that are problematic in meeting contractual responsibilities.
- They export some of their products (and are exploring new markets) but their main market until recently has been the SA municipal markets. The South African Bureau of Standards (SABS) have only recently put a set of 3 standards in place, which are in the process of being revised. The NGS sector worked with ISO to put the standards in place globally and are currently supporting SABS through providing training and standards revision. These standards have not yet been cascaded into the building codes. There are however Agrement[1] standards in place, which have legal status therefore as the only NGS standards in South Africa.
- The municipalities do not adequately specify sanitation components in built environment contracts. Thus, construction companies are awarded the contracts based on price-competitive tenders, but import cheaper components that do not meet Agrement quality standards. The limited life-cycle and lack of guarantees on these mean replacement costs are displaced onto households who cannot afford them. The SA manufactured pedestals are guaranteed for 3 years, and manufactured to last a lifetime.

The above analysis suggests that – as in case of the Plastics Industrial Masterplan – "optimising the growth potential of legally compliant manufacturers in South Africa is only possible if the costing differences between legal and illegal local producers is corrected" (TIPS 2020: 3). It also suggests that there may be regional and global market potential, but this will require rapid action to take advantage of.

4.2 Ceramic Components of Pedestals

Ceramics manufacturing is classified into traditional and advanced manufacturing. Traditional ceramics manufactures objects from inorganic, non-metallic materials and subject them to heat (DMR,

[1] Agrement is a body under DPWI, which provides certification for innovations where no national standards yet exist. They have a working relationship with SABS captured in the Agrement Act.

2010:3). Sometimes raw materials can be used without adding other materials. For high-quality ceramics such as porcelain, plastic and non-plastic clays are combined with fluxes such as feldspar and silica. South Africa has abundant and high-quality reserves of these materials (kaolin, ball clays, feldspar and silica).

Traditional manufacturing of ceramic products is forecast to continue dominating the sanitary segment over the next five years (Grandreview Research, 2020).

Advanced manufacturing often uses additive manufacturing technologies (3D printing and nanotechnology) to produce an increasing range of ceramic products from medical equipment through to cell phones. 3D printing of ceramics is still a developing field of innovation. Raw materials used in 3D printing of ceramics include alumina, hydroxyapatite and zirconium.

Advanced manufacturing is used in Next Generation Sanitation currently to manufacture the test pedestals only, after which traditional ceramics or injection-moulded plastics are used to manufacture the products.

The ceramics manufacturing process is summarised in the flow diagram below:

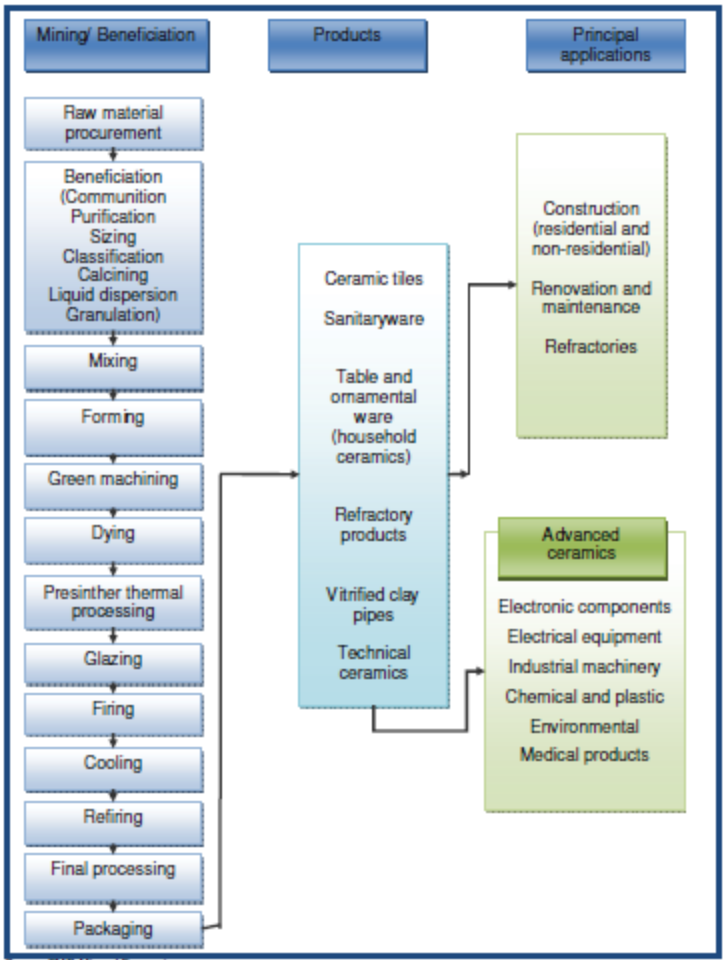


Figure 8: Ceramics Manufacturing Process
Source: DMR, 2011: 13.

The ceramics market includes tiles; bricks and pipes; sanitary ware; abrasives; pottery and others. Sanitary ware represents a sizeable share of the market.

The global ceramics market was valued at US%228.13 million in 2018. Projections are that this will grow 8.6% between 2019 and 2025 (Grandview Research, 2020).

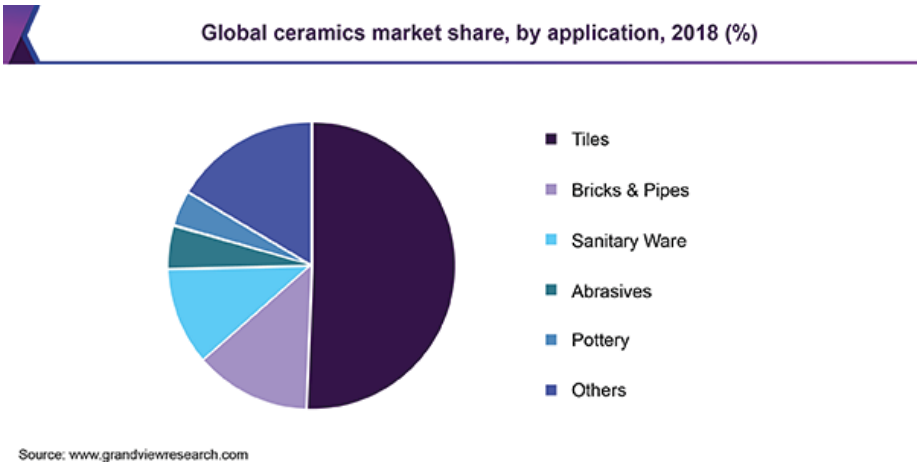


Figure 9: Global Ceramics Market Share by Product Segment
Source: Grandviewresearch.com, 2020

Sanitary ceramic imports have increased erratically over the past decade, with a major increase in 2018/2019. NGS manufacturers believe this is partly due to the state investments in improved sanitation, but in which the sanitation components are not being locally sourced.

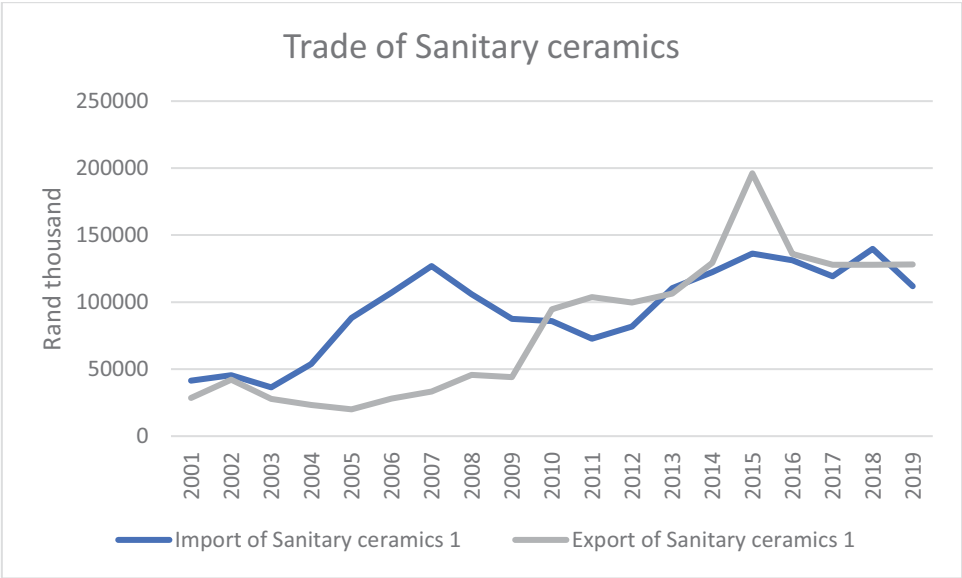


Figure 10: Imports and Exports of Sanitary Ceramics
Source: Authors Calculation, Based on Trade Map Data

The current import tariff rate of sanitary ceramics ranges from 0% to 20%. However, South Africa has different tariff rates imposed on exports of sanitary ceramics to different countries. The export tariffs for the top 10 countries that South Africa exports to are listed in table 2 below:

Table 2: Import and Export Tariffs on Sanitary Ceramics
Source: Trade Map

	Export			Import	
MARKET	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**	**Pref. Margin**	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**
Botswana	0%	0%	0%	20%	0-20%
Congo, Democratic Republic of	20%	20%	0%	20%	0-20%
Eswatini	0%	0%	0%	20%	0-20%
Lesotho	0%	0%	0%	20%	0-20%
Malawi	25%	15%	10%	20%	0-20%
Mozambique	7.50%	0%	7.50%	20%	0-20%
Namibia	0%	0%	0%	20%	0-20%
Spain	7%	0%	7%	20%	0-20%
Zambia	25%	0%	25%	20%	0-20%
Zimbabwe	40%	10%	30%	20%	0-20%

Raw materials used in traditional ceramics include clays; feldspar; kaolin; ball clays; and silica.

Feldspar is widely available globally. South African production of feldspar represents less than 1% of global production. In the decade 2001-2010, there was been an annual growth of 5.7% of domestic feldspar partly due to the growth in the South African ceramics industry (DMR, 2010: 17).

Silica is the second most abundant mineral. South Africa holds reserves in Gauteng, Limpopo, the Eastern Cape and Mpumalanga. Many of these are high-grade silica. South African production represents about 2.6% of global production. Production grew at an average annual rate of 4.2% between 2000-2009, but dipped in 2009 due to depressed global and national infrastructure spend.

Production and sales of both silica and feldspar have been relatively stagnant since then.

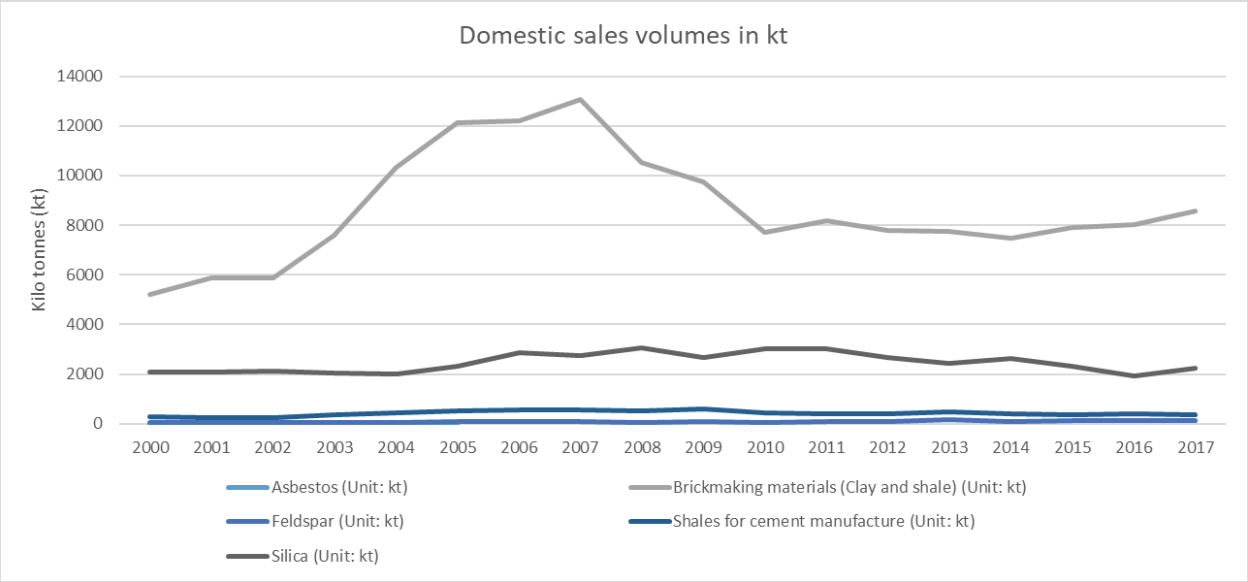


Figure 11: South African Sales Volume of Feldspar and Silica by kt
Source: Authors own calculations

South Africa holds 100Mt reserves of kaolin in the Western Cape, Eastern Cape and Gauteng. The paper and ceramics industries account for more than 60% of use. South African production of Kaolin dropped an aggregate 11% from 2000-2009. (More recent statistics are not available). This was attributed to global decline in paper production, and the import of cheap Chinese, South Korean and Vietnamese ceramics.

