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In-depth Assessment of Water Efficiency Opportunities in South Africa

JANUARY 2021

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ACKNOWLEDGMENTS

Thanks go to Theo Covary, Unlimited Energy Resources, and Herman Strauss, for additional review and consultation on the state of the South African water and electricity market and policy landscape

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Note

Water efficiency standards represent a major, untapped global opportunity to mitigate CO_2 emissions, address water scarcity, and promote resource efficiency policies, therefore playing a major role in advancing sustainable development. CLASP, supported by philanthropic funds, conducted a global scoping study exploring how water efficiency standards can mitigate the impacts of climate change in several economies around the world.

Our objective was to evaluate the opportunity to reduce CO_2 emissions from water efficiency standards for faucets and showerheads and prioritize countries for engagement. In particular, efficient showerheads and faucets both save water and reduce CO_2 emissions by reducing demand for hot water. A comprehensive scoping approach involved consideration of the following factors:

- **Impact Assessment** to investigate of the presence of "concurring factors" which would influence the potential impact of implementing water efficiency standards. These factors include hot water consumption, pressure on water resources (water scarcity and water crises), and projected urban population increase.
- **Policy Environment Assessment** on the viability of successfully implementing said water standards, based on policy prerequisites.
- **Geographic Diversity:** The scoping study maintained a global approach, therefore ensuring a global coverage of one country in each region.

The global study identified India, Brazil and South Africa as countries with the highest impact opportunities.

- **India** is a country where both water resources are under pressure and the policy environment is receptive to the introduction of water efficiency standards.
- **Brazil** is another priority country where recent and severe droughts have led to strict water rationing and water management and security are a top priority for policy makers.
- **South Africa** is the only African country among the top-20 carbon-emitting countries, and policymakers are beginning to examine the existing water policy framework from an efficiency and conservation standpoint.

CLASP, with the support of local partners, led in-depth assessments of each country above, analyzing the existing policy and institutional environment along with barriers and opportunities to introduce water efficiency policies. The global scoping study and each individual report are located on our website at clasp.ngo.

Introduction and Methodology

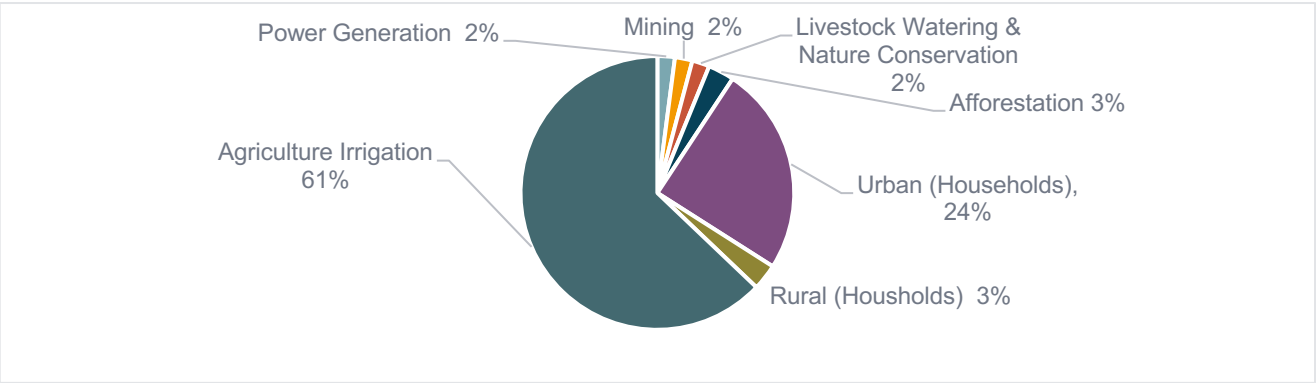
Water efficient faucets and showerheads could reduce South African water use by over 1 trillion liters per year, reducing energy consumption by 18 TWh per year and CO_2 emissions by 16 Mt per year.

1.1 INTRODUCTION

South Africa is projected to experience a significant population increase in the next decade, forecast to grow from 59 million to 66 million by 2030[1]. Decelerating economic growth[2], which will undoubtedly be compounded by the COVID-19 pandemic, raises concerns regarding resource availability. Water, in particular, is growing increasingly scarce as a result of rapid population growth and urbanization. Water efficiency policies can help mitigate this impending crisis, reducing water use, electricity consumption, and associated greenhouse gas emissions.

In South Africa, water is a guaranteed constitutional right[3]. In 2018, of an estimated 16.7 million households, 91.2% and 89% had access to electricity[4] and water respectively. Half (46.3%) had access to piped water inside the dwelling (7.7 million), 28.5% accessed piped water on site (4.7 million); and 14.2% relied on communal or neighbors' taps (2.3 million)[5,6]. However, household water uses constitute just over a quarter of total use, the agricultural sector constitutes another 61%. The graph below provides a breakdown of water use by sector in 2018[7].

FIGURE 1 WATER USE BY SECTOR IN SOUTH AFRICA



Source: Department of Water and Sanitation

Unfortunately, South Africa's water situation has always been precarious, aptly summarized by a 2009 study on water security undertaken by the Development Bank of South Africa[8]: "South Africa is recognized as a water-scarce country in

[1] UN World Population Prospectus 2019
[2] Estimates of the economy shrinking by as much as 10% in 2020.
[3] All poor households enjoy access to free basic municipal services in the form of 6 kL of water, 50 kWh, of electricity and R50 (~$4) off sewage and sanitation (per month) charges. This is based on a 4 person household using 50 litres / person / day
[4] World Bank (2018), Access to electricity (% of population)
[5] Remainder accessed non-piped water from rainwater tanks; boreholes; water carriers/tanks, directly from rivers, streams, springs and stagnant water pools.
[6] https://www.gcis.gov.za/sites/default/files/docs/resourcecentre/pocketguide/2012/23-Water%20and%20Sanitation-2018-19%28print%29%20.pdf
[7] Afforestation, livestock, mining, energy generation and industrial use collectively use the remaining 12%. How We use our water resources in South Africa (NWSMP Vol 2, 2018, p3-14)
[8] DBSA (2009) https://www.dbsa.org/EN/About-Us/Publications/Documents/DPD%20No12.%20Water%20security%20in%20South%20Africa.pdf

terms of a commonly used definition, namely that of the average "total actual renewable water resources," (TARWR) per person per year. Using this definition, South Africa is the 29th driest country out of 193 countries, with an estimated 1,110 cubic metres (m3) of water per person in 2005. Most of the "drier" countries are either small islands or oil states in the Middle-East."

As South Africa's population continues to rise, as will water usage in all sectors. The National Water and Sanitation Master Plan (2018) estimates that by 2030, 17% more water will be required than the quantity available today. At the same time, a primary reliance on coal for electricity[9] places South Africa as the world's 14th largest emitter of greenhouse gases[10]. The Master Plan thus aims to prioritize access to water and sanitation while ensuring sustainability through water efficiency and conservation[11].

This report investigates the opportunity for introducing water efficiency policies for faucets and showerheads in South Africa to reduce water consumption and, by reducing hot water, CO_2 emissions. Water efficient faucets and showerheads meeting the latest international standards could reduce water use by over 1 trillion liters per year, reducing energy consumption by 18 TWh per year and CO_2 emissions by 16 Mt per year.

1.2 METHODOLOGY

This report is a summary of research activities carried out by Solid Green Consulting over a two-month period in South Africa (April - May 2020). We approached the research in two phases to link existing academic research with practice-oriented findings from industry experts and to cross-validate data.

In phase one, we examined the South African local context through secondary data collection for policy, regulation, water services, and socio-economic context through a literature and desktop review to understand efficiency standards of water fixtures and fittings in South Africa. We also identified experts to gain more in-depth understanding of the research findings.

In phase two, we carried out semi-structured interviews with industry professionals, one product manufacturer, and two sustainability consultants. Other manufacturers refused to participate. We used questionnaires for quantitative data collection to enrich the findings and seek more inputs from retailers, distributors, and manufacturers. The questionnaires served to obtain information regarding the current stock of faucets, showerheads, and water heating technologies, along with sales figures and future sales forecasts. We also conducted semi-structured virtual interviews with industry experts to fill in the gaps from the desktop research in phase one. A list with contact information is available in Appendix A.

Research Limitations

- **Access to information:** There has been little water efficiency research done in South Africa recently, so our desktop research consisted mostly of reports published before 2010. Also, many manufacturers were reluctant to share sales figures as they deemed this information as confidential. Information on fittings, fixtures, and relative efficiencies available to the public via website searches is also limited. The assumptions for usage calculations reference regulations SANS 1400-P and SANS 10252-1 which date to the 1980's and thus are out of date.
- **Impact of COVID-19:** The South African government placed the entire country in a mandatory lockdown to stunt the spread of COVID-19. This directly affected access to information for the report as we were unable to visit industry representatives or other relevant stakeholders. Furthermore, government officials were temporarily assigned to COVID-19 related duties.
- **Impacts of Cape Town crisis:** In 2018, after three years of poor rainfall, the city came within 90 days of running out of water (day zero). Strict restrictions were introduced – banning all forms of outdoor water use (gardens, fountains

[9] Electricity is supplied by ESKOM's vertically integrated monopoly which was established in 1923 and relies primarily on coal
[10] https://www.carbonbrief.org/the-carbon-brief-profile-south-africa
[11] Department of Water and Sanitation, National Water and Sanitation Master Plan, 2018.

etc) and limiting consumption to 50 liters per person per day, for all daily activities. Residents paid high tariffs, while households using high volumes of water faced big fines. Water quality and shortages are not limited to this crisis and are now common throughout the country. Constant warnings about water scarcity are having a major effect on all South Africans. Data of how these recent events have impacted actual consumption and usage (if at all) was not found by the researchers.

Stakeholder and Policy Mapping

Several key stakeholders and policies govern water administration throughout South Africa and must be considered in the development of water efficiency policies for faucets and showerheads.

