clasp Efficient Appliances for People & the Planet

In-depth Assessment of Water Efficiency Opportunities in India

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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.

Water efficiency in India is an urgent opportunity. A draft national standard for faucets and showerheads could avoid 71 MT of CO_2 emissions annually.

Introduction and Methodology

An ambitious efficiency standard for faucets (taps) and showerheads in India would reduce water consumption by 7 trillion liters per year, avoiding 71 TWh/yr in energy and 71 MT/yr in CO_2 emissions.

1.1 INTRODUCTION

India, with a population of 1.3 billion, comprises 17% of the world's population. Among its 331 million households, only 193 million (58%) have access to piped water in the dwelling. According to the Ministry of Water Resources, 78% of water consumption within India is used for irrigation followed by 6% for the domestic sector, where it is used primarily for cooking, drinking, bathing, flushing, washing, and gardening.

Additionally, the government of India predicts that the average annual per capita water availability will decline 13% between 2011 and 2025. The ongoing water crisis, along with population growth and competing water uses (e.g., from the construction sector) call for improved water management and water efficiency.

This report investigates the opportunity for introducing water efficiency policies for faucets (also known as taps) and showerheads to reduce water consumption and—by reducing hot water—CO_2 emissions. While not all households have running water, and an even smaller proportion have or use hot water, the opportunity is nonetheless large and growing rapidly. Meanwhile, low-flow, water efficient faucets and showerheads are widely available in India and will be promoted through a national standard under development by the Bureau of Indian Standards. Adopting ambitious standards now will maximize the potential CO_2 and water reductions, helping address the climate and water crises.

1.2 METHODOLOGY

EDS collected data on the market size and technical characteristics of faucets and showerheads through secondary and primary research techniques. Secondary research involved comprehensive review of relevant publications and online sources. It provides a broad overview of the key stakeholders and major players in the water efficiency space, along with water fitting (or fixture) information and the expected market growth. Appendix B lists the publications.

EDS also conducted primary research interviews with key stakeholders in industry and government. The stakeholders validated the data collected through secondary research as well as provided additional policy information. As most of the government organizations and industries were working at reduced capacity due to the Covid-19 pandemic, EDS conducted the interviews virtually. The list of stakeholders is in Appendix A.

Policies and Stakeholder Mapping

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

2.1 STAKEHOLDER MAPPING

2.2.1 OVERARCHING WATER MINISTRY

- **Ministry of Jal Shakti**: *The main institution responsible for water resources management is the Ministry of Jal Shakti, established by merging the Ministry of Water Resources and the Ministry of Drinking Water and Sanitation. The Ministry's objective is to conserve water and ensure equal distribution across the country and within the states through water resource management.*

2.2.2 WATER EFFICIENCY GOVERNING AGENCY

- **National Bureau of Water Use Efficiency**: *This institution is expected to be established as provided under the 2019 National Water Framework, Ministry of Jal Shakti. However, as of now, there is no authenticated information as to when the agency is going to be established by the Ministry.*

2.2.3 STANDARDIZATION BODIES

- **Bureau of Indian Standards (BIS)**: *BIS is the national standard body of India responsible for standards formulation, products and system certification, marking and quality certification of products, and prescribes the performance requirements and the test protocol of appliances and equipment.*
  Currently BIS is working on the development of STAR rating criteria for water fittings in India. It recently released draft standards for public view and comment that are expected to be finalized in early 2021. The proposed rating system covers water closets, urinals, faucets and overhead showers which are categorized into three rating levels based on flow rates.
- **Bureau of Energy Efficiency (BEE)**: *The Government of India set up the BEE under the Ministry of Power in 2002 through the Energy Conservation Act 2001 with the goal of increasing the energy conservation and efficiency in the country, mainly through equipment and appliances. The main objective of the agency is to provide policy recommendations for energy efficiency and establish strategies to monitor and verify energy performance. BEE has designed various programs for energy efficiency including the initiation of the standards and labeling (S&L) scheme for appliances and equipment in 2006. Specifically, 26 appliances types have been taken up in either mandatory or voluntary labeling regimes respectively since 2016. This includes S&L for storage water heaters (also known as geysers; mandatory labeling) and solar water heaters (voluntary labeling), both of which will be addressed in the policy section below.*

2.2.4 INDUSTRY ASSOCIATIONS

- **Indian Plumbing Association (IPA)**: *IPA is the principal organization of plumbing professionals in the country. It was formed in 1993 to redefine plumbing standards and promote advancements of the plumbing industry in India.*
- **IAPMO Plumbing Codes and Standards India Private Limited (IAPMO)**: *Founded in 2007 to assist local plumbing professionals, IAPMO India creates awareness about the issues and prospects concerning the industry. It collaborated with IPA to establish extensive plumbing codes and education programs and is a member of the World Plumbing Council. Appendix D enlists the requirements for various plumbing codes and labeling falling under IAPMO in further detail.*

2.3 POLICY MAPPING

2.3.1 OVERARCHING NATIONAL WATER FRAMEWORK

Main policies at the national level include the following:

- **National Water Policy (NWP)**: *The Ministry of Water Resources, Government of India established the policy for the first time in 1987. It was revised in 2002 and again in 2012 with the primary goal of setting up a standardized national database of hydrological information and setting priorities for water allocation for domestic consumption, followed by irrigation, hydro-electric power, navigation and industrial use. It sets the overarching water framework to advance water efficiency in relation to irrigation and water supply management. However, no programs or measures were developed to improve water efficiency for domestic products.*

  This gap has prompted the government to begin revising the policy in November 2019. The draft has not been released yet. The drafting committee includes professionals from the Department of Water Resources, River Development and Ganga Rejuvenation and Ministry of Jal Shakti[1].

- **Jal Jeevan Mission**: *The mission is a long-term vision plan by the Ministry of Jal Shakti under the Department of Drinking Water and Sanitation initiated in 2019. It aims to ensure drinking water supply to every rural household in India i.e. Functional Household Tap Connection (FHTC) by 2024. Out