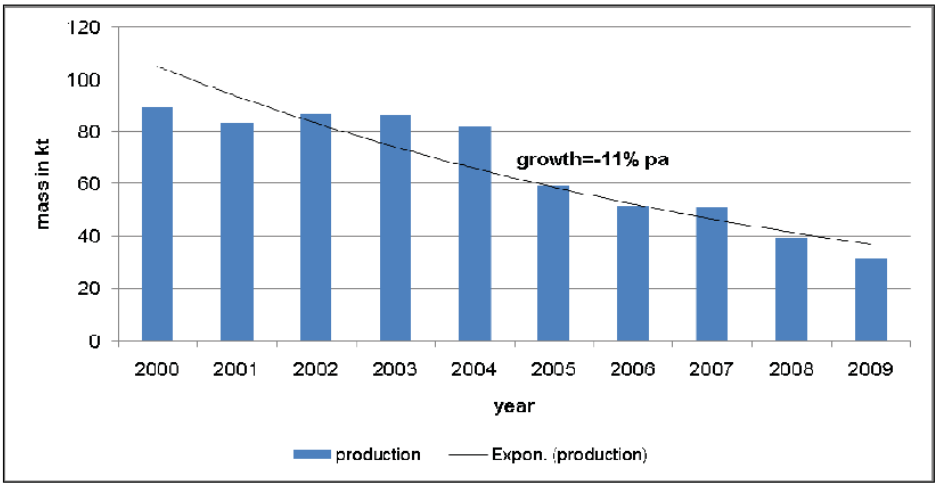


Figure 12: South African Production of Kaolin 2001-2009
Source: DMR, 2010

Ball clays are crucial for high quality ceramics. Some South African reserves exist in Mpumalanga and the Western Cape. There are no disaggregated statistics for production and sales of ball clays.

South Africa hosts high-quality reserves of all the minerals used in ceramic manufacturing. Growth in the manufacture of NGS ceramic pedestals will have upstream impacts on supporting small-scale mining. Additive manufacturing of ceramics is used on a small scale, and the business case for supporting shifts to additive manufacturing more widely should be further explored.

4.3 Plastic Components of Pedestals

Plastics components of the pedestals are focused on the manufacturing of toilet seats. The Plastics Industrial Masterplan aims amongst other things to localise manufacturing through the "active identification and development of new domestic production capabilities within selected portions of the value chain to replace imports with existing markets" (TIPS 2020: 3). This specifically promotes the need to identify and pursue opportunities where "the excess of PP homo-polymer can be utilised to grow the PP conversion industry, to replace imported PP products and to stimulate the export of PP products" (ibid).

The NGS sector represents one such opportunity.

The domestic plastics industry accounts for less than 5% of global production. Virgin consumption in volume grew by 20.6% over the past 9 years, whereas domestic consumption of recyclate grew by 58.3% (TIPS 2020:4).

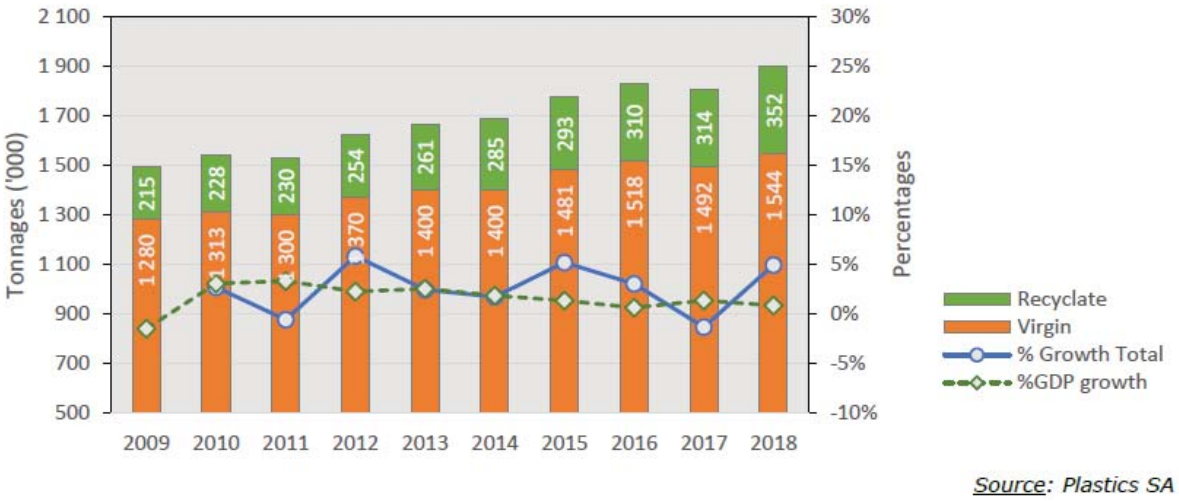


Figure 13: South African Plastics Industry Growth
Source: TIPS 2020(b)

The draft Plastics Masterplan has established three objectives:

- reducing the trade deficit to less than 10% of the total value of the industry by 2035,
- maintaining or improving the tons per employee which equates to 30 tons per formal job in 2018, and finally

- reducing the visible amount of plastics litter in the environment and to increase recycling rates to 60%.

Growth in NGS pedestal manufacturing is already supported through the Plastics Industrial Masterplan.

5. Value Chain Analysis of Conveyancing components

Connecting pedestals to containment or treatment systems currently uses the same components as are used in traditional water and sanitation systems. This includes plastic, HPDE, steel and concrete piping; as well as valves. The analysis below therefore draws largely on the TIPS Water Value Chain Analysis (Chigumira, 2020), which analysed these components.

5.1 Plastic Pipes

At aggregate level, Chigumira demonstrated that (plastic, HPDE, steel and concrete) pipe production in SA has had an erratic trade balance. There are many possible reasons for this.

Table 3: Pipe Production in SA in Tons
Source: Chigumira, 2020, drawn from SAPPMA 2019

Year	PVC	HDPE	Steel	Concrete
2009	90 000	40 000	NA	289 000
2012	81 000	50 000	250 000	245 000
2014	94 000	56 000	NA	NA
2016	104 000	50 000	175 000	293 000
2018	97 000	51 000	NA	NA
2019	78 000	48 000	115 000 (e)	220 000

Plastic pipes are used "across the complete spectrum of many industries" (ibid). There are compelling critiques of the environmental impact of plastics (the production of which is environmentally harmful and the output of which includes toxic and bio-accumulative by-products).

These environmental considerations have contributed to the circularisation of the plastics value chain; advances in plastic pipe manufacturing that enhance life-cycle or efficiency advantages; and the (still emergent) production of less environmentally harmful polymers (such as biopolymers and bioplastics). An industrial development strategy and implementation plan for these is in place (PAGE 2019).

In South Africa (and possibly other developing world contexts), plastic pipes are preferentially used in DEWATS systems due to pricing and because metal pipes are more liable to vandalism and theft.

The output (sales) value of the plastic piping industry in South Africa is roughly R3b per annum (ibid). The South African Plastic Pipes Manufacturers Association (SAPPMA) membership is concentrated in a few leading companies capturing the majority of market share in terms of revenue. SAPPMA reports major redundant capacity in the plastics piping sector and argues for increases in state infrastructure spending to stimulate domestic demand.

Domestic manufacturers compete generally based on price, quality and product availability. As the industry is fairly small with only a few role players, vested interests continue to impact negatively on the industry. In this sense, the industry already saw some significant judgements by the Competition Commission and Tribunal for anti-competitive behaviour by some companies. In one such case, the Competition Commission in 2012 found that DPI Plastics, Marley Pipe Systems, Petzetakis Africa, Swan Plastics, Amitech South Africa, Flo-Tek Pipes & Irrigation, Andrag, Gazelle Plastics, Gazelle Engineering and Macneil Agencies had meetings in which they fixed prices, rigged tenders and divided markets by allocating contracts and customers and had to pay penalties amounting to just over R50 million. (ibid).

Challenges reported in relation to the plastics piping industry include:

1. *The lack of and slow pace of government funding and actual spending on infrastructure projects, especially as it relates to projects dealing with water and sanitation. This includes spending from national government as well as deficiencies in investments by municipalities.*
2. *Many plastic pipe companies find themselves in a challenging situation as they are awaiting either the implementation of water projects or the final payments due to them for work already done.*
3. *Furthermore, relating to import parity pricing of polymers, the Competition Tribunal has also found SASOL guilty of excessive pricing of propylene and polymers. Although SASOL appealed this decision, it still points to monopolistic behaviour by a supplier of a key ingredient in the manufacturing of plastic pipes, thereby making the production process more expensive than what it should be.*
4. *South Africa's geographic location and resultant logistics costs is impacting on transportation cost, not only to domestic markets, but also to export destinations.*
5. *Insufficient R&D and innovation (specifically in the short term) is hampering the sector. Global plastic pipe companies spend on average 5% of turnover on R&D, while South African companies spend around 1% on R&D.*
6. *The reduction of import tariffs on plastic pipes has increased the influx of imported products, thereby increasing the competition.*
7. *Cheaper plastic pipe imports which have forced local manufacturers to restructure their cost elements and to find new markets for their products*
8. *Electricity supply constraints (especially shutdowns) as well as increased electricity tariffs have had a negative impact on plastics manufacturers in the form of increased production costs (electricity consumption of plastic pipe manufacturers range from 5 to 10% of total production costs).*
9. *Limited availability of local skills and lack of new technology absorption for plastic conversion.*

(Chigumira, 2020).

5.2 Steel and Concrete Pipes

Steel pipe manufacturers in South Africa include approximately 20 tube and pipe firms, falling into two main categories: producers of large and small diameter pipes. As in the case of plastic pipes, manufacturers again report significant overcapacity.

Steel piping production has declined from 250 000 tons in 2012 to 11 500 tons in 2019. Concrete pipes production declined from 289 000 tons in 2009 to 220 000 tons in 2019 (ibid).

There has been significant growth in regional exports of pipes, hoses, joints, elbows and flanges – from R91m in 2001 to R1.5 billion in 2019.