2.1 STAKEHOLDER MAPPING

Overarching Water Stakeholder Framework

The public water and sanitation sector in South Africa is organized in three different tiers:

- **The national government,** represented by the Department of Water and Sanitation (DWS12), is responsible for the overall national and regional framework under the 1998 National Water Act and the 1997 National Service Act. DWS can propose bylaws as a guidance for the Water Services Authorities (WSAs). More information on bylaws and WSAs is provided **Error! Reference source not found.Error! Reference source not found.**. The Ministry's objective is to ensure that water is protected, used, developed, conserved, managed, and controlled in a sustainable and equitable manner. DWS is responsible for the National Water Resource Strategy (NWRS), last revised in 2013 to address water supply and efficiency, implemented through the National Water & Sanitation Master Plan (NWSMP) which is updated every five years.
- **Water Boards**, which provide primarily bulk water, but also some retail (distribution) services and operate some wastewater treatment plants, in addition to playing a role in water resources management;
- **Municipalities**, also referred to as WSAs, which provide most retail services and also own some of the bulk supply infrastructure.

The professional association Water Institute of South Africa (WISA), the Water Research Commission (WRC), and civil society also are important stakeholders in the sector.

Water efficiency government stakeholders in South Africa

- **The Department of Water and Sanitation (DWS**) has a mandate to ensure the sustainable management of water resources in South Africa. Through legislation, water supply installations and associated plumbing components are required to comply with minimum standards. However, no enforcement structures have been implemented to ensure compliance.
- **The Department of Labour** is the custodian of pressure equipment regulations (known as PER) which ensure pressure safety of vessels. Water heaters (geysers) fall within the technical scope of PER, which relies on compliance with plumbing standards to ensure the safety of water heaters.

[12] The Ministry was called Department Water Affairs and Forestry (DWAF) up to 2009. Its name changed to Department of Water Affairs until 2014, when it became the Department of Water and Sanitation (DWS).

- **The Department of Trade, Industry and Competition (DTIC)** is the ministry responsible for the National Building Regulations and Building Standards Act. DTIC can set mandatory standards for buildings and therefore play a leading role in introducing water efficiency policies[13]. Key water efficiency agencies report to DTIC.
- **Municipalities** have a key implementation role to determine and implement building regulations through by-laws. WSAs are situated in any district, metropolitan or local municipality that is responsible for providing water services to end users[14]. WSAs are responsible for formulating and enforcing bylaws. In the South African context, bylaws are laws that regulate a specific area of jurisdiction, including water efficiency in buildings (more information on bylaws is provided in the policy section**Error! Reference source not found.**).

Standardization bodies

- **South African Bureau of Standards (SABS)** is the national standardization body under the Department of Trade and Industry[15]. SABS was established under the Standards Act[16], and it is mandated, among others, to develop, promote and maintain South African National Standards (SANS) [17]. SABS, through the Technical Committee (TC) and supported by the NWSMP has been tasked to develop the Water Efficiency Labelling and Standards (WELS) Scheme.

Testing, certification and conformity assessment bodies

- **South African National Accreditation System (SANAS)**, a DTIC agency, is the national entity responsible for the accreditation of conformity assessment bodies.
- The main SANAS-accredited certification bodies that can certify products to SANS standards are:
    - **SABS Commercial (SOC):** A subsidiary of SABS that offers testing and certification services and issues the SANS mark of approval (more information below).
    - **AENOR**: An international certification body based in Spain that offers certification services in South Africa
    - **South African Product Certification Services (SAPCS)**: Provides certification against SANS standards as well as international and private standards.
    - **South African Watermark**: A non-profit scheme that publishes a register of products that complies with SANS standards. This scheme relies on verified test results or certification.
    - **South African Technical Auditing Service (SATAS)**: Provides certification against SANS standards as well as international and private standards.
- **The National Regulator for Compulsory Specifications (NRCS):** A DTIC agency, NRCS emerged as an independent organization from the original regulatory division of SABS. NRCS is mandated to advise DTIC on compulsory specifications, and is responsible for their development. Compulsory specifications "are technical regulations that require conformity of a product or service to health, safety or environmental protection requirements of a standard, or specific provisions of a standard"[18]. The standard made compulsory must be a SANS standard[19]. NRCS administers the National Building Regulations and Building Standards Act, which is implemented by local authorities.

Industry Organizations

[13] Crouse, A. (2013). A study on water use efficiency in building regulations and compulsory requirements for specific plumbing and piping products. Trade and Industry Chamber. Fund for research into industrial development, growth and equity (FRIDGE). T37/09/12. 2 December 2013.

[14] Kopano Ya Metsi, National Business Initiative (2019). Strengthening South Africa's Water Services Authorities. Available at https://www.nbi.org.za/wp-content/uploads/2019/05/NBI_KYM-Report-2_Strengthening-WSAs.pdf

[15] Application guidelines and not enforceable unless promulgated.

[16] Act No. 24 of 1945 and continues to operate in terms of the latest edition of the Standards Act, 2008 (Act No. 8 of 2008).

[17] https://www.sabs.co.za/About-SABS/index.asp

[18] https://www.nrcs.org.za/content.asp?subID=4140

[19] SANS may adopt an IES or ISO standard making it an equivalent

- **Institute of Plumbing South Africa (IOPSA)** was created in 1989 and represents the South African plumbing industry. IOPSA is involved in regular consultations and coordination with the plumbing industry, governmental and regulatory bodies and it is recognized and represented on most national and several international plumbing and legislative bodies. Stakeholder interviews indicated that IOPSA members would be supportive of improved water efficiencies standards. IOPSA is represented on the working groups for both water efficiency-relevant standards as well as the ongoing development of the International Standards Organization (ISO) Water Efficiency Labelling Scheme guidelines (addressed below). Finally, IOPSA is a member of the World Plumbing Council representing plumbing industry associations, industry and unions.
- **Plumbing Industry Registration Board (PIRB)** is a registered professional body for plumbers. PIRB is registered under the South African Qualifications Authority (SAQA) Act of 1995. Plumbers registered with the PIRB can obtain professional status. While plumbers self-certify that their work meets all requirements, the PIRB performs audits to promote compliance. These audits include verifications to ensure that compliant products are used.

Energy supply organization

- The South African electricity system was built on the country's vast coal reserves, estimated in 2005 to be the 6th largest in the world. **Eskom**, the state owned vertically integrated utility founded in 1923, dominates electricity generation (>95%), transmission (100%), and distribution (60%). It has an installed capacity of approximately 44 GW, which is almost exclusively from coal (91%). Eskom's emission factor is 0.98 $MtCO_2$/TWh.
- A combination of factors, including delays in the building of new power stations, lack of maintenance, loss of skills and corruption resulted in the country entering an electricity supply crisis in 2005 which persists in 2020. During this period electricity tariffs have increased by over 300% in real terms. The country experiences regular rolling blackouts which have devastated economic growth, further entrenching the high rates of unemployment and inequality.
- **Municipalities** are Eskom's biggest customer and distribute 40% of the electricity to 60% of the customers[20]. The remaining 60% of electricity is supplied to end users directly by Eskom.

2.2 POLICY MAPPING

Water policy framework relevant to water efficiency

- The **2013 National Water Resource Strategy (NWRS)**[21] states that South Africa is a water-stressed country, facing water challenges, such as security of supply and the inefficient use of water.[22] The strategy aims to ensure that water is sustainably, efficiently and effectively managed through water conservation and demand management. The 2013 NWRS priorities includes the significant reduction in water use by all sectors, and a 50% reduction in water loss by 2017.
- **The 2019 National Water and Sanitation Master Plan (NWSMP**)[23] aims to reduce the average domestic consumption from 237 liters per person per day in 2019 to 175 liters by 2025. The NWSPM proposes to achieve this target by:
    - Including water use efficiency and water loss reduction targets within municipal implementation plans.
    - Establishing a Water Efficiency Labelling and Standards (WELS) Scheme under the responsibility of SABS and DWS.

[20] http://www.cityenergy.org.za/uploads/resource_455.pdf

[21] The DWS intention is to update and publish a revised Strategy document every 10 years

[22] For more information https://cer.org.za/news/national-water-resource-strategy

[23] https://www.gov.za/sites/default/files/gcis_document/201911/national-water-and-sanitation-master-plandf.pdf

Water efficiency standards

All plumbing components in South Africa (including water fixtures) must comply with SANS testing standards. Relevant standards for the scope of this study include:

1. **Part X of SANS 10400** (originally SANS 0400-1978) - Code of Practice for Buildings[24,25]
    a. Part XA informs energy efficiency and states that hot water supply must be regulated, where no more than 50% of the annual volumetric requirement of domestic hot water may be supplied by means of electrical resistance heating. The rest could be heated by any means of water heating. [26]
    b. Part XB will cover water efficiency but it is still under approval. To be approved, Part XB must be integrated into the National Building Regulations (NBRs) under the Department of Trade and Industry[27]. The expected timeline is 2020-2021.[28] Part XB will be based on SANS 3088[29], which provides maximum flow rates for different types of fixtures and fittings (Table 1).
2. **SANS 10252-1 plus various product standards**[30]. SANS 10252-1 is the mandated standard to which all plumbing installations must comply. Additional product standards contain requirements relating to performance including efficiencies and flow rates. The Water Services Act requires all plumbing components to comply with their national standards.

The installation standards (10252-1 and 10400-XA and 10400-XB) are not aligned with each other nor with individual product standards.

Water bylaws and water efficiency labeling

As noted in the stakeholder mapping, DWS can define water by-laws as a guidance for municipalities, which are responsible for water management. The current DWS model bylaw includes “labelling of termination fittings” in clause 47. This states that “all terminal water fittings and appliances using or discharging water shall be marked, or have included within the packaging of the item, the following information: (a) the range of pressure in kpa over which the water fitting or appliance is designed to operate; (b) the flow rates, in liters per minute.” Additionally, the 2018 Amendment to the 2013 Cape Town Water Bylaw limits showerhead flow rates to 7 liters per minute (L/min), and bathroom faucet flow rates to 6 L/min[31]. However, only certain municipalities adopted this bylaw, therefore national-level enforcement is limited.

While municipalities may publish bylaws to fulfill their constitutional functions and implement national legislation, bylaws may not detract or contradict national legislation. Therefore, it will be important to ensure that all parts are aligned around water efficiency: the national legislation, plumbing standards, and local bylaws, before local authorities can enforcement water efficiency requirements.

[24] http://cgrarchitectural.co.za/wp-content/uploads/2018/04/The-complete-SANS10400-and-NBR-Guide.pdf
[25] https://www.sans10400.co.za/
[26] https://www.buildinganddecor.co.za/ammended-national-building-regulations-for-energy-use/
[27] Crouse, A.
[28] https://www.saisc.co.za/rainwater-harvesting/
[29] SANS 3088, “Water efficiency in buildings”, 2019.
[30] This includes ~140 standards covering plumbing components and products under the scope of this report.
[31] http://resource.capetown.gov.za/documentcentre/Documents/Bylaws%20and%20policies/Unofficial_Consolidated_Water_By-law_2010_2018.pdf

SANS-related labeling programs and schemes

FIGURE 2 EXAMPLE OF ONE SABS CERTIFICATION MARK

- **SABS Mark of Approval**: This is a commercial certification or endorsement label which indicates that the product complies with national standards. However, it does not imply that products which do not have the SABS mark of approval do not comply with SANS standards and requirements. Other private sector organizations exist which provide similar certification marks.

- **Joint Acceptance Scheme for Water Services Installation Components (JASWIC)** was formed in 1980 and its committee is composed of WSAs, SABS, the South African Water Research Commission (WRC) and the Institute of Plumbing of South Africa (IOPSA). JASWIC's objective is to help municipalities assess product compliance to the relevant SANS. SABS or another SANAS-accredited body tests products, and JASWIC adds the compliant products to a publicly accessible list, which can be used as a source of information by water practitioners. The JASWIC list includes a product description; the name of the manufacturer; the related SANS specifications; and compliance with SABS mark[32] .

- **South African Watermark** (SAW) is an industry labeling scheme with industry participation introduced in 2019. SAW provides a register of plumbing components that complies with the relevant national SANS standard for that product. Products are listed along with a 3-star rating indicating the extent of verification conducted (design verification, production verification and blind testing). Due to the high verification cost, certified products with fewer stars do not necessarily imply a lower quality. Listing on the SA Watermark is voluntary.

- **International Water Efficiency Labelling System:** Starting in 2019, South Africa has been participating in the International Organization for Standardization (ISO) Project Committee (PC) 316, which is developing a global standard for labeling water efficiency of fixtures. The SABS Technical Committee responsible for plumbing components (TC0138/SC2) represents South Africa on PC 316.

- The 2013 NWRS, included the creation of a South African **Water Efficiency Labeling Scheme (WELS)**, scheduled between 2018 and 2020. The NWSMP identifies SABS as the agency responsible to support DWS in developing such a labeling system for South Africa. However, no action plan has been developed to implement such scheme. Despite the similar name, this effort is separate from the International WELS discussed above, but does depend on it. When the ISO standard is completed (expected by end of 2020), the government[33] will consider implementing it in South Africa. No formal decisions on implementation have been made to this point. WELS could be introduced under SANS 10400-XB or under a different standard. Currently, some support from the private sector exists to introduce it under its own standard as a voluntary process which can later be called up in legislation (or SANS 10400) to make it a legal requirement.

Energy Efficiency Standards and Labeling Programs

The Department of Mineral Resources and Energy (DMRE) is the authority responsible for energy efficiency for the mandatory standards and labeling (S&L) program for specific large residential appliances, as envisaged under the National Energy Efficiency Strategy of 2005. Related to water, the program regulates washing machines, dishwashers, and water heaters. Details on standards are available in Annex 1 and www.savingenergy.org.za. Through our stakeholder interviews, we learned that DMRE does not have a mandate or interest in extending the program to faucets and showerheads.

[32] JASWIC official website https://www.jaswic.co.za/IndexPage.
[33] Currently difficult to say what agency might be responsible for this, it might be DWS or DTIC.

Water heating in South Africa

According to a 2013 study[34], the residential sector is responsible for 17% of electricity use in South Africa and 35% during peak periods. Electric water heaters, called geysers in South Africa, account for up to 7% of total consumption and contribute substantially to peak demand. Large houses may have as many as three water heaters. In addition, 3.2% of households use gas water heaters and 0.5% use solar water heaters.[35] Lower income and indigent households heat water using electric kettles, electric stoves, or coal or wood fires.[36]

Almost all water heaters in South Africa are locally manufactured. More detailed information on water heating technologies in available in Annex 3.

Standards covering water heaters include:

- SANS 10254, which addresses the installation of fixed electric storage water heating systems,
- SANS 151, which deals with performance and safety requirements, and
- VC 9006 (national regulation), which came into effect in 2016 and revised the existing maximum allowable standing losses from 2.54 kWh to 1.45 kWh/24 hours. This Minimum Energy Performance Standard will ultimately result in 3 820 000 MWh of electricity savings on an annual basis. DMRE is currently investigating additional measures to shift consumers solar water heaters and heat pumps.

Building codes and initiatives

- **Green Star Certification:** The Green Building Council of South Africa (GBCSA) is the custodian of the Green Star Africa rating system for green buildings[37], which takes into account water and CO_2 emissions.

- **Excellence in Design for Greater Efficiencies (EDGE)** is a global green building certification system and platform introduced by the International Finance Corporation (IFC). In South Africa, residential buildings are managed by GBCSA. To obtain EDGE certification buildings must demonstrate a 20% improvement over the EDGE baseline. The EDGE baseline was customized at the local level through the support of country-based institutions that provided market studies and data collection. For energy and water parameters, typical building practices as well as national/local building performance codes were used. EDGE encourages the use of low flow fittings, mostly for large residential developments.

Table 1, below, shows the water flow requirements in the building certification schemes listed above, as well as SANS 1040 Part XB, currently under development.

TABLE 1 EDGE, GREEN STAR, AND ANTICIPATED SANS 10400 FLOW RATES FOR RESIDENTIAL BATHROOM AND KITCHEN FAUCETS AND SHOWERHEADS

WATER FIXTURE	AVERAGE ON THE MARKET (THIS STUDY) (L/min)	EDGE BASELINE (L/min)	EDGE REQUIREMENT (L/min)	GREEN STAR REQUIREMENT (L/min)	ANTICIPATED SANS 10400 PART XB REQUIREMENT (L/min)

[34] McNeil M.;Covary t., Vermeulen J. (2015) Water Heater Technical Study to Improve MEPS – South Africa. LBNL
[35] Statistics South Africa, "General Household Survey", 2018, p. 39. http://www.statssa.gov.za/publications/P0318/P03182018.pdf
[36] Technical study to improve water heater efficiency in South Africa – Energize Magazine
[37] Green Star tools available: Office v.1.1, Public and Education Buildings v1, Multi-Unit Residential, Retail v1, Existing Building Performance (EBP) v1, Interiors v1, and some custom tools for mixed use developments as well as for hotels and industrial buildings.

Showerheads	14.7	10	8	9	9
Kitchen Taps	9.2	8	6	6	15
Bathroom Taps	10.6	8	6	4	5

- **C40 Cities South Africa Building Program** was launched in Tshwane in 2018. The goal of this program is to make zero carbon buildings standard by 2030 in four major South African cities, namely Johannesburg, Tshwane, eThekwini and Cape Town. As part of this, municipalities are in the process of developing green building bylaws for net zero carbon. The cities have used this development as an opportunity to address water efficiency as well. The bylaws are currently being drafted and planned to become publicly available during 2020.

- **Agrément South Africa**[38] is an independent organization that sets performance requirements for non-standardized building and construction products and systems. Only one residential product is currently certified: 2016/525: Pro Close Slip-Clutch Garden Bib Tap. This certificate covers Pro Close Slip-Clutch Garden Bib Taps for outdoor use for potable water shut off and garden hose pipe connection in all areas of South Africa.

A summary of water efficiency policies is available in Annex 1.

[38] https://www.agrement.co.za/page/agrement-certification

Roadmap to Introducing Water Efficiency Policies

To advance the state of water efficiency standards in South Africa, policymakers must utilize opportunities in legislative and compliance framework.

3.1 BARRIERS AND OPPORTUNITIES TO THE INTRODUCTION OF WATER EFFICIENCY POLICY

The NWSMP includes the development of a water efficiency and labeling scheme. Introducing water efficiency policies represents an opportunity to support efficient use of water while reducing costs for consumers. Lower water use would reduce both water bills and energy bills due to heating. The avoided energy use would also result in reduced CO_2 emissions.

The introduction of water efficiency policies and potential CO_2 emission reduction should take into account the high disparity in income in South Africa which affects piped water access and demand. Water efficiency policies would therefore benefit from an in-depth assessment to understand how to benefit the different population segments. In particular, we found that hot water use varies by building type, density, and income. For example, in Johannesburg, people occupying low-density houses (typically higher income) use 3.6 times more hot water than those living in high-density houses (typically lower income), as seen in Table 2[39]. The same study also notes that hot-water consumption is 70% higher in winter compared to summer. However, this study is over 20 years old and may not represent the fundamental socio-economic changes that have occurred in the country. Instead, a new in-depth study that shows amount and patterns of use in the different areas and income groups would help identify the kind of project likely to be accepted by the communities and more accurately characterize the expected benefits.

TABLE 2 ANNUAL AVERAGE HOT-WATER CONSUMPTION PER PERSON PER DAY (MINIMUM 65 DEGREE CELSIUS).

DWELLING TYPE	LOW DENSITY	MEDIUM DENSITY	HIGH DENSITY
Houses (formal)	91.4 L	59.3 L	25.4 L
Apartment (formal)	88.4 L	56.0 L	21.6 L
Townhouses (formal)	88.6 L	66.8 L	61.5 L
Shacks (informal)	2.7 L (generally heated on stoves or alternative water heating devices)		

The type of plumbing system is also relevant as taps in South Africa could either be mixers or have separate taps for cold and hot water (**Error! Reference source not found.**). We took this characteristic into account when calculating the estimated stock of taps using hot water, which reaches about 7.7 million.