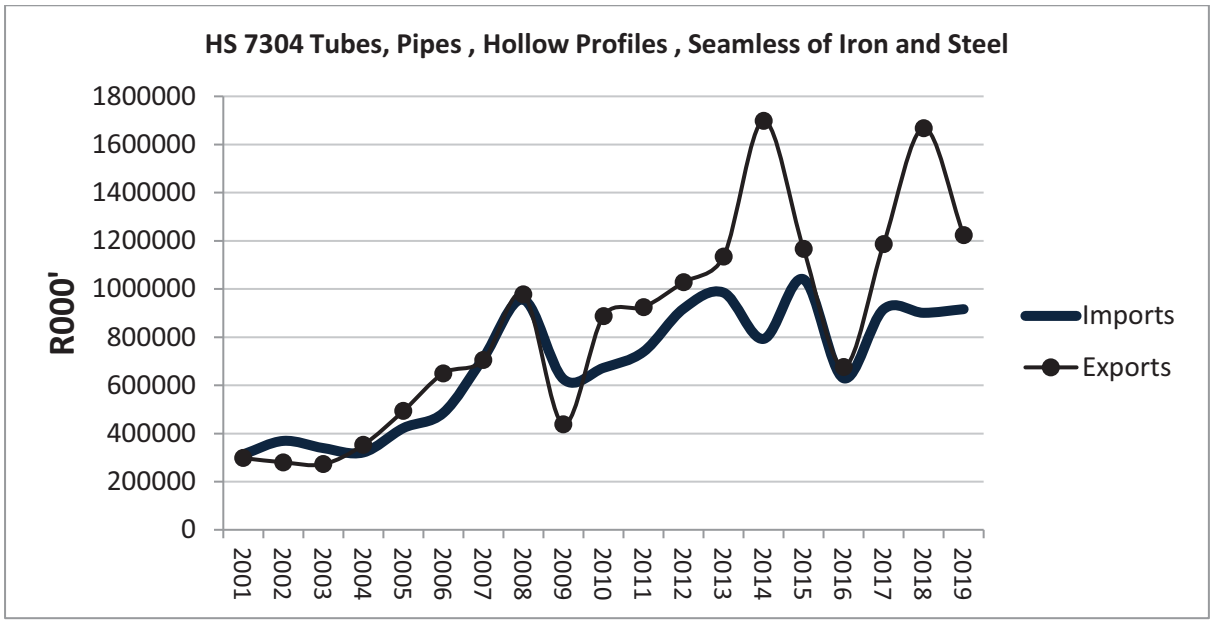


Figure 14: Trade of Steel Pipes
Source: Chigumira, 2020

Imports in tube or pipe fittings of iron and steel have grown from R293 million in 2001 to R1, 5 billion in 2019. Imports largely emanate from China, Italy, Germany and the USA. The recent (2016/17 designation of local steel content for state infrustructural projects should assist in strengthening local manufacturing by improving price-competitiveness.

Constraints reported in steel pipe manufacturing include:

1. *Overpricing of local steel. For example, other SADC-based manufacturers are able to source their hot roll coil (input material) from ArcelorMittal South Africa cheaper than manufacturers based in South Africa can from the same supplier. These non-SA manufacturers are then able to manufacture their pipes with a cost advantage and export them into South Africa tariff free due to SADC free trade agreement and be far more competitive than the local manufacturers.*

2. *Lack of demand – there is a lack of infrastructure spend/ expenditure by the government and SOEs. In addition, there has not been adequate prioritising of procuring only locally manufactured steel tubes and pipes.*

3. *Supply chain cost – high raw material costs, high electricity costs, high transport costs and high port tariff costs.*

4. *Circumvention of local content – some municipalities and SOEs still go through great lengths in order to circumvent the use of locally manufactured steel tubes and pipes. When large bore spiral submerged arc welded steel conveyance pipes were first designated by National Treasury in 2016, the instruction note did not explicitly exclude* ***ductile iron pipe*** *(not manufactured locally, wholly imported) which some municipalities and water boards decided to use at the expense of a superior, locally manufactured product that was readily available. DTIC together with manufacturers of large bore spiral steel pipes succeeded in getting the National Treasury note amended in December 2019 to exclude imported ductile iron.*

5. *Imports – Small-bore tubes and seamless pipes from Asia which are exacerbating the pressure which South Africa's steel tube and pipes industry has been under during the past three years. Due to this, some companies have had to restructure their tube division operations in response to a depressed market, such as steel tube manufacturers Macsteel Tube & Pipe and Aveng Trident Steel. In addition, there is no-bound rate import tariff protection for small-bore steel tubes.*

5.3 Valves

South Africa produces high quality valves compliant with ISO quality standards. Companies in the industry have declined from 18 to 12 over the past decade due to Chinese imports. Members of the South African Valve and Actuators Manufacturers Association produced 80% of all valves used in South Africa in 2017, market share has reportedly declined significantly. Growth in the sector dipped significantly during 2020 due to the pandemic. SEIFSA reports that capacity utilization across the entire manufacturing industry at around 71%. They attribute this to "unsustained demand patterns in both the domestic and international markets" (SEIFSA 2020).

The valve sector is worth R4.5b per annum. About 43% of the market lies in the energy and water sector. High utility costs; unreliability in energy supply; labour unrest; skills shortages; and a dramatic decline in the number of foundries have all contributed to the industry being less competitive in global markets.

There is a negative trade balance in valves, reflected in the graph below. General imports rose from R228 million in 2001 to R1, 5 billion in 2019 whilst exports grew from 2001 to 2014 and have remained constant since. The designation of valves has been initiated to support local manufacturing.

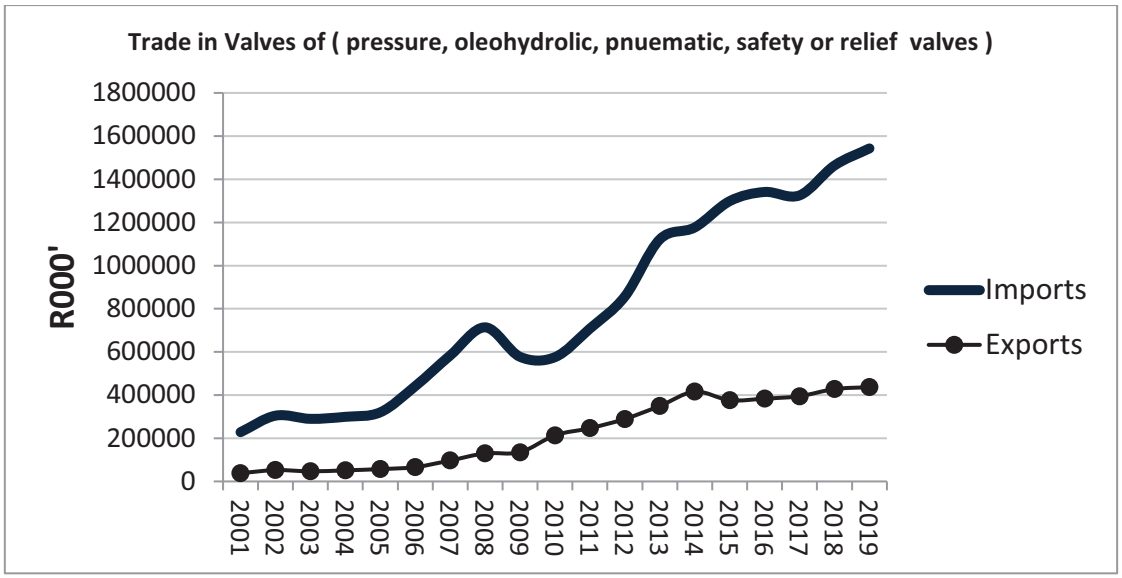
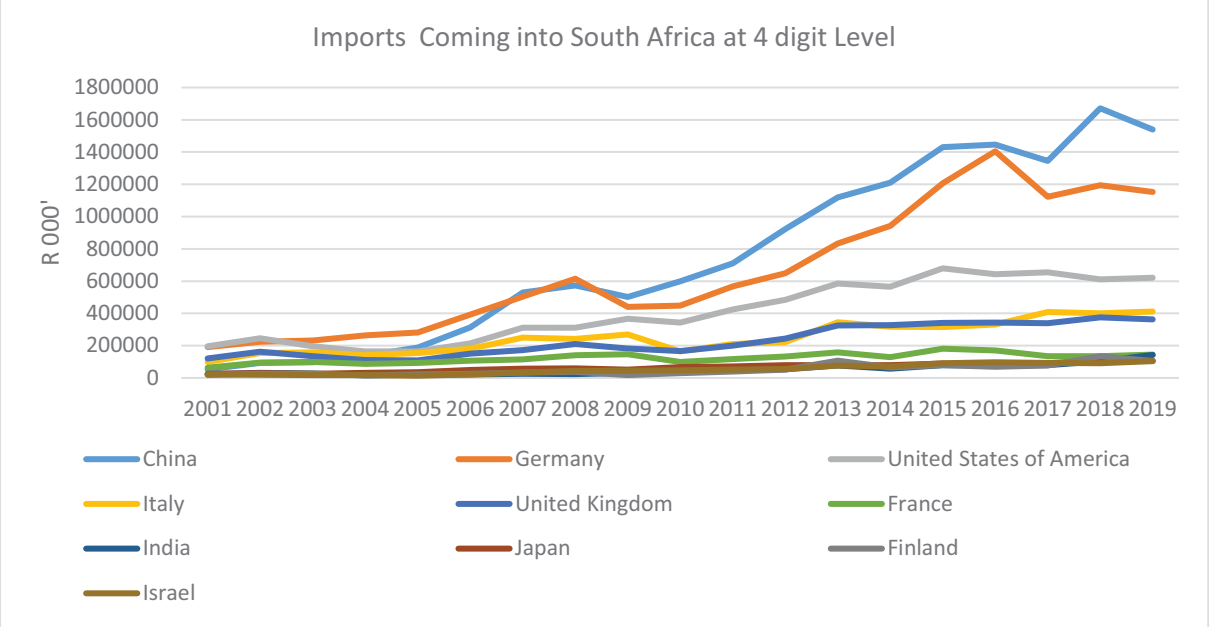


Figure 15: Trade in Valves
Source: Chigumira, 2020

Imports of valves of the HS code 8481 which includes taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats originate primarily from China, Germany and the USA.



Source: Trade map (2020)

Figure 16: Imports of Valves
Source: Chigumira, 2020

Policy recommendations in the Water and Sanitation Industrial Masterplan on supporting the conveyancing components of water apply also to supporting the conveyancing components in the NGS sector – both use the same materials.

6. Value Chain Analysis for Decentralised Waste Water Treatment Systems (DEWATS)

Decentralised Waste Water Treatment Systems are not products. They are technical approaches to waste water treatment that use mechanisms such as sedimentation, floatation, aerobic and anaerobic treatment of both domestic and industrial waste water. The systems are designed to be:

- cost-effective (components are not expensive, construction is quick and easy, it is usually cheaper to provide DEWATS systems to peri-urban settlements and almost all rural settlements, and there are downstream savings in municipal treatment costs)
- safe (DEWATS systems purify water and effluence)
- environmentally friendly (water, energy and nutrients can be harvested and reused)
- less liable to vandalism, theft and hence replacement (few metal elements are used)
- household or community led (providing employment in the management of sanitation).

DEWATS systems range from small systems (processing 1 m^3 per day, typically provided to households) to large (processing 1000 m^3 per day). Both are illustrated in the two images below.

6.1 DEWATS Construction

DEWATS systems commonly share a number of technical treatment steps, illustrated in the diagram below. These include:

- Primary treatment (in sedimentation ponds, settlers, septic tanks or biodigesters);
- Secondary treatment in anaerobic baffled reactors, anaerobic filters, or anaerobic and facultative ponds;
- Secondary aerobic/facultative treatment in horizontal gravel filters; and
- Post-treatment in aerobic polishing ponds (ibid).

Primary raw materials are explored here. Conveyancing and other components of DEWATS systems have been treated in the preceding section. More specific biotechnology or nanotechnology components are not explored.

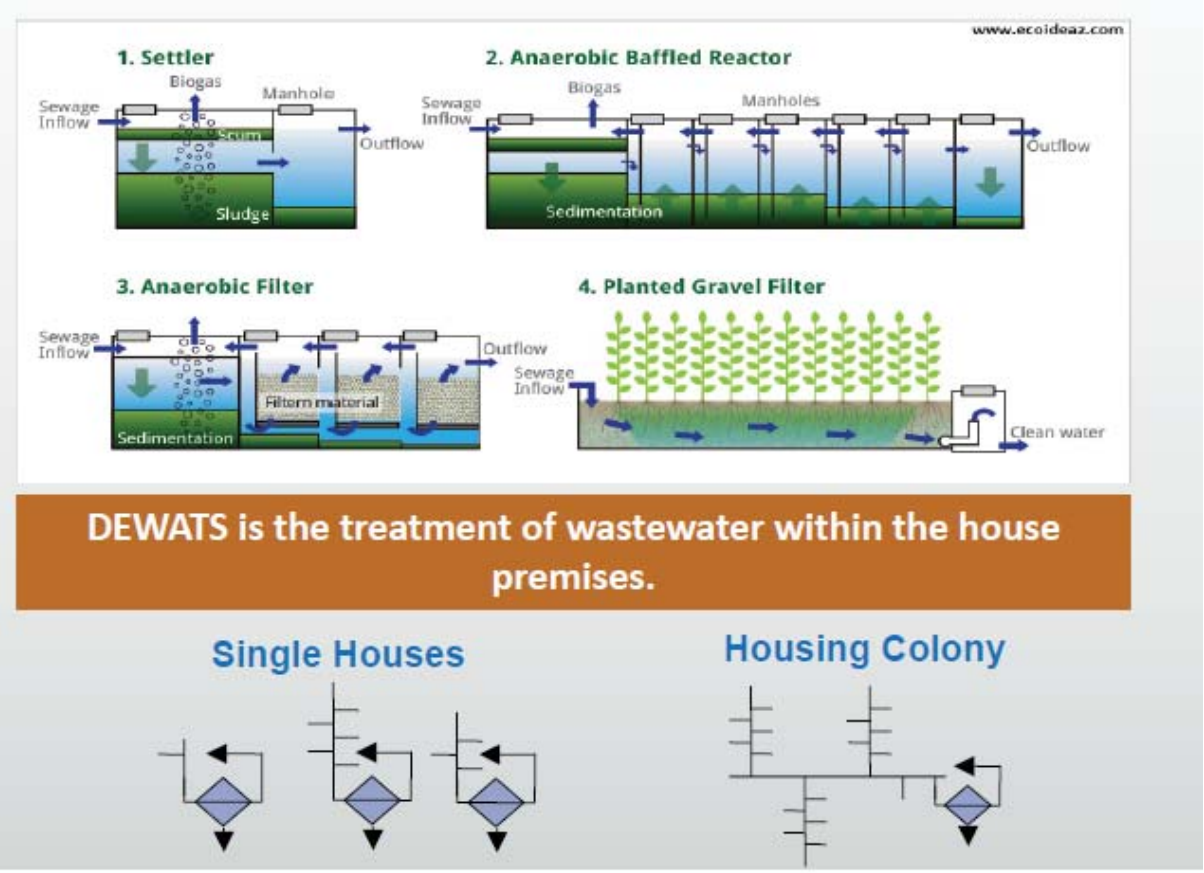


Figure 17: Technical Configuration of DEWATS
Source: Handbook 2017: 16

Specific technical and engineering issues need to be interpreted against local environmental, economic and social situations. DEWATS construction therefore can take 3 to 6 months, and is preceded by a feasibility study and geotechnical assessment. A programme usually has the following elements:

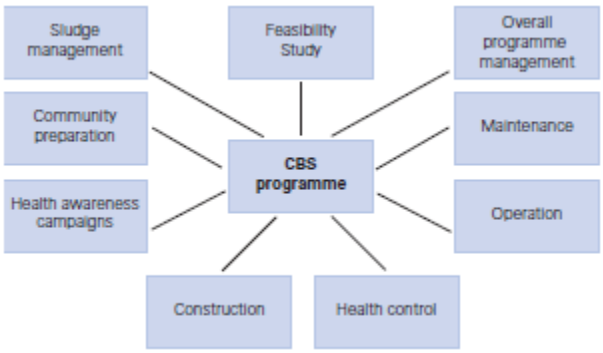


Figure 18: Project Components of DEWATS Construction
Source: DEWATS Handbook 2017: 19

Interviews with a major DEWATS system provider suggested that pricing of DEWATS systems could be probably lowered by 20%, since contractors are often unfamiliar with the system and price risk into their quotations. This reflects the maturity of the construction industry in relation to DEWATS.

6.2 DEWATS Components

Components used in DEWATS systems differ across system designs. Those below were provided through a Bill of Quantities for a typical DEWATS system by Borda (2020). They include:

- Equipment used in excavation
- Prefabricated structural components
- Cement and concrete
- Gabions of wire mesh
- Epoxide resins
- (Sometimes) activated charcoal.

Smaller DEWATS systems use simple excavation and construction equipment, as well as local (including household) labour. Larger DEWATS systems normally require excavation equipment, such as bulldozers, angle dozers, graders, levelers, scrapers and shovels. The import and exports of these are summarized in the figure below. Imports rose after 2009; declined from 2011-2016; and have risen again. Imports in 2001 stood at nearly R2 billion and since have risen in 2019 to R10 billion worth of equipment. Exports these have been improving since 2001 from R232 million to R2,8 billion in 2019.

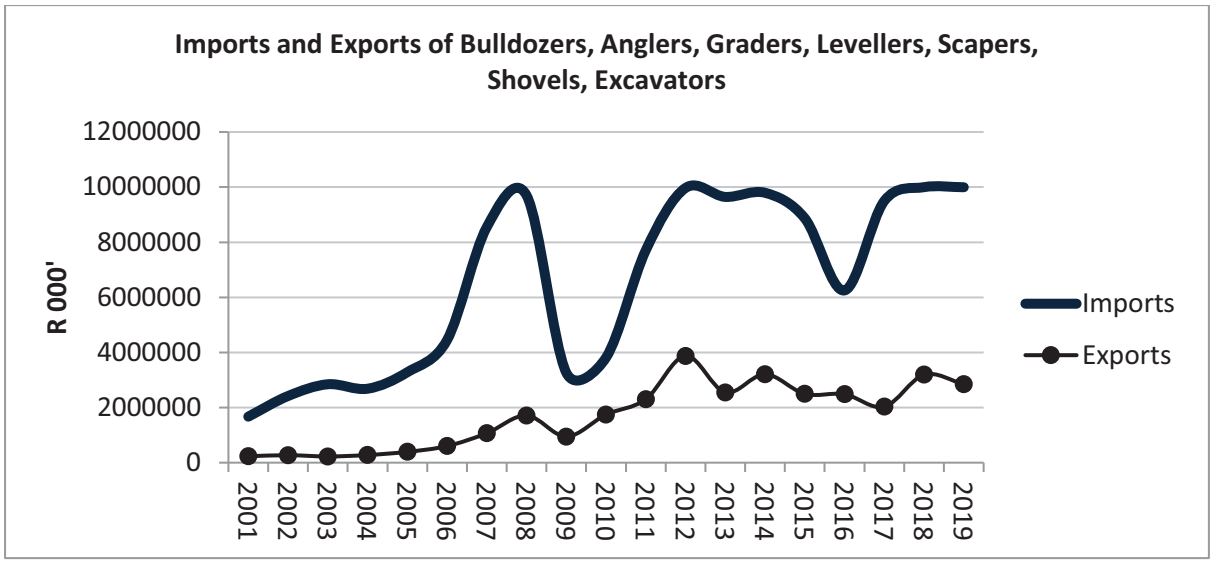


Figure 19: Imports and Exports of Construction Equipment
Source: Chigumira, 2020

Cement is then used in DEWATS construction. This includes both cement mixed on site as well as some prefabricated concrete components.

Globally more than 1000 cement producers operate over 2300 integrated cement plants. Five countries account for nearly three-quarters of world production. Demand has stagnated over the past decade, with average global utilization capacity sitting at roughly 70%. Capital intensification has further exacerbated the challenges (IFC 2020).

South African cement and concrete manufacturing is supported by a strong R and D capacity – South Africa has globally respected research capabilities, driven by the universities and with a strong focus on durability of materials. South Africa is therefore producing highly quality-competitive materials.

As of 2016, there were six cement producers in the South African market. These were estimated to be worth R48 billion in 2014 and employed about 7 000 workers (TIPS 2020c). "PPC enjoys the largest market share at 22%, with NPC at 15%, Sephaku at 12%, Afrisam and Lafarge at 9% each and Mamba at 5%. The remaining 29% of the market is serviced by imports (about 5%) and third-party blenders… In 2006, the retail market accounted for 52% of domestic sales. Ready Mix accounted for 15% of the market and 16% of cement production was channelled to concrete product manufacturers. Direct civil engineering company purchases accounted for 9% of sales, third-party blenders 6%, and 2% for others" (ibid).

Lafarge Holcim operates the biggest cement plant in Lichtenberg with a production capacity of 2.4m tons pa. It has been reported that Lafarge Holcim is considering closing plants in 2020, with poor capacity utilization being one factor (Global Cement, 2020).

Global cement production is projected to shrink during the pandemic (3% year on year in 2020 including China, and 6.4% excluding China). South African domestic production and consumption has been particularly hard hit by the pandemic.

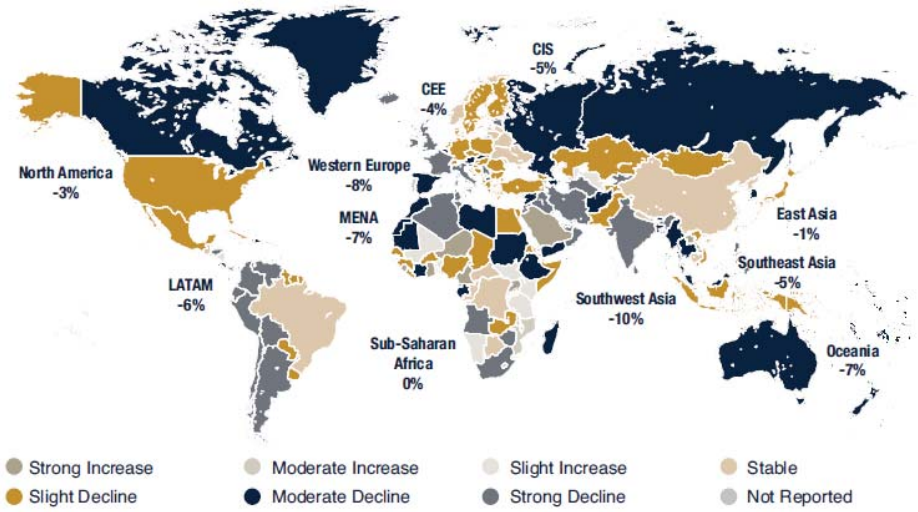


Figure 20: Impact of COVID-19 Pandemic on Cement Production
Source: IFC 2020

These 2020 impacts of the pandemic mirror a consistent history of decline, reflected in the graph below.

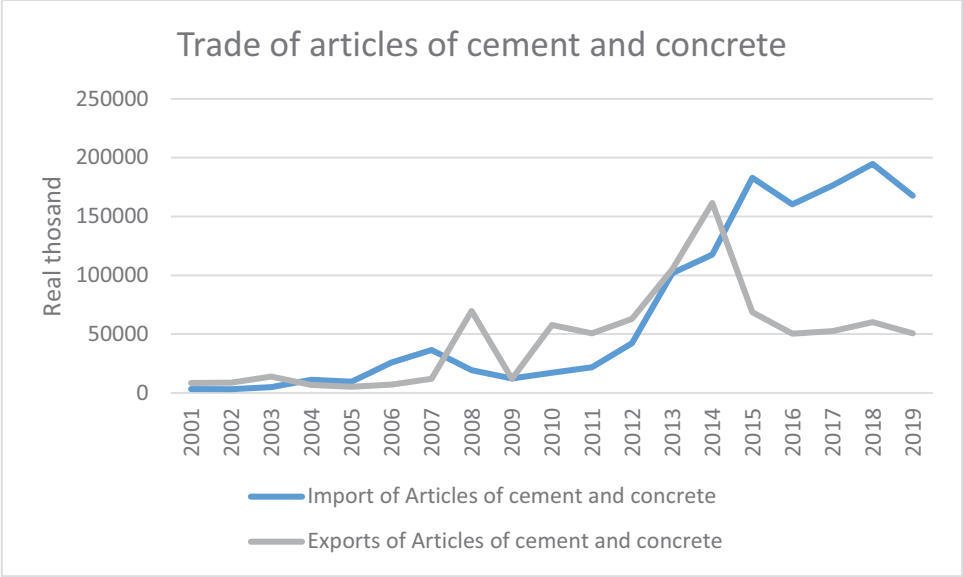


Figure 21: Imports and Exports of Cement and Concrete
Source: Trade Map

The global precast concrete market was estimated at $89.3 billion in 2019 and is forecast to grow at a compound industry growth rate of 6.3% from 2020 to 2027 (Grandview Research 2020b). This is driven by the improved efficiency offsite construction and the emergence of a green building sector (which relies on these).

South Africa has 60 major precast cement manufacturers. The National Precast Concrete Association (NCPA) estimates that there are more than 1000 smaller manufacturers, including small block yards. The NCPA Plant Evaluation programme provides technical assistance and business development to manufacturers.

The prefabricated concrete components reflect an erratic trade balance over the past decade, as illustrated in the graph below.