FIGURE 3: EXAMPLE OF A SEPARATE HOT AND COLD WATER TAP IN SOUTH AFRICA

Currently no standards are available for showers or shower heads, leaving these components largely uncontrolled. In order to implement water efficiency products, product standards for showers and shower heads must be introduced.
While legislation is in place to compel all plumbing installations and components to comply with their respective South African national standards, enforcement is limited. Moreover, local authorities introduce and implement by-laws within their area of jurisdiction which may not align and are thus in conflict with national regulation. Effective implementation of a water efficiency program will rely on consistent enforcement

[39] Meyer (2000)

throughout the country. National and local authority legislation will have to be aligned, and a consensus must be found on the method of enforcement and entities responsible.

3.2 EXISTING WATER EFFICIENCY POLICY FRAMEWORKS: OPPORTUNITIES AND CHALLENGES

National Building Regulations

Plumbing is essential for safe living and working environments, but also poses substantial safety and hygiene risks if not maintained correctly with legislation that includes minimum safety standards. Any water efficiency program must ensure that compliance with these standards are maintained. These standards are mandated from at least 3 different government departments (DTIC, DOL & DWS). The requirements of all departments must be addressed in a water efficiency program.

Among water policies, the development of SANS 3088, Water Efficiency in Buildings, and its incorporation in the SANS 10400 Code of Practice of Buildings as part XB represents the most relevant opportunity to limit maximum water flow rates and prioritize efficient use of water despite its low cost.

Once SANS 10400 Part XB is approved, the National Building Regulation (NBR) must be amended by DTIC for the water efficiency standards to become mandatory. Here, it is important to note that SANS 10400 is a "deem to satisfy" standard, which means that if there is compliance with SANS 10400 then it is legally accepted that the relevant regulations have been satisfied.

Various challenges were identified with the development and implementation of SANS 10400 XB

- Limited funding for standards development results in extended development process. To address this issue, SABS recently introduced a time limit of 18 months.
- NBR development, which goes along with the standard implementation, requires training for Building Control Officers (BCOs) to ensure the regulations are applied through building plan approvals and results in implementation delays.
- The misalignment between national legislation and local authority legislation, as well as the fragmented enforcement of such legislation.
- South Africa's various water standards are outdated and focused on providing minimum instead of maximum water flows and pressure requirements.[40] As a result, any product which aims to be water-efficient may contravene the existing SANS standards. To ensure products comply with both the WELS and SANS 10400-XB requirements, at least the following standards will require review:

NATIONAL STANDARD	SCOPE
SANS 226	Metallic water taps (including stop taps) for the supply of water at temperatures not exceeding 75 °C
SANS 821	WC flushing cisterns
SANS 1021	Water taps and stopcocks with plastic bodies for indoor at pressures not exceeding 1 600 kPa and at temperatures not exceeding 75 °C.
SANS 1480	Single control mixer taps
SANS 1733	WC flushing systems (low-flushing capacity) that operate with flushing cisterns

[40] Plumbing Africa, "SA joins WELS ISO 316 discussion group", 1 August 2019. https://plumbingafrica.co.za/index.php/2-uncategorised/755-sa-joins-wels-iso-316-discussion-group

SANS 1808-35	Electronically operated taps and valves
SANS 1808-16	Drinking fountain taps
SANS 1808-9	Metering taps and Valves
SANS 1808-30	Laboratory water taps
SANS 1808 – 37	Single control mixer taps (Plastic)

In addition to SANS 10400, there is a further potential opportunity to assist with the development of the SABS-led WELS Scheme. The International WELS standard under development by ISO PC 316 will provide guidelines for development of a national WELS system. Such a system will have to account for the local environment with respect to product supply, water usage, and desired outcome.

Industry Participation and Market Characterization

Through stakeholder interviews we learned that some representatives of the industry would be favorable to the introduction of water efficiency standards.

- IOPSA indicated that their members are supportive of improved water efficiencies standards, and they are represented on the working groups for both SANS 3088, SANS 10400-XB as well as the ongoing development of the ISO WELS guidelines.
- Lixil is the only local manufacturer and confirmed to be supportive of any national standards related to water efficiency. As a result of COVID-19, they are increasing their online retail presence, including increased transparency around product performance, specifically flow rates.
- High import volumes of fittings and fixtures necessitate the creation of a conformity assessment at the point of entry to ensure compliance with possible future water efficiency standards and labels.

Alignment of SA WELS requirements with that of other countries will prevent technical barriers to trade between countries, as most taps are imported.

3.3 POLICY IMPACTS

Solid Green collected performance data for showerheads (one manufacturer), bathroom taps (predominantly from two manufacturers) and kitchen taps (again, predominantly from two manufacturers). No data were available for public lavatory taps.

As the data came from only a few brands and many of the models tended to be more expensive, during further analysis, CLASP also analyzed a subset of models priced under ZAR 2,000 (USD 123) to make sure that any conclusions based on the data would be applicable to the typical consumer. Table 3 shows the average flow rates from the dataset and the less expensive sample (The pressure was assumed to be 3 bar or higher based on data provided by one manufacturer). As can be seen in the table, the price seemed to have a large impact in the case of bathroom taps, so CLASP used the less expensive sample in later analysis.

TABLE 3. AVERAGE FLOW RATES FOR THE THREE DIFFERENT PRODUCT TYPES ANALYZED, FOR THE FULL DATASET AND SUB-2,000 ZAR SAMPLE.

PRODUCT	AVERAGE FLOW RATE FULL DATASET (L/min)	AVERAGE FLOW RATE SUB-2,000 ZAR SAMPLE (L/min)
Bathroom Tap	7.0	12.0
Kitchen Tap	9.3	9.0
Showerhead	15	14

In addition, Solid Green collected estimates of the stock of fixtures, their lifetime, and usage, as well as some key facts about home plumbing systems, such as the share of water heaters of different types and the typical water temperature coming into the house from the municipal water utility's pipes as well as the preferred warm water temperature, which impacts the ratio of hot water used. CLASP combined these data with assumptions on the efficiency of the various types of water heaters, how much of a fixture's full flow is used, amount of water wasted while waiting for hot water to arrive, and emission factors for electricity and natural gas.

The resulting model estimates the impacts of a mandatory efficiency standard, which leads to the gradual replacement of all fixtures in stock with lower-flow fixtures that do meet the standard. Higher-flow fixtures that do not meet the standard are assumed to be replaced with fixtures that just meet the standard requirements. The lower average flow rates due to standards result in different amounts of water consumption, some of which is heated. This in turn results in electricity or natural gas reductions and CO_2 emissions reductions. The list of assumptions and detailed methodology appear in Appendix B.

To estimate the potential water, energy, and CO_2 reductions from water efficiency in South Africa, CLASP analyzed two requirements that are in wide use in the United States and supported by global manufacturers, which ship compliant fixtures worldwide.[41] These requirement levels are shown in Table 4 together with the Australia/New Zealand WELS[42] top and bottom star labeling levels.

[41] The CLASP recommendations are based on California mandatory standards for kitchen and bathroom taps and US Environemntal Protection Agency WaterSense voluntary standards for showerheads.
[42] Standards Australia Limited and Standards New Zealand, "Water Efficient products—Rating and labelling", AS/NZS 6400:2016. Showerhead standards shown are for high-pressure showerheads, but pressure-compensating aerators can maintain these requirements down to 1 bar.

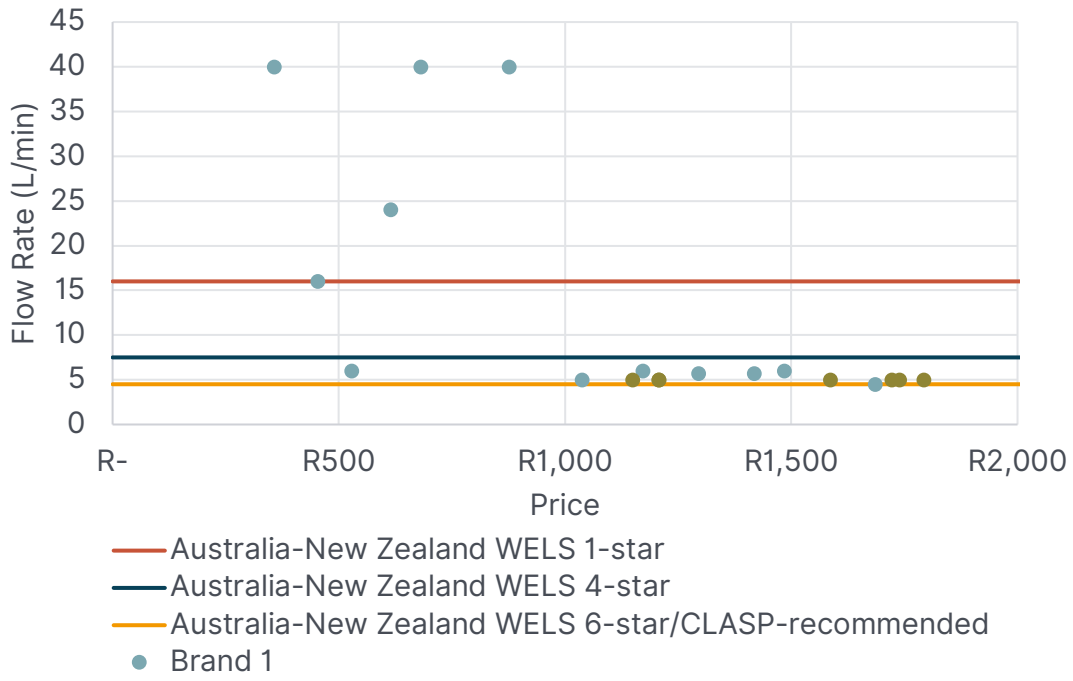


Figure 4 through Figure 5 show the distribution of models collected by Solid Green relative to these levels.