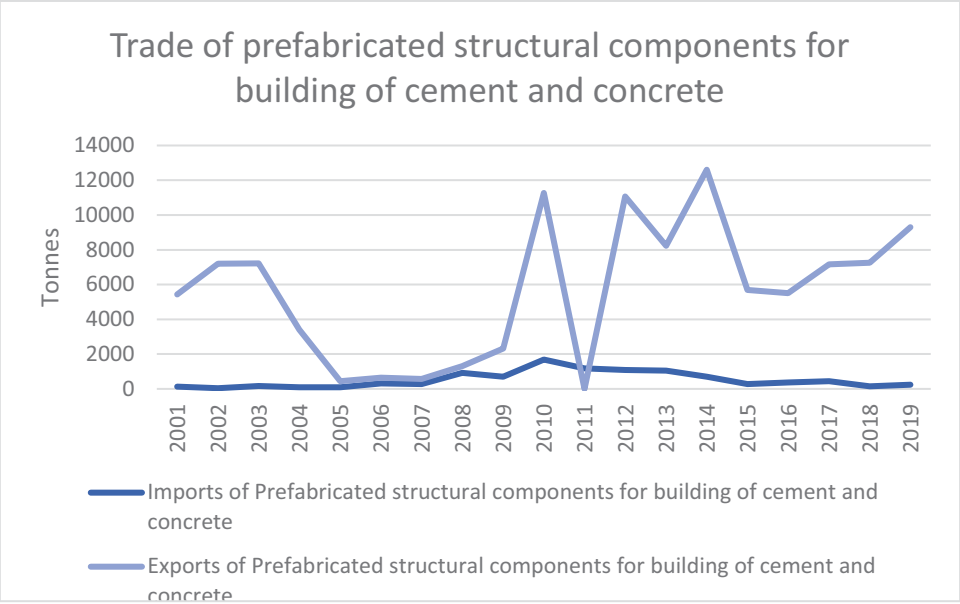


Figure 22: Imports and Exports of Prefabricated Structural Components
Source: Trade Map

The current import tariff rate of prefabricated structural components of cement and concrete stands at 0%. However, South Africa has different tariff rates imposed on exports of prefabricated structural components of cement and concrete to different countries. The export tariffs for the top 10 countries that South Africa exports to are listed in table 4 below:

Table 4: Import and Export Tariffs on Prefabricated Structural Components
Source: Trade Map

	Export			Import	
MARKET	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**	**Pref. Margin**	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**
Botswana	0%	0%	0%	0%	0%
Cameroon	30%	30%	0%	0%	0%
Eswatini	0%	0%	0%	0%	0%
Kenya	25%	25%	0%	0%	0%
Lesotho	0%	0%	0%	0%	0%
Mozambique	7.50%	0%	7.50%	0%	0%
Namibia	0%	0%	0%	0%	0%
United Arab Emirates	5%	5%	0%	0%	0%

	Export			Import	
MARKET	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**	**Pref. Margin**	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**
United Kingdom	1.70%	0%	1.70%	0%	0%
Zimbabwe	10%	0%	10%	0%	0%

Gabions of wire netting is also used in the construction of DEWATS systems. The global wire mesh market is highly fragmented – the top 20 players held only 12% of market share in 2018. The total market size is forecast to reach $3.1 billion by 2026, up from $2.5b in 2020. This represents a compound annual growth rate of 3.5%. (MarketWatch, 2020).

The South African Wire Association (SAWA) has 45 members responsible for 80% of domestic market share in 2013. In the same year, wire sales came to between R6-7 billion. Despite wire accounting for only 6% of steel used, it brought in 39% of steel export earnings – a strong argument for local beneficiation (Solidariteit, 2014: 27).

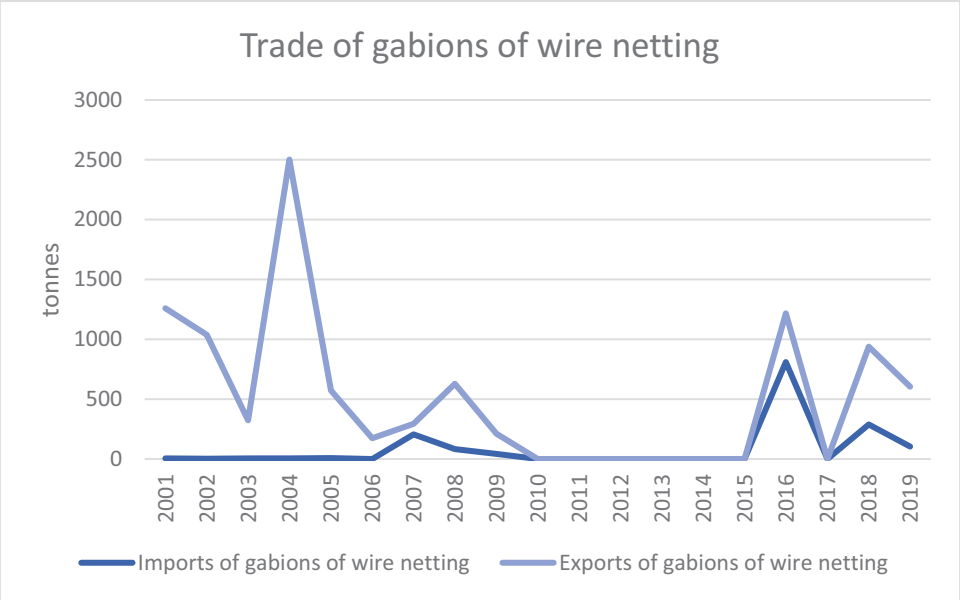


Figure 23: Imports and Exports of Gabions of Wire Netting
Source: Trade Map

The current import tariff rate of gabions of netwire stands at 11.25%. However, South Africa has different tariff rates imposed on exports of gabions of netwire to different countries. The export tariffs for the top 10 countries that South Africa exports to are listed in table 5 below:

Table 5: Tariffs on Imports and Exports of Gabions of Wire Netting
Source: Trade Map

	Export			Import	
MARKET	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**	**Pref. Margin**	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**
Botswana	0%	0%	0%	11,25%	11,25
Eswatini	0%	0%	0%	11,25%	11,25
Kenya	25%	25%	0%	11,25%	11,25
Lesotho	0%	0%	0%	11,25%	11,25
Malawi	25%	11.25%	13.75%	11,25%	11,25
Mozambique	20%	0%	20%	11,25%	11,25
Namibia	0%	0%	0%	11,25%	11,25
Senegal	15%	15%	0%	11,25%	11,25
Tanzania, United Republic of	25%	0%	25%	11,25%	11,25
Uganda	25%	25%	0%	11,25%	11,25

Epoxide resins are used in the construction of DEWATS systems in a variety of ways. The global epoxy resin market was valued at US$5.9 billion in 2019 and projected to reach US$10.3b in 2027, at a compound annual growth rate of 7%. There are some established manufacturers in South Africa (Poxytech, AMT Composites, Masterbond, RCB Epoxy…), some of whom are multinationals. There is no specific industry association or data. The South African imports of Epoxide Resins are summarized in the Figure below.

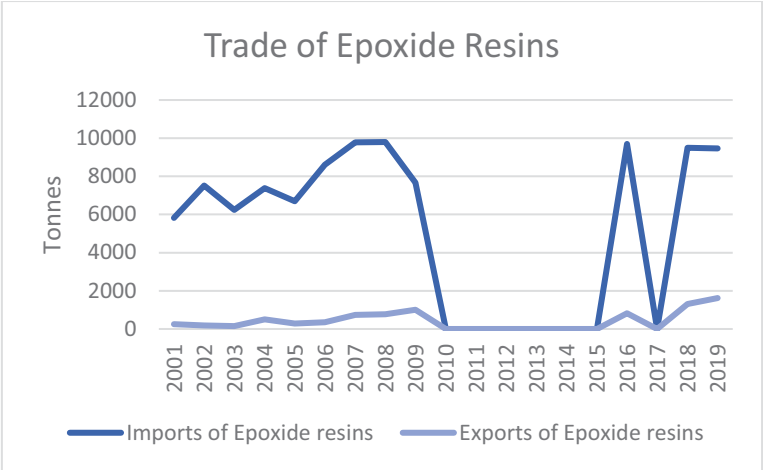


Figure 24: Imports and Exports of Epoxide Resins
Source: Trade Map

The current import tariff rate of epoxide resins stands at 0%. However, South Africa has different tariff rates imposed on epoxide resins to different countries. The export tariffs for the top 10 countries that South Africa exports to are listed in Table 6 below:

Table 6: Imports and Export Tariffs on Epoxide Resins
Source: Trade Map

	Export			Import	
MARKET	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**	**Pref. Margin**	**MFN (Most Favoured Nation) Tariff**	**Effectively applied tariffs**
Australia	5%	5%	0%	0%	0%
Botswana	0%	0%	0%	0%	0%
Congo, Democratic Republic of	5%	5%	0%	0%	0%
Madagascar	5%	5%	0%	0%	0%
Malawi	0%	0%	0%	0%	0%
Mozambique	2.50%	0%	2.50%	0%	0%
Namibia	0%	0%	0%	0%	0%
Nigeria	5%	5%	0%	0%	0%
Zambia	0%	0%	0%	0%	0%
Zimbabwe	5%	0%	5%	0%	0%

7. Value Chain Analysis for Membranes

Membranes are used in the separation, concentration and purification of a vast number of materials across a wide spectrum of industries. Their use in water (including wastewater) treatment is extensive. Studies have shown that their use in secondary effluent polishing has a viable return on investment in addressing gaps in the supply and demand of water (Bick et al., 2012).

There is a great deal of research, development and innovation taking place in the membrane sector. South Africa innovated the first water and sanitation membranes in the world during the 1990s and has continued to innovate. Lack of capital and business development (combined with what people interviewed for this study reported as intellectual theft) resulted in these not being taken up, or being produced in other countries. During the 1990s there were only about 5 membrane manufacturers globally. There are now hundreds (including some in South Africa).

The gap in the water filtration membranes market lies in small scale, developing world applications. One South African innovation has been a woven fabric microfiltration membrane that filters pathogens from wastewater. It has been piloted in South Africa (providing clean water to schools and households) as well as Vietnam (filtering water from contaminated rivers). This innovation (funded by WRC, developed at universities and being commercialised by VulAmanz) is scheduled to start production in 2021.

The global membrane filtration market was valued at US$13.42 billion in 2019 and was projected to reach US$25.13 billion by 2027. This represents a Compound Annual Growth Rate of 8.36% (Verified Market Research 2020). Drivers for the membrane market include population growth; rising need for wastewater reuse; and environmental standards governing industrial effluence.

The major markets for membranes by geographical region are summarised in the figure below.

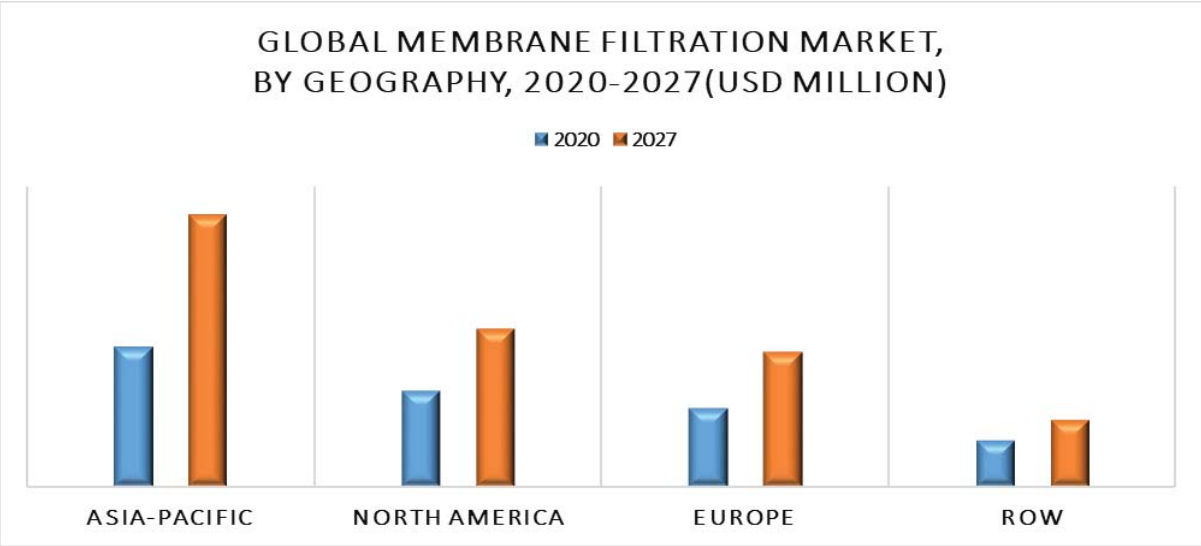


Figure 25: Projected Growth in Membrane Filtration Markets 2020-2027
Source: Verified Market Research 2020.

There is no membrane manufacturers association in South Africa. Most companies that retail membranes in South Africa (including Africa Membranes, MEMCON, Process Plant Technology, Huber) all serve as local agents who supply imported membranes.

Derbigum are the only waterproofing membranes manufacturer in South Africa, with one factory and several retail outlets employing a total of 50 staff. They held 80% of market share 20 years ago, dropping to 20% in 2020. The primary cause has been cheaper, but poor quality imports (from Europe and Asia). Limestone is the key ingredient in the quality of waterproofing membranes. Derbigum use 70% limestone, imported products use substantially less. This impacts on product lifespan and replacement costs. In public tenders, quality is poorly specified and there are no SABS standards in place for waterproofing membranes. (Derbigum use Agrement certification, imported products are not locally certificated).

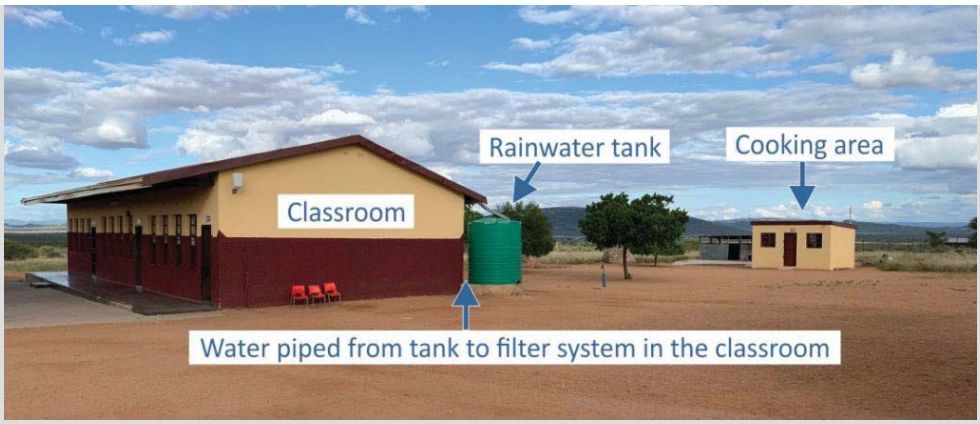
The VulAmanzi membrane is a woven polyester microfiltration fabric that filters pathogens from water. VulAmanzi work with a local specialist textiles manufacturer but import the nylons that are used. The technology has the potential to address many of the health concerns related to water and sanitation in South Africa, but Treasury under the MFMA does not allow local authorities to purchase such alternative "point of use" technologies in private households. Local authorities therefore do not include point of use systems in tender specifications. Interview respondents also suggested that there may be intrinsic conflicts of interest in water and sanitation design specifications. Engineers charge as a percentage of the total value of the technology system constructed, and are therefore disincentivised from designing low-tech and cheaper solutions.

VulAmanz Water Filters

The VulAmanz Microfilter ("VM"), is a novel water treatment technology aimed at decentralized water treatment for drinking water provision and the treatment of wastewaters for recycling and reuse. It is a niche 'fabric microfiltration' technology developed in South Africa between University Researchers and the Specialist Fabrics Industry. The development was aimed specifically at the realities of developing economies and brings the advantages of membrane technology to developing economies. It offers significant advantages over conventional (physio-chemical) water/wastewater treatment, and over current commercial membrane technologies.

The core of the technology is a very robust woven polyester microfiltration fabric. The VM requires no water treatment chemicals, is gravity-driven, extremely robust, easy to operate and maintain, and is potentially inexpensive and economically attractive. Cleaning of the fouled membrane is achieved by simply brushing the membrane, or allowing it to dry out, and no exotic chemicals are required.

Two products have been developed. One (the Raw Water Filter) is for rural, peri-urban and informal households where no (or poor) formal water supply services exist. In some areas the raw water is manually collected from rivers or dams. The Pressurised Water Filter can be connected to continuous water supplies (untreated water supplied from a reticulated water system; pumped from a river into a tank; or sourced from rainwater collection tanks).


Rainwater tank
Cooking area
Classroom
Water piped from tank to filter system in the classroom

8. Summary of Value Chain Analysis Findings

Key issues arising from the value chain analysis are summarised in the table below. In essence:

- South Africa has abundant, high quality mineral resources for the manufacture of NGS pedestals, DEWATS systems and membranes.
- South Africa also has the research, development and innovation capabilities to use these in addressing local, regional and global challenges.
- Growing domestic markets could assist in springboarding SA NGS to regional and global markets but this requires work at the level of strategy, capacity-building, regulatory review and other areas.

	Component	***Strengths***	***Weaknesses***
1	Pedestals	• South Africa has abundant, high quality raw materials used in both ceramic and plastic pedestals • SA NGS pedestal manufacturing innovations have potential markets in Africa, Asia and South America. • Strong arguments for post-pandemic stimulus package to prioritise NGS in water scarce areas • SA would be price- and quality-competitive in other markets with design intensification. • Many innovations are still between TRL 4-7, there may be market potential for these not yet explored	• Standards were not in place, are still being revised and cascaded, SABS does not yet have labs in place • Slow and costly process from product development through testing and certification • High capitalisation costs • Obstacles in municipal markets due to poor understanding, SCM bid specification, politicians promising “gold standard” of high-flush, municipal capex and opex budgets
2	Conveyancing	• SA produces all the components used in water	• Unregulated imports are causing attrition in the sector

	Component	*Strengths*	*Weaknesses*
		and sanitation conveyancing • Investing in upgrading or expanding water and sanitation infrastructure could assist in sustaining upstream employment	• High energy costs and unreliability of energy supply
3	DEWATS	• SA holds leading regional DEWATS expertise • SA produces all the raw materials used in DEWATS • Prioritising DEWATS as sanitation solutions in South Africa could help sustain upstream industries, in addition to providing safe, cost-effective and circularised sanitation that takes pressure off municipalities	• Lack of national strategy • Poor municipal capabilities • Transition from centralised to decentralised systems not being coordinated or supported
4	Membranes	• South Africa well positioned to take advantage of gap for small scale, developing world applications	• Regulations, procurement systems and lack of awareness of alternative NGS technologies

9. The NGS Sanitation Industrial Eco-System

Annexure B to the WRC/TIPS/DTIC Memorandum of Understanding clarified that the Value Chain Analysis would seek to identify the obstacles to the growth and industrial development of the NGS sector (see extract below). Interviews suggested that these challenges lie primarily in the eco-system.

This work seeks to understand [the] sanitation value chain and find ways of how to position next-generation sanitation as a sustainable solution to the myriad of challenges bedeviling the sector. The research will follow a value chain approach in order to map and understand each stage and component of the sanitation sector. This is aligned to SASTEP's aim to supporting the commercialisation, localisation, manufacturing and scaling up of sanitation technologies in the country.

The analysis will combine economic analysis using statistics as well as transactional data from the public and private sector, and engagement with key informants through interviews and workshops. It will rely on value chain analysis as the basic conceptual framework so as to leverage upstream and downstream advantages and access national and international markets. Once opportunities have been identified, the research will focus on identifying avenues to relieve constraints on growth, particularly around infrastructure, skills, industrial finance and regulatory alignment, not only a vision and subsidy schemes.

[The existing] simple value chain for the NGS sector…will be refined through the research process. Extensive gap analysis will be used to reveal the current gaps in the sanitation system. Industrial development opportunities in the sanitation sector may arise at different stages, from the manufacturing of parts and components, to the testing of systems to the installation and maintenance of sanitation systems.

Interviews conducted for this study universally agreed that unlocking domestic demand would assist in springboarding NGS into regional and global markets; and that the constraints lie in the eco-systems explored below.

SWA partners have articulated a framework to lay out key elements for sector strengthening into five building blocks: policy and strategy; institutional arrangements; sector financing; planning, monitoring and review; and capacity development (SWA 2016).

9.1 Sanitation systems

The Water and Sanitation sectors are complex, transversal and multi-faceted:

Usually, when talking about 'sanitation' one speaks not of sanitation, but rather of a single technology, or an instrument, that is designed to handle excreta and wastewater. Septic tanks, pit latrines, and composting toilets, among others, are often referred to as sanitation systems. In fact,

these are technological components. They may, when linked to a range of other components, designed appropriately and possibly after up-grading form a robust, sustainable sanitation system…

The planning and design of a sustainable sanitation system requires a holistic view and a bottom-up approach. The re-use of waste for urban agriculture or energy production may lead to additional incentives but add to additional managerial and institutional complexity. (SUSANA Working Group 6 Thematic Paper).

"Sustainable sanitation systems require strong partnerships between different institutions and stakeholders as no single stakeholder will be able to cover the entire chain" (ibid).

The sanitation industrial value chain is likely to require more dialogue and coordination across a wider range of role-players than is common in industrial strategy processes.

9.2 Scientific and technological innovation

Scientific and technical innovation in the alternative and next generation sanitation industry has provided South Africa with its current advantage. In 2018, South Africa ranked 13th in the world in terms of sanitation publications, and had strong collaborations with other countries (Zhou, 2018). The publications network analysis under-represents the global stature and relationships South Africa has. Interviews also pointed to global donor funding SA has attracted, and could potentially further attract, as a result.

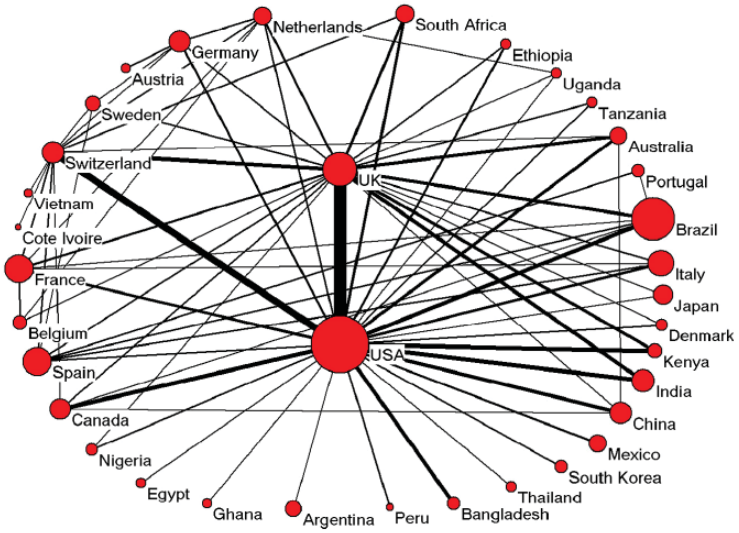


Figure 26: Publications and Collaborations in Sanitation Research
Source: Zhou, 2018

The Water Research Commission has thematised the scientific and technical capabilities in South Africa around the 7 key themes identified in the Research, Development and Innovation (RDI) roadmap. University maturity levels and capabilities have been thematised around these.

South Africa's eminence in the science of NGS is providing the platform for local innovation in the manufacturing industry. Sustaining, coalescing and further developing this platform is key as NGS technologies move to market readiness. They will also be central to cascading sanitation science at municipal level to support further roll out.

9.3 The Regulatory Regime

At least two sets of issues in the regulatory regime provide significant constraints on growing domestic markets.

First, building professionals legally cannot sign off on NGS infrastructure unless it meets quality standards. There are two regulatory agencies operating in the standards space, and their work is cascaded via a range of other agencies. Agrement develops specifications for innovations where there are no national standards in place, then hands over to SABS once there are. Agrement and SABS have a working relationship, although this is based on the Agrement Act rather than any formal agreement.

In the absence of SABS standards, local NGS manufacturers have applied for certification from Agrement. The Agrement business model recoups costs from clients. Manufacturers report that this has been a further investment cost that constrains them.