TABLE 4. CLASP-RECOMMENDED STANDARDS REQUIREMENT ANALYZED COMPARED TO AUSTRALIA-NEW ZEALAND LABELING REQUIREMENTS.

PRODUCT	CLASP-RECOMMENDED REQUIREMENT (L/min)	AUS-NZ WELS 1-STAR LABEL (L/min)	AUS-NZ WELS 4-STAR LABEL (L/min)	AUS-NZ WELS 6-STAR LABEL (TAP ONLY) (L/min)
Bathroom Tap	4.5	16.0	7.5	4.5
Kitchen Tap	6.8	16.0	7.5	4.5
Showerhead	7.5	16.0	7.5	N/A

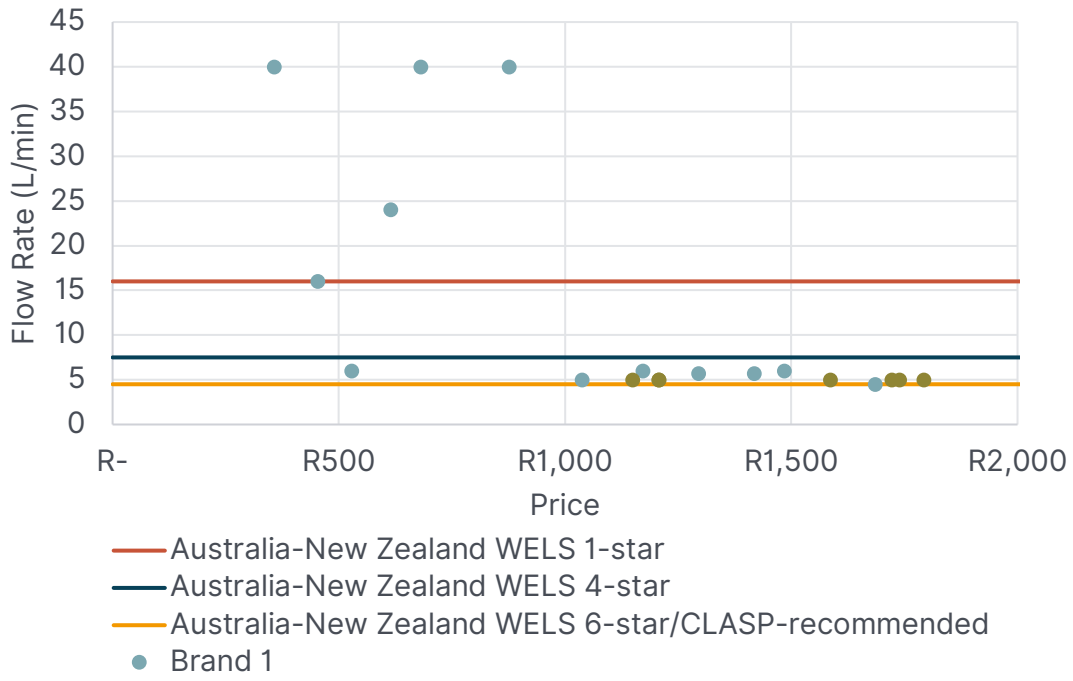


FIGURE 4: FLOW RATES OF SUB-2,000-ZAR BATHROOM TAPS ON THE SOUTH AFRICAN MARKET COMPARED TO DIFFERENT STANDARD LEVELS. DIFFERENT COLORS REPRESENT DIFFERENT BRANDS. WHILE IT DOES NOT APPEAR THAT ANY BATHROOM TAPS ON THE MARKET CAN MEET THE CLASP-RECOMMENDED REQUIREMENT, THAT MAY BE DUE TO ROUNDING OF THE REPORTED FLOW RATE (FROM 4.5 L/MIN TO 5 L/MIN). FURTHER RESEARCH AND DISCUSSIONS WOULD BE REQUIRED TO CONFIRM THE PERFORMANCE.

FIGURE 5: FLOW RATES OF KITCHEN TAPS ON THE SOUTH AFRICAN MARKET COMPARED TO DIFFERENT STANDARD LEVELS. DIFFERENT COLORS REPRESENT DIFFERENT BRANDS. MODELS WITH UNKNOWN PRICES ARE SHOWN AS COSTING ZAR 0.

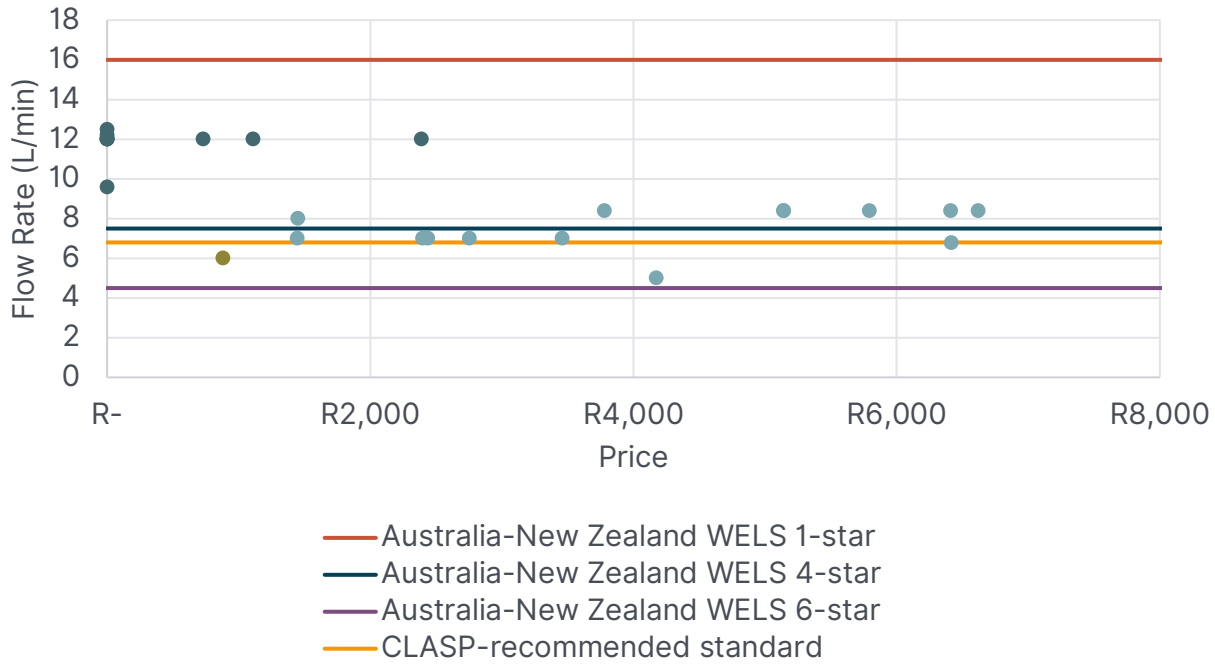
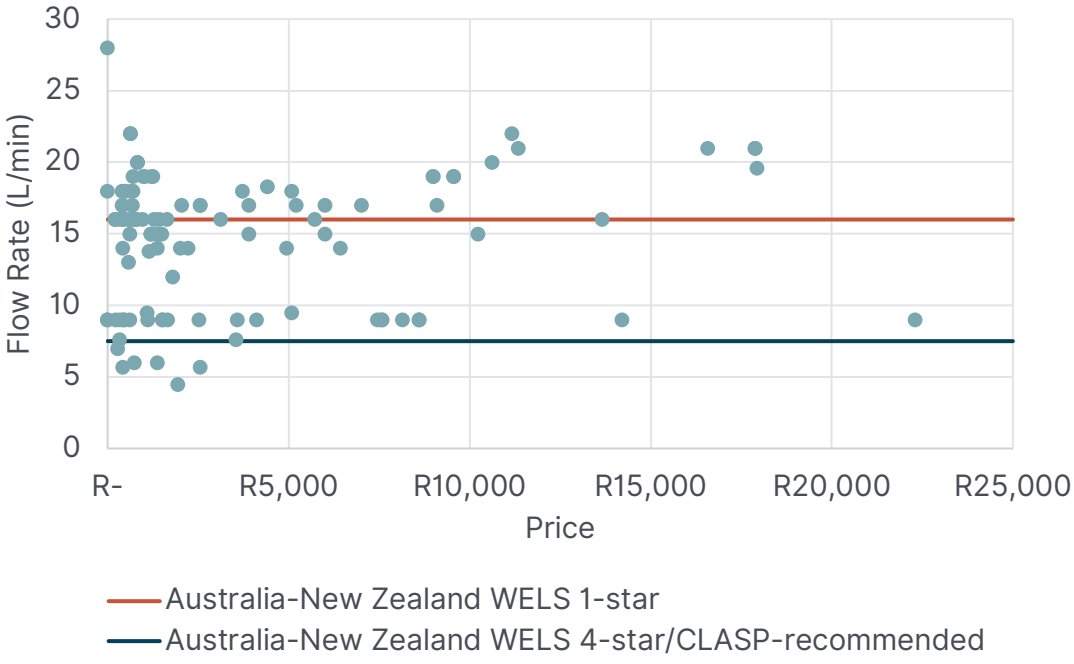


FIGURE 6: FLOW RATES OF SHOWERHEADS ON THE SOUTH AFRICAN MARKET COMPARED TO DIFFERENT STANDARD LEVELS. DIFFERENT COLORS REPRESENT DIFFERENT BRANDS. MODELS WITH UNKNOWN PRICES ARE SHOWN AS COSTING ZAR 0.



Finally, Table 5 shows the impacts of adopting the CLASP-recommended standards in South Africa. All reductions assume that the standard would become mandatory and that 100% of fixtures are replaced with compliant models. The CLASP-recommended levels should be considered a trial requirement, and further research and review through a collaborative stakeholder process would help identify the final requirement level and impacts. Nonetheless, the results in Table 5 show that ambitious water efficiency standards in South Africa would result in significant additional water, energy, and CO_2 reductions.

TABLE 5. IMPACTS OF CLASP-RECOMMENDED STANDARDS FOR TAPS AND SHOWERHEADS IN SOUTH AFRICA.

HEADER TEXT	STANDARD REQUIREMENT	MINIMUM FLOW RATE (L/min)	WATER REDUCTION (trillion L/yr)	ENERGY REDUCTION (TWh/yr)	CO_2 REDUCTION ($MtCO_2$/yr)
CLASP RECOMMENDED STANDARD	Bathroom Tap	5.0	0.10	1.2	1.1
	Kitchen Tap	6.8	0.03	0.5	0.4
	Showerhead	7.5	1.05	15.9	14.4
	Total		**1.18**	**17.6**	**15.9**

3.4 RECOMMENDED NEXT STEPS

CLASP could support the following actions to advance the state of water efficiency standards in South Africa and realize the water, energy, and CO_2 reductions estimated above.

- Participate in the standards committee developing SANS 10400-XB, to speed the process and provide a counterweight to the industry experts that overwhelmingly constitute the committee.
- Participate in the development of the ISO standard and subsequently help determine all the factors that need to be taken into account when a national WELS system is developed. Such factors should include at least:
    - Legislative framework
    - Water usage patterns
    - Realistic water saving targets
    - Supply chain for plumbing components, considering the product requirements in the countries of origin.
    - Potential compliance framework (the SAWatermark scheme could be a good choice as it provides manufacturers with a choice of testing and certification partners and is effective at proving manufacturers' ability to comply with legal requirements).
- Conduct a gap analysis between installation standards (SANS 10252-1, 10400-XA, and 10400-XB), which are not aligned with each other, as well as with the multiple product standards. Focus should shift from maximum water supply (70's concept) to appropriate and sustainable supply.
- Review the compliance framework and make recommendations for a uniform system applicable countrywide.
- Continue supporting DMRE in potential future work to:
    - Include water usage limits in appliance standards included in the Compulsory Specification for Energy Efficiency and Labeling of Electrical And Electronic Apparatus (VC 9008)
    - Advance water heater efficiency: water heater standing loss requirements were revised in 2016 (2.54 to 1.45 kWh/day—Level D to B) and there is no scope to strengthen these levels as it would be strongly resisted by industry and would yield minimal additional savings. The next opportunity for electricity savings would be to develop a strategy to shift consumers from electric resistance (>90% of the market) to solar and heat pump water heaters.

Appendix A: Table of contacts interviewed

STAKEHOLDER GROUP	STAKEHOLDER NAME	OBJECTIVE AND METHOD
Associations	• Institute of Plumbing SA	Email interaction to discuss the involvement with IOPSA on water efficiency; WELS Scheme development; and plumbing overall.
Government policy makers	• SANS3088 and SANS 10400 XB Committee member • City of Tswhane	Phone interviews on SANS3088 and SANS 10400 XB development; water efficiency policy framework development, bylaws importance in the South African context and barriers to their development
Plumbing Consultants and Industry Experts	• Interact Media, publishers and organizer of Plumbdrain trade fair • Demacon Market Studies I PO • GIZ South Africa • Water Group • Herman Strauss • Theo Covary	Email and phone interviews on the WELS Scheme and manufacturing market overview; information on import-export (no research available); data for commercial and residential fixtures stock information; embodied energy in water treatment; in-depth discussion on the water efficiency policy and market context in South Africa.

Appendix B: Supporting data for policy impacts

Summarized policy mapping

All information previously presented on standards, certifications, and labels is summarized in Table .

TABLE 6. WATER AND ENERGY EFFICIENCY POLICIES IN SOUTH AFRICA RELEVANT FOR WATER FIXTURES

	WATER FIXTURES/APPLIANCES							
	Showers	Showerheads	Res. Taps	Comm. Taps	Washing Machine	Gas Water Heater	Electric Geyser	Solar Water Heater
Overarching Policy	2001 National Water Act; National Water Sanitation Strategy 2013; National Water and Sanitation Masterplan							
Test Method	SANS	SANS	SANS 226 & 1480	SANS 226 & 1480	SANS 941 SABS VC 9008	SANS 1808-24 & VC9006 SANS 151	SANS VC9006 SANS 151	SANS 1307 & VC9006 SANS 151

Voluntary Programs	GBCS-led Green Star and EDGE;						
Certification schemes	JASWIC; South Africa Watermark, SABS, AENOR, SATAS, SAPCS,						
Compliance Scheme			Water services Act, Government notice R509 of 2001		Water services Act, Government notice R509 of 2001 National Building Regulations and Building Standards Act 103/1977; VC 9006; SANS 151		
MEPS				SANS 941 SABS VC 9008	SABS VC9006	SABS VC9006	SABS VC9006
Categorical Label				SANS 941 SABS VC 9008	SABS VC9006	SABS VC9006	SABS VC9006

IMPACT ASSESSMENT DATA

- **Model Methodology**

  CLASP's water efficiency impact model estimates the water, energy, and CO_2 emissions reductions due to maximum flow rate standards. It is based on the model developed by the Appliance Standards Awareness Project to estimate the impacts of flow rate standards in the United States. The model first calculates the annual amount of water that flows through an average fixture under business-as-usual conditions and under an efficiency policy. Then taking into account the distribution of water heater types and efficiencies as well as typical cold and hot water temperatures, calculates the energy consumption. Finally, taking into account transmission and distribution losses and national emissions factors, the model calculates the CO_2 emissions reductions.

  As inputs, the model takes the following country data regarding the number and flow rate of water fixtures, the plumbing system that they are connected to, and their usage.

  - Number of fixtures in use (stock) or shipments and lifetimes to estimate stock
  - Usage (minutes/fixture/day)
  - Average flow rate (calculated from the performance of models on the market average and the shift in response to policy assuming non-compliant models are replaced with models just meeting the flow-rate standard)
  - Water heater fuel and combustion efficiency
  - Average temperature of warm water by the user (takes into account mixing of cold and hot water from the heater)
  - Typical piped water temperature (based on average surface temperature for the country)[43]

  These are combined with the following assumptions:

[43] Mitchell, T.D., Carter, T.R., Jones, P.D., Hulme, M., New, M., "A Comprehensive Set of High-Resolution Grids of Monthly Climate for Europe and the Globe: the Observed Record (1901-2000) and 16 Scenarios (2001-2100)", as referenced in Lebanese Economy Forum, "Average yearly temperature (1961-1990, Celsius) - by country", https://web.archive.org/web/20150905135247/http://lebanese-economy-forum.com/wdi-gdf-advanced-data-display/show/EN-CLC-AVRT-C/.

- How much of a fixture's maximum flow is actually used (67% derating factor for taps[44]; 85% for showerheads[45]; increasing to 75% for low-flow taps[46], unchanged for showerheads)
- Water wasted while waiting for hot water to arrive (additional 272 L/showerhead/yr for low-flow showerheads[47])
- Energy required for water heating is calculated by multiplying the volume of water in liters, by the temperature rise, and the specific heat of water ($1.16 \times 10^{-3}\ kWh/kg/°C$), and dividing by the water heater's efficiency
- Emissions factors for electricity generation (0.831 $MtCO_2$/TWh)[48] and liquefied natural gas (0.55 $MtCO_2$/TWh), and electric transmission and distribution losses (9%)[49]

- **Key Model Data**

DATA	VALUE	SOURCE AND METHOD	NOTES
Current stock (million units)[50]			
Bathroom Tap	7.7	Estimated from 2018 General Household Survey – STATS SA SANS 10400:1990 Part P	Used the assumption of number of fittings used in Part P and the number of households with piped water. 1 washbasin per household. We calculated single or mixed taps as 1 tap (hot water).
Kitchen Tap	7.7		
Public Lavatory Tap	0.036	Retail Space: SACSC - Shopping Centre Benchmarks (2018); National Building Regulations SANS 10400 Commercial Space: SAPOA Office Vacancy Report April 2020, p21	Retail Space: 24 million sqm of Retail Space; Population: 1 person/10sqm;2,400,000 people;1 Tap per 100 people Commercial Space: 18 800 000 sqm of Commercial office space; Population: 1 person/15sqm;1,253,333 people;1 Tap per 100 people
Shower head	7.7	Estimated from 2018 General Household Survey – STATS SA SANS 10400:1990 Part P	Used the assumption of number of fittings used in Part P and the number of households with piped water. 1 showerhead per household

[44] California Energy Commission, "Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets", August 2015, California Energy Commission 2015 Appliance Efficiency Rulemaking, Docket Number 15-AAER-1, p. A-3. http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-01/TN203718_20150220T141432_Staff_Analysis_of_Water_Efficiency_Standards_for_Toilets_Urinal.pdf

[45] California Energy Commission, "Staff Analysis of Water Efficiency Standards for Showerheads", February 2015, California Energy Commission 2015 Appliance Efficiency Rulemaking, Docket Number 15-AAER-5, p. A-2. https://efiling.energy.ca.gov/GetDocument.aspx?tn=205654&DocumentContentId=11944

[46] Ethan Guy, Heidi Hauenstein and Sarah Schneider, Tracy Quinn and Ed Osann, "Codes and Standards Enhancement (CASE) Initiative For PY 2013: Title 20 Standards Development: Analysis of Standards Proposal for Residential Faucets and Faucet Accessories", Updated, July 29, 2013, California Energy Commission 2012 Appliance Efficiency Rulemaking, Docket Number 12-AAER-2C, p. 14. https://efiling.energy.ca.gov/GetDocument.aspx?tn=71810&DocumentContentId=8119

[47] Heidi Hauenstein, and Carolyn Richter, "Codes and Standards Enhancement (CASE) Initiative For PY 2015: Title 20 Standards Development: Analysis of Standards Proposal for Showerheads", July 31, 2015, California Energy Commission Docket Number 15-AAER-05, p. 18. https://efiling.energy.ca.gov/GetDocument.aspx?tn=205606&DocumentContentId=11922

[48] International Finance Institutions, "Harmonized Grid Emission factor data set", July 2019, https://unfccc.int/sites/default/files/resource/Harmonized_Grid_Emission_factor_data_set.xlsx.