Agrement has played a valuable role in quality specification. Tax rebates for Agrement certification of innovations may be a helpful industrial policy instrument to incentivise innovation.

SABS began adopting standards for NGS in 2016. They currently have three standards in place (one currently undergoing revision). Further work on revising these standards and providing training is underway. SABS do not yet have laboratories in place to do the testing. They have also not yet cascaded the standards down through building codes (which cannot happen under Agrement specifications).

Consensus between SABS and Agrement as to the relationships between NGS standards and on how standards are cascaded down to Building Compliance Officers is central to infrastructure approval processes at municipal level. SACAP, CIDB and CBE are possible partners in resolving this.

Second, procurement processes at municipal level do not adequately specify sanitation components in human settlement or sanitation infrastructure bid specifications. Doing so – including taking life-cycle, guarantees of sanitation equipment and a multi-criterion analysis into consideration – is almost certainly unlikely to happen at municipal level.

Centralisation of sanitation infrastructure components in municipal tenders should be considered, under the Office for the Chief Procurement Officer. Alternatively, WRC should consider developing sanitation bid specification guidelines and examples, and share these.

9.4 The Local Government Sector

Social pressures to extend sanitation provision and the dysfunctionality of a great deal of centralised sanitation provision are putting the municipal sanitation systems under great pressure. The SPIH report reported four sets of issues:

- Environmental (poverty levels, vandalism, illiteracy, culture of non-payment for services)
- Capacity (limited staff capacity, limited technical skills, poor budgeting for operations and maintenance, high debts to water boards)
- Infrastructural (aging sewer networks, funding for bulk infrastructure, providing services on private land, poor contractor management, poor project scoping)
- Water related (limited and unreliable water supply, high water losses)

  (SPIH, 2018: 9).

Interviews suggested also that the political environment is compounding these challenges – politicians promise flush toilets as the gold standard when resources are not available to provide these.

Unlocking domestic NGS market potential will not happen without addressing municipal dysfunctionalities. The upside is that NGS has the potential to address many of the challenges. WRC and DTIC should engage the Department of Human Settlements, Water and Sanitation on a considered, multi-pronged and inclusive NGS industrial strategy.

9.5 The Community Sector

Interview respondents widely reported that citizen understanding and buy-in to NGS is the primary obstacle to uptake. Incentivising community interest NGS through enterprise development and job creation is one way of addressing this challenge.

This is not without challenges. Recognizing the limits of a singular focus on market-based approaches is not admitting defeat but highlighting areas that require different types of intervention…. Without serious consideration of the institutional setting, the new wave of projects aimed to develop products and services around the sanitation value chain will underestimate the transactional costs of working in informal settlements and overestimate the profit to be made at the bottom of the pyramid…. (O'Keefe et al., 2016).

NGS has demonstrated the potential for enterprise development and job creation at local level in the installation, maintenance and operation of sanitation services. Potential revenue sources (with associated enterprise development possibilities) are illustrated in the figure below.

Figure 27: Enterprise Development Possibilities across the NGS Value Chain
Source: OECD, 2019

The Water Research Commission funded a series of 7 studies in developing a "Water Franchising" model. The studies provided a business case for creating local level "franchisee" micro-enterprises (trained, supported and quality-controlled by small business "franchisors"). The model has been piloted in different forms across the Eastern Cape and elsewhere, and has demonstrated viability.

A similar Sanitation Franchising model may assist in unlocking the enterprise development and job creation possibilities illustrated in the figure above.

9.6 The Post-School Education and Training Sector

Universities play three main roles in the NGS sector:

- They have developed the research informing NGS innovation, and continue to drive this.
- They provide the science, engineering, technology and other skills required for innovation and implementation.
- They have become sites for piloting and user education.

Discussions with various universities and TVET colleges have suggested that NGS does not require specific new skill sets at this stage. For example:

- The current training of artisans such as plumbers adequately equips them to install and maintain NGS pedestals.
- The current training of engineers adequately trains them to design DEWATS systems. There is an adequate supply of civil engineers currently, but there appear to be regional and preference mismatches; or some engineering graduates struggle to find relevant work experience. Thus many engineers "disappear" between graduation and professional registration.

However, an awareness programme may help build citizen awareness of NGS as well as illustrate the principles of a circular economy. DHET is currently discussing the possibility of running such programmes in TVETs and universities.

The education and training sector itself is a major sanitation market. Universities have almost a million students enrolled and TVET colleges have a further 700 000. A further 90 000 students attend various private institutions. On average, people urinate 6-7 times daily with one faecal flush.

Retro-fitting TVET and HEIs in water stressed areas with low-flush urine diversion pedestals would have a meaningful impact in reducing water consumption. Linking these to on-site DEWATS systems would provide "living laboratories" for SET education. Running student awareness programmes would help achieve citizen awareness. Science and Technology Innovation parks could incubate enterprises linked to NGS. Focusing infrastructure development and maintenance grants on NGS could incentivise

9.7 Funding and Financing of Sanitation

A key issue in unlocking the growth and development of sanitation markets in South Africa, regionally and globally is the funding and financing of sanitation strategies. Sanitation has traditionally relied on public financing (with concessional finance playing an important role in developing countries). Because the public sector does not have the resources to address sanitation gaps in line with SDG 6, a series of global initiatives has been developing and promoting "blended financing" models.

Blended finance is the strategic use of development finance to mobilise additional finance towards sustainable development in developing countries. Development finance can include concessional finance or non-concessional finance coming from public or private sources, such as philanthropic actors. Additional finance focuses on commercial finance, which refers to finance invested at commercial rates from private sources or public investors such as sovereign state funds. Blended finance approaches can be categorised according to mechanisms and instruments" (OECD, 2019: 2).

At this stage, blended financing models are still evolving; and the scale of blended financing is small. Typical mechanisms and instruments are summarised in the figure below.

Figure 28: Blended Finance Mechanisms and Instruments
Source: OECD (2019: 3)

Issues raised in interviews for this study suggested:

- Weak municipal institutions, poor financial management, political instabilities and a culture of non-payment on the part of communities are obstacles to attracting private sector investments.
- Sanitation in South Africa and the region requires
- The funding of sanitation components is insufficiently delicate, and probably requires considered financial modelling in its own right.
- The viability of user-payback models (currently under development for energy) should be explored also for sanitation.
- Development Finance Institutions should be approached to work with the NGS sector in taking projects through project preparation processes.
- Existing state sanitation infrastructure budgets should be concentrated preferentially in water-stressed areas, where these have comparable sanitation needs.

9.8 Partnerships for End-To-End Support

A key issue emerging from the value chain analysis is the need for end-to-end support for NGS innovation. An emerging initiative under MERSETA represents a viable partnership through which NGS industrial development could take place.

The manufacturing industry – in a partnership between Merseta, three universities and the manufacturing industry associations – is in the process of exploring a re-industrialisation agenda. Their view is that reindustrialisation requires industrial diversification. They are establishing a process to support industrial diversification from product development through patenting and certification through to market access. They are interested in partnering with the NGS sector as a workstream in the process.

The NGS sector should approach Merseta to partner with them in providing end-to-end support for industrial development, as part of the existing project.

10. Key Findings, Policy Implications and Relevance to National Water and Sanitation Industrial Masterplan

10.1 Synthesis of Key Findings

Industrial policy typically focuses on the creation or expansion of activities within the manufacturing sector (broadly conceived, it can also target resource shifts in favour of any "modern sector" activity).

Key issues in this report and proposed (industrial and other) policy instruments to address these are summarised in the table below. Industrial policy instruments are within the DTIC mandate, "other" interventions have been explored in line with the WRC objectives of unlocking eco-system obstacles.

Key Concern	***Industrial Policy Instruments to address these***	***Other Interventions Explored in This Study***
Expensive, bureaucratic and slow processes along the manufacturing pipeline		Tap into existing end-to-end support for industrial diversification from R&D through patenting, certification, small business support and market access
Slightly cheaper imports that do not meet local quality standards are displacing local sanitation ware (including NGS)	Import tariffs to make local pricing more competitive outside of SADC	Policy directive from COGTA that human settlement tenders must fully specify sanitation components Centralisation of sanitation bid specification under OCPO to include requirements for • Local certification • Product life cycles and • Minimum guarantees
Domestic sales volumes too small to sustain growth, capacity underutilisation	Public procurement via post-pandemic construction infrastructure budget allocations to include NGS (budgeting and specification, local procurement designation)	HEI, TVET and schooling involvement in user awareness
Product development at high end	Development finance for high-end market penetration Market exposure via international trade fairs	Design intensification and brand development Rollout in public buildings (malls, stadiums, conference centres, community halls, schools…)

Key Concern	*Industrial Policy Instruments to address these*	*Other Interventions Explored in This Study*
Sustaining and leveraging SA Research, Development and Innovation	Special Economic Zones	Science and Technology Park Innovation Hub Business Incubator (SASEBI) SETA funding for research chairs, student bursaries, skills development interventions, CPD courses
Difficulties in accessing middle and high end markets		Design intensification Brand development

10.2 Elaboration of Key Findings

More fully expressed, central issues arising from the report are:

a. NGS technologies are disruptors in the sanitation market. There are good arguments for the state to incentivise the NGS market segment because of intrinsic efficiencies and externalities; because NGS is a major growth market; and to grow and leverage SA's capabilities as an NGS world leader.

b. Sanitation markets are highly segmented. The potential of NGS in providing cost-effective, safe, basic and improved sanitation to those who need it was established by TIPS (2018) and reaffirmed by subsequent work. However, NGS also has potential in other market segments that has not received adequate attention.

c. NGS technologies are developing rapidly. The science behind some is well-established, others require further research. Some technologies are market-ready, others are not. The basic technologies are open source. South Africa's advantage lies in how our world-class scientific, technical and manufacturing capabilities are being applied to developing world challenges in product differentiation. The SA NGS manufacturing sector is therefore focused on this (safe, "improved" sanitation) market segment. Design intensification, brand development and market exposure may be needed to support middle- and high-end market penetration.

d. SA has substantial, high-quality reserves of most of the raw materials used in traditional manufacturing of both NGS toilet pedestals and decentralised waste water treatment systems (DEWATS). SA also produces raw materials used in new additive manufacturing processes. Local beneficiation of these raw materials has upstream impacts on sustaining and growing small scale mining and the chemicals sector.

e. Traditional manufacturing of toilet pedestals and conveyancing as well as DEWATS components is small-scale but well-developed in SA. Additive manufacturing (using 3D

printing and nanotechnologies) is currently on a much smaller scale. Manufacturing for both market segments require end-to-end support (from design and development, through patenting and testing, remodification, certification, production, marketing and distribution through to monitoring). Potential partnerships exist to take this forward. The business case for growing domestic additive manufacturing capabilities merits further attention.

f. SA is price- and quality-competitive with US and EU suppliers, and is only slightly less price-competitive (but more quality-competitive) than Asian producers.

g. Growing domestic markets can provide a springboard for expansion into regional, continental and global markets. Unlocking domestic markets requires an eco-systems approach encompassing the design of sanitation systems; the funding and financing of NGS; resolving regulatory constraints; aligning system components and building institutional capabilities; achieving civic awareness and incentivising buy-in; and growing the scientific and technical capabilities to further enable manufacturing, implementation and monitoring of NGS technologies. There may also be possibilities for growing regional value chains (for pedestal manufacturing in particular).

h. Strategically deploying existing state budgets in highly (then moderately) water stressed areas can strengthen the business case for NGS, through savings on water; nutrient harvesting; local enterprise development and job creation; and saving other water-dependent jobs downstream. Financial models, instruments and incentives are required for this, and to encourage retro-fitting of existing buildings for middle- and high-end markets.

i. Achieving public understanding and buy-in has been a key obstacle in NGS uptake to date. Installing NGS technologies in educational institutions (schools, TVET and universities) can address this through building citizen understanding; and serving as "living laboratories" for SET education.

j. Scientific and technical capabilities are key not only in research, development and innovation. They are also central to rolling out NGS safely. NGS does not require new skills sets (although they do reflect the increasing trans-disciplinarity common across most sectoral skills sets).