[49] US Energy Information Administration (EIA), "International", Data for Electricity Consumption and Distribution losses, 2019.

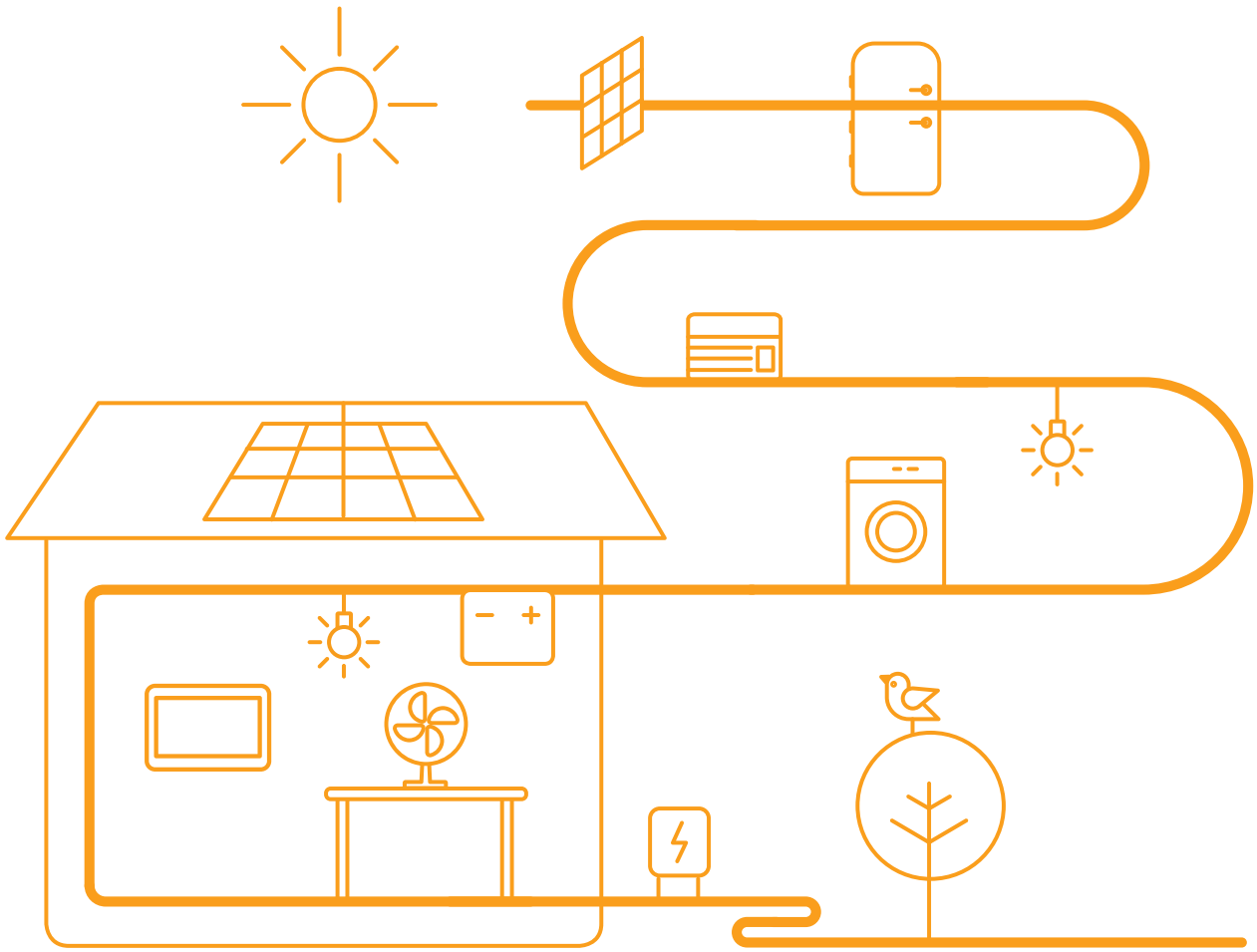
[50] This stock number takes into account fixtures of each type connected to cold water, hot water, or both. However, the usage of hot water below has been adjusted to reflect that not all fixtures are connected to hot water.

Shipments (million units)			
Bathroom Tap	N/A		
Kitchen Tap	N/A		
Public Lavatory Tap	N/A		
Shower heads	0.23	2017 estimate from manufacturer	
Lifetime (years)			
Bathroom Tap	17.5	Manufacturer warranty periods	15-20 years
Kitchen Tap	17.5	Assumed the same as bathroom taps	
Public Lavatory Tap	17.5		
Shower head	17.5		
Flow rates of fixtures in the market (L/min)			
Bathroom Tap	12.3	Manufacturer websites (COBRA, Hansgrohe, Tipolino, ISCA)	
Kitchen Tap	9.3	Average of data from manufacturer websites (Kobra, Frankes, Hansgrohe)	
Public Lavatory Tap	N/A		
Shower head	14.7	Manufacturer website (Hansgrohe)	Secondary sources provide similar ranges and average: 15 L/min average non-efficient Less than 10 L/min average efficient (Eskom http://www.eskom.co.za/sites/idm/Documents/127581ESKD_DSM_Showerhead.pdf) 18 L/min average non-efficient 7.5 L/min average efficient (Oxygenics http://www.oxygenics.co.za/background%20data.htm)
Water heater technologies Stock share %	Electric storage: 57% Solar water heater: 6% Electric heat pump: 3%	Correspondence with efficiency experts STATS SA, "General Household Survey", 2018.	The General Household Survey reports that 4.6 million households have "geyser[s], providing hot running water" while 7.7 million have "piped (tap) water in dwelling". CLASP divided this 60% water heater penetration among piped-water households by technology based on estimates by experts.

	Gas fired tankless water heater: 1%		The resultant penetration of electric storage geysers across all households with and without piped water (34%) appears to be roughly in line with 29% estimated penetration in P.A. Hohne , K.Kusakana, B.P.Numbi (2019) “A review of water heating technologies: An application to the South African context”. The General Household Survey separately reports that 483,000 households had “Solar hot water geysers”, or 6% of the 7.7 million with piped water in the dwelling.
Water heater technologies Market share %	N/A		
Average energy efficiency by type of water heater technology %	Electric storage: 99% Gas: 82% Electric heat pump: 150%	CLASP assumptions	
Typical use (min/fixture)			
Bathroom Tap	7	SANS 10252-1 Water supply in Buildings - Calculations, Domestic Waterwise South Africa website SANS 2012 per capita use values and storage volumes - hot water demand Total hot water demand per SANS 2012 Ranges of l/c/d vary depending on the premises	2 minute assumption based on 30 s of use 4 times per person per day on average—consistent with 20-30 L/person/day (personal washing and bathing – hot and cold) at 10-15 L/min. Multiplied by approximately 3.5 people per household.
Kitchen Tap	5	SANS 10252-1	8-12Litres per meal prep at 3 meals a day 18-22Litres/person/day, so approximately 1.5 minutes at 10-15 L/min. Multiplied by approximately 3.5 people per household.
Public Lavatory Tap	N/A	Water supply in Buildings - Calculations, Domestic; Estimates as per SANS 10252-1	Educational institutions: 40-50L/capita Hotels/ motels/boarding houses: 200-300L/bed Offices: 10-15L/gross floor area Clinics/Hospitals: 450-500L/bed Industrial ablutions: 100-200L/capita Handwashing normal taps: 8-15 L/d/person

			Handwashing Spray taps: 3-7 L/d/person 4-8 L/per operation (wash basin)
Shower head	56	Water supply in Buildings - Calculations, Domestic per SANS 10252-1 Analysis of shower water use and temperature at a South African University Campus - BE Bota, HE Jacobs et al. 2017	1 shower per day for low-income groups, 2 showers per day for medium-income, and 2 showers per day for high-income, weighted equally Average shower durations – 9 min 33 seconds Multiplied by approximately 3.5 people per household.
Hot Water Share			
Bathroom Tap		Plumbing standards to manage *Legionella* disease risk specify 60 °C hot water Household Hot Water Temperature – An Analysis at End-Use Level - Hot water use Water supply in Buildings - Calculations, Domestic: Estimates as per SANS 10252-1	13°C to 20°C average hot and cold water use per dwelling
Kitchen Tap			
Public Lavatory Tap			
Shower head		Household Hot Water Temperature – An Analysis at End-Use Level- Hot water use, Stellenbosch University.	Temperature 40.2-43.8°C
Price of fixture in the market (ZAR)			
Bathroom Tap	357-30,739	Product list research from manufacturers' websites (COBRA, Hansgrohe, Tipolino, ISCA)	
Kitchen Tap	60–75,016	Ubuy.za.com last opened July 21st 2020	
Public Lavatory Tap	N/A		
Shower head	90–70,811		
Energy embedded in water desalination; treatment; pumping; waste processing (kWh/m3)	N/A		
Residential water rates (ZAR/kL)	18	Rates from 10 Municipalities: Buffalo City (East London);Cape Town; City of	Indicative average as every municipality has their own rates and the rate

		Johannesburg; Ekhurhuleni (East of Johannesburg); Ethekwini (Durban); Mangaung (Bloemfontein);Msunduzi (Pietermaritzburg);Nelson Mandela Bay (Port Elizabeth);Tshwane (Pretoria)	structures use a stepped approach based on water use that changes depending on the municipality.
Residential electricity rate (ZAR/kWh)	1.35	https://www.thesouthafrican.com/news/eskom-tariff-what-it-costs-household-appliances/ (Jan 2020)	
Residential gas rates (ZAR/gigajoule)	356	https://www.egoligas.co.za/calculator.html	Gas is not commonly used for water heating in households



Annex

List of Acronyms

ACRONYM	DEFINITION
DMRE	Department of Mineral Resources Energy (previously Department of Energy)
DTIC	Department of Trade Industry Competition
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation (previously DWAF and then DWA)
IOPSA	Institute of Plumbing South Africa
JASWIC	Joint Acceptance Scheme for Water Services Installation Components
NRCS	National Regulator for Compulsory Specifications
NWRS	National Water Resource Strategy
NWSMP	National Water and Sanitation Master Plan
SABS	South African Bureau of Standards
SANAS	South African National Accreditation System
SATAS	South African Technical Auditing Service
SANS	South African National Standards
SAW	South African Watermark
SOE	State-owned Enterprise
WELS	Water Efficiency Labelling and Standards
WSAs	Water Services Authorities

GUIDANCE ON SETTING WATER EFFICIENCY STANDARDS FOR FAUCETS AND SHOWERHEADS

CLASP has developed the following general guidance for setting new water efficiency standards based on experiences in the United States, where water efficiency standards have been in place since 1994. These recommendations should be adapted to the country context and requirements but can serve as a starting point for analysis and discussions.