k. Sanitation is a transversal, multi-faceted and "wicked" challenge. So is NGS industrial development. Project partners will need to engage in a more multi-party dialogue than is common in industrial strategy, to coordinate a coherent and effective policy intervention.

l. South Africa has highly differentiated domestic sanitation markets. Unlocking domestic markets can provide a springboard into differentiated global markets. A range of policy instruments should be used achieve this.

m. SA scientific and technical capabilities in NGS have provided the platform for innovation and competitive advantage. They will also be central to growing domestic and regional NGS markets. Sustaining, coalescing, growing and cascading these capabilities should be a policy priority. A range of existing policy instruments and resources should be leveraged:

    - Longer-range research partnerships rather than only project-based research funding, conceptualised within a field/eco-systems development strategy.
    - SETA funding of research chairs and student bursaries, with a transdisciplinary focus.
    - Innovation hubs, Science and Technology Innovation Parks and business incubators, using not only DTIC tax incentives but also private sector partnerships and BBBEE scorecard funding for skills development, enterprise development and supplier development.
    - Entrepreneurial approaches to capacity-building (through short courses located within continuous professional development strategies).
    - Leveraging SA advantages in growing the sanitation industry is one focus. Transitioning to additive manufacturing should be another.

n. Aligning the eco-systems for NGS can provide the enabling conditions to unlock domestic demand. This involves:

    - DTIC and Treasury reviewing the financial models and incentives for different system components;
    - Review of built environment regulatory frameworks (SABS/SANS/Agrement standards);
    - Centralisation of bid specification for sanitation under the Office for the Chief Procurement Officer and training of SCM officials under Treasury Chief Directorate for Capacity Building/National School of Government;
    - DHSWAS and COGTA taking NGS into consideration in planning and implementation, and working with municipalities;
    - DBSA including NGS in their infrastructure development grants;
    - DHET and DBE including NGS in infrastructure development grants, and encouraging institutions to lead student awareness programs across the curriculum.

o. Possible partnerships have been identified and should be established to

    - Coordinate local government capacity building and network development;
    - Support the NGS manufacturing sector from product development through testing and certification to brand development and market access;
    - Contribute to construction industry development and transformation;
    - Build awareness and skills in the built environment professions;
    - Facilitate enterprise development and job creation at local level.

10.3 Relevance to National Water and Sanitation Industrial Masterplan

A small expert group workshop discussed a possible vision for the NGS sector and possible strategy objectives, as an input into the National Water and Sanitation Industrial Masterplan dialogue. A proposed vision was:

The National Water and Sanitation Industrial Masterplan will grow and leverage existing scientific and technical advantages in relation to NGS in South Africa to develop a competitive, high-growth and transformed sanitation manufacturing industry as well as to contribute positively to upstream and downstream industries, in support of a circularized and environmentally sustainable sanitation value chain.

The specific objectives were:

- *to coalesce, grow, transform and leverage South Africa's NGS scientific and technical capabilities in support of sustained competitive advantage;*
- *to grow NGS sanitation manufacturing output at compound annual growth rate of 10% to 2030;*
- *to increase beneficiation of raw materials used in NGS through localization.*

Enabling conditions proposed are:

These objectives will be enabled through a transversal coordination of eco-system elements, including regulatory reforms; providing financial instruments and incentives; aligning municipal systems; and building citizen awareness and buy-in to NGS through educational and other public institutions.

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Appendix 1: Participants in NGS value chain analysis dialogues

A "snowball" approach to networking and dialogues is reflected in the formal interviews and dialogues with participants in the value chain analysis. All participants below availed themselves for interviews and/or group dialogues. Most also provided information or documentation via emails.

A much more extended list of people also shared primary research, published papers/theses and comments.

	Organisation	Name of Person	Focus of discussion
1	Trade and Industrial Policy Strategies	Gaylor Montmasson-Clair	Mandate, research conducted to date, line of analysis
2	Water Research Commission	Akin Asinete, Charmaine Twala, Vivian Reddy	Confirming line of analysis, accessing contacts and further research
3	International Toilet Board Coalition	Cheryl Hicks and team	TBC work and networks, further support and information
4	South African Council for Civil Engineers	Dr Allysson Lawless	SAICE specialists in NGS, SAICE capacity building
5	South African Institute of Civil Engineering/SAICE/PRG	Neil Macleod	Clarification of NGS R and D, history of sector, key contacts
6	Pollution Research Group, UKZN	Professor Chris Buckley	Scope and scale of NGS research, state of development, clarify scope of NGS VCA, suggested contacts for further interviews
7	eThekwini Municipality	Teddy Gounden	eThekwini history in relation to NGS, current state, future directions, wider municipal involvement, obstacles and possibilities
8	Envirosan	Jacques Rust	Market analysis and Value chain analysis of NNGS pedestal Manufacturing
9	Borda Africa	Lloyd Govender	Market analysis and Value chain analysis of DEWATS systems
10	Stellenbosch University	Lingam Pillay	Membrane technologies developed at SUN
11	Bill and Melinda Gates Foundation (BMGF), head of commercialization	Maggie Clout	Work BMFG is doing commercialise, clarity on RTI model, research on employment impacts
12	Ekurhuleni Municipality	Lindelwa Ximiya	Ekurhuleni awareness of and plans for addressing sanitation
13	Construction Industry Development Board	Dr Ntebo Ngozwana	Construction industry plans, data, budgets, capabilities, transformation strategies
14	Council for the Built Environment	Dr Sitsaba Dlamini	Built Environment planning for post-pandemic stimulus in relation to construction

	Organisation	Name of Person	Focus of discussion
15	Metals and Engineering Sector Education and Training Authority	Sebolelo Nomvete	MERSETA partnerships for industrial diversification
16	Energy and Water Sector Education and Training Authority	Candice Moodley	Skills development and research funding
17	Department of Higher Education and Training (DHET)	Dr Diane Parker (DDG HEI) Plus team of 10 senior DHET senior management responsible for infrastructure development and maintenance grants	DHET infrastructure development and grants, water and sanitation challenges and priorities, possibilities for HEI and TVET partnerships on NGS
18	Plumbing Industry Regulatory Board	Daryl Long	Costs and processes for pedestal installation, skills and qualifications for NGS
19	Coega Development Trust	Meike Wetsch	Role of regional development agencies in human settlement and other infrastructure, financial models
20	Development Bank of South Africa	Johan Lubbe Alwyn Coetzee Elliot Monama	Development financing for NGS, Project Preparation processes
21	Council for Scientific and Industrial Research (CSIR)	Kevin Cilliers Wynand van der Merwe	CSIR sanitation standards, water efficiency technologies
22	TVET Colleges	Pauline Seemise	Sanitation infrastructure in TVETs, plans and capabilities
23	Green Cape	Jane Reddick	Market Intelligence reports on water, Green Cape work on sanitation
24	Amanzabantu	Oliver Ives	Water franchising model
25	Worldlife Fund for Nature (WWF) South Africa	Tatyana Bornman	WWF-SA on water, relationships to sanitation
26	Agrement Board	Lerato Mogala	SABS and Agrement Standards
27	Savvyloo	Theo Pistorius	Pedestal manufacturing, linking NGS to 4iR

Appendix 2: Experts approached for review

For each content area, at least one local (and sometimes one international) expert was approached to review a few paragraphs or pages in which they have experience. The list of people approached is listed below.

In addition, a small core expert group reviewed the entire document, but focused on the strategic line of sight.

	TOPIC	*LOCAL REVIEWER*	*INTERNATIONAL REVIEWER*
1	The sanitation value chain	Shakespear Mudombi	Funamizu
2	NGS technologies	Chris Buckley (PRG)	Brian Stoner (Director, Center for WaSH-AID, Duke Uni, USA)
3	Pedestals	Jacques Rust (Envirosan) Theo Pistorius (Savvyloo)	Harald Gründl (EOOS)
4	DEWATS	Lloyd Govender (BORDA)	Pedro Kraemer (BORDA: Director Regional – Las Américas)
5	Membranes	Lingam Pillay (SUN) Laurie Barwell (VulAmanz)	Visu Visvanathan (AIT)
6	Sanitation markets	Jane Reddick (Greencape) SUSANA Working Group	Cheryl Hicks (PRG) Maggie Clout (BMGF)
7	Costing comparisons of NGS vs traditional sanitation	Tim Hutton	Jeremy Guest (University Illinois at Urbana-Champaign)
8	Health economics arguments for sanitation investments	Tim Hutton	Huang van Minh
9	Water economics arguments for sanitation investments	GreenCape (Jane Reddick)	Liz Tilley (ETH)
10	Faecal sludge reuse economics	Barbara Brouckaert (PRG)	Adrian Mallory (Cranfield) Linda Strande (Eawag)
11	Soil economics		Gorlach (UK) Dr Akissa Bahari Tunisia
12	Employment impact of NGS investments	Conrad Barbeton (Cornerstone)	
13	SA scientific and technical capabilities	Michelle Carstens (SUN)	
14	Regulatory challenges relating to NGS	Lerato Mogalo (SABS/Agrement) Tina Velkushanova (PRG)	Sun Kim (BMGF)
15	Local government challenges and opportunities	Teddy Gounden (eThekwini) Lindelwa Ximiya (Ekurhuleni) William Moroka (Salga)	Kathy Eales (CounterPoint) Marlene van der Merwe-Botha (WaterGroup)
16	Engaging communities around NGS	Cathy Sutherland (UKZN) Kathy Eales (CounterPoint)	Alison Parker (Cranfield)
17	Educational infrastructure around NGS	Di Parker (DHET) Steve Mommon (DHET TVET)	
18	Funding and financing of NGS	Meike Wetch (Coega) Treasury? Greencape Kim Walsh (Palmer Development Group)	World Bank/Unicef WaterAid /Oxfam
19	Partnerships to take forward NGS	Sebolelo Nomvete (MERSETA)	

	TOPIC	*LOCAL REVIEWER*	*INTERNATIONAL REVIEWER*
		Haroon Bhorat (DPRU)	
20	Designing sanitation businesses	Elize Hattingh Oliver Ive	SUSANA Working Group 2 TBC BMGF Commercialisation Desk
21	Legal framework for sanitation	Kate Tissington (SERI)	

Appendix 3: Sample questionnaire

Date of Interview	Respondent	Organisation and Role

Notes to cover in introduction:

- Industrial masterplan, not WASH
- Components of masterplan:
  - Vision/objectives
  - Pillars
  - Foundations
- Process of study
  - Value chain elaboration/interrogation
  - Growing Domestic Markets
  - Value chain localisation/transformation
  - Skills development, enterprise development, capacity building
  - Defining the vision, objectives, enabling policy/strategies required, monitoring
- Therefore the role we propose for you:
  - Value chain analysis?
  - Formulating vision and objectives/enabling policy environment/unlocking obstacles?
  - Reference group?
- Feel free to take discussion in direction you believe is most helpful…

	Focus of analysis	***Responses***
1	***NGS technologies*** How many NGS technologies do you have at different stages of development? What are they? Which ones are ready to go to market, when? What help you do need in terms of product development? Who else in SA has NGS technologies existing or under development? Who else in the world has or is developing comparable technologies?	
2	***IP***	

	Who owns the patents? What stages of patenting? What changes are required to standards (e.g. SANS) What help do you need further on these?	
3	**Value chain map process flows – if you have these, please share?** Please describe the process for manufacture, installation, maintenance of each of these? Please describe target market infrastructure/ selection criteria	
4	**Inputs – if you have these mapped/ quantified please share** What finance is needed, for what, when? Including life-cycle. What organisational capabilities and municipal infrastructure are needed, when? What skills are needed, by whom, when?	
5	***Outputs – if you have any of these mapped/ quantified please share?*** What are the outputs in terms of • Water savings • Energy savings • Biomass value • Health and safety • Carbon trading • etc.	
6	***Business case – if this is developed at all, please share?*** How far along the lines of the DBSA project development guidelines are you (project definition, project preparation…bankability)?	

	What help do you need?	
7	***Obstacles and opportunities*** What lessons have you learned from the pilot? What regulatory or institutional challenges need to be addressed to build domestic/regional/ global market access?	
8	***Priority interventions*** What are the 3-5 most important things that can be done to begin rolling out NGS technologies in SA, regionally and globally?	
9	***Who else do you recommend we speak to, and why?***	