Product Types for Coverage

We recommend including faucets/taps, showerheads, and replacement aerators within the scope of any water efficiency standards. Faucets and showerheads are the water fixtures/fittings that typically deliver hot water, so regulating their flow rates will deliver not just water but also CO_2 emissions reductions due to reduced energy use for water heating.

We recommend consolidating products into fewer classes/types with clear definitions to eliminate confusion and potential loopholes. Also, fewer product types will simplify manufacturer stocking, as manufacturers will only have to keep one type of aerator for all configurations of the same fixture (e.g., overhead and handheld showers).

We also recommend including replacement aerators within the scope of the standard as labeling these will promote correct replacement[51]

Pressure Conditions for Testing

We recommend testing performance across a several pressure conditions between 1 and 7 bar (0.1 to 0.7 MPa) to reflect performance across a range of pressure conditions in plumbing installations, from gravity-fed rooftop tanks (as low as 1 bar) to high-pressure water mains (7 bar).

Maximum Flow Rate Requirements

While maximum flow rate requirements will depend on local conditions, including national water, energy, and CO2 reduction goals and availability of efficient products, the following requirement levels can serve as a starting point for analysis and discussions.

FIXTURE	MAXIMUM FLOW RATE (L/min)	% OF MODELS MEETING SIMILAR VOLUNTARY REQUIREMENT IN THE UNITED STATES[52]	FLOW RATE FOR HIGH-PERFORMANCE DESIGNATION (L/min)
Faucet	6	84%	4
Showerhead	8	73%	6

As can be seen in the table above, fixtures that meet the above requirements are widely available in the global market due to popular voluntary EPA WaterSense specifications in the United States. High-performance requirements are based on the top efficiency of products in the Australia/New Zealand WELS product database.[53]

Applicability of Requirements

We recommend that fixtures meet requirements over the full range of pressure conditions in plumbing installations, as tested above. In addition to maximum flow rate requirements for water efficiency, requirements should require that fixtures maintain a minimum flow rate to guarantee performance and user satisfaction. Example requirements are shown below:

The flow rate shall be:

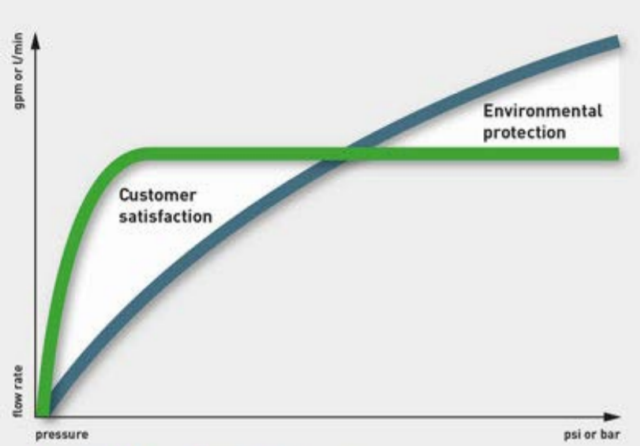
1. Less than or equal to the applicable maximum flow rate (in liters per minute) shown in <REQUIREMENTS TABLE> at all of the tested pressure conditions
2. Greater than or equal to 90% of the intended flow rate, when measured at 0.2 MPa (minimum flow rate)
3. Greater than or equal to 70% of the intended flow rate, when measured at 0.1 MPa (minimum flow rate)

[51] California Code of Regulations, Title 20, Section 1605.3(h)(2)

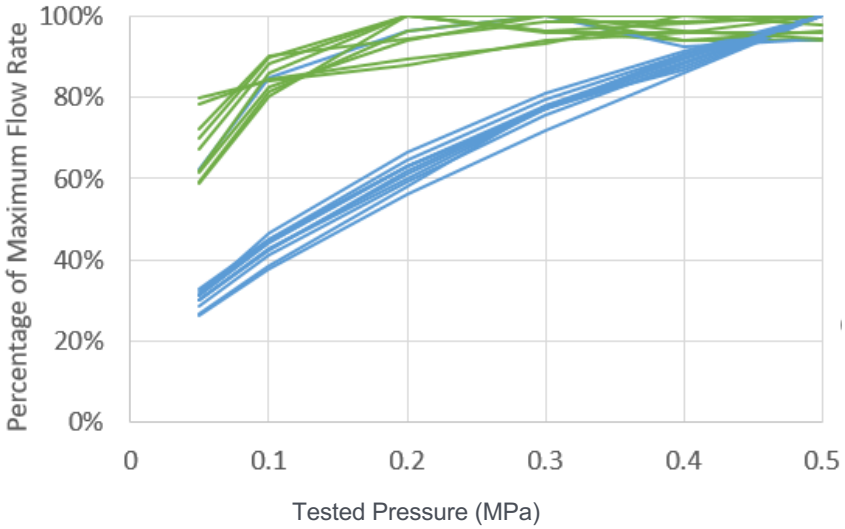
[52] Mauer, deLaski, and DiMascio. "States Go First 2020 Assumptions update".

[53] Australian Government, Water Rating Product Search, accessed August 31, 2020.

Excessively low flow rate at low pressure was a concern with early water-saving fixtures using fixed-orifice aerators. This is illustrated in the figure below[54], with the green line showing the desired performance that maintains a satisfactory flow rate across a range of pressures. The blue line is a traditional fixed-orifice aerator which may meet a flow-rate specification at one pressure, but deliver unsatisfactory flow at lower pressures while wasting water at higher pressures.



In practice, satisfactory performance at a range of pressures is achieved with pressure-compensating orifices, which reduce flow at higher pressures. Pressure compensation is used by all global plumbing brands in both faucets and showerheads. Manufacturer-reported performance curves for an Indian manufacturer of lavatory faucets are shown below, showing the pressure-compensating orifices maintaining flow rate across a range of pressures (green), in contrast to fixed orifice (blue).



Other Requirements:

Spray Force and Coverage

As flow rate decreases, maintaining sufficient force and coverage will ensure customer satisfaction with water efficient fixtures. The WaterSense voluntary specification in the US has the following requirements for minimum performance for spray force and coverage, based on the American Society of Mechanical Engineers (ASME) standard A112.18.1.

1. The minimum spray force for high-efficiency showerheads and hand-held showers shall not be less than 2.0 ounces (0.56 newtons [N]) at a flowing pressure of 20 ± 1 psi (140 ± 7 kPa) at the inlet. 4.1.2.
2. The minimum spray force for high-efficiency rain showers shall not be less than 1.4 ounces (0.40 N) at a flowing pressure of 20 ± 1 psi (140 ± 7 kPa) at the inlet.

[54] Gary Klein, "Flow Rates for Faucets, Showers and Tub/Shower Combination Valves", ACEEE Hot Water Forum presentation, p. 11.

3. The total combined maximum volume of water collected in the 2- and 4-inch (50-, 101-millimeter [mm]) annular rings shall not exceed 75 percent of the total volume of water collected, and;
4. The total combined minimum volume of water collected in the 2-, 4-, and 6-inch (50-, 101-, 152-mm) annular rings shall not be less than 25 percent of the total volume of water collected.[55]

As an alternative to minimum requirements, standards organizations can consider labeling with icons depicting different ranges of spray force and coverage performance on the label to allow customers to choose showerheads to meet their preferences (e.g., harder stream versus mist).

Multiple Showerheads

The following requirement addresses the risks of a situation where multiple showerheads are added to a shower to avoid standards:

> The total flow rate for showerheads with multiple nozzles must be less than or equal to the maximum flow rate in <REQUIREMENTS TABLE> when any or all the nozzles are in use at the same time[56]

Multiple Modes

We suggest that operation of multi-function equipment be precisely specified during test to avoid ambiguity or loopholes (e.g., mist or massage settings on showers, temporary pot-filling mode on kitchen faucets). This ensures that the typical mode is tested while still allowing for some product features that may temporarily use more water.

> If the product has multiple modes of operation, the test shall be conducted in the product's normal mode, as indicated with a label, or for temporary modes, the default mode.

Anti-Tampering

We recommend adding anti-tampering requirements to ensure water savings throughout the life of the fixture. Requirements can take the form of warnings or mechanical impediments to retain the original water-efficient aerator. An example of a warning requirement is shown below

> The fitting shall not be packaged, marked, or provided with instructions directing the user to an alternative water-use setting that would override reported flow rate.
>
> Any instruction related to the maintenance of the product, including changing or cleaning faucet accessories, shall direct the user on how to return the product to its intended maximum flow rate.
>
> Accessory, as defined in ASME 112.18.1/CSA B125.1, means a component that can, at the discretion of the user, be readily added, removed, or replaced, and that, when removed, will not prevent the fitting from fulfilling its primary function. For the purpose of this specification, an accessory can include, but is not limited to lavatory faucet flow restrictors, flow regulators, aerator devices, and laminar devices.[57]

[55] EPA WaterSense, "High-Efficiency Lavatory Faucet Specification", Version 1.0, October 1, 2007, pp. 2-3.
[56] California Code of Regulations, Title 20, Section 1605.3, Table H-5.
[57] EPA WaterSense, "High-Efficiency Lavatory Faucet Specification", Version 1.0, October 1, 2007, pp. 1-2.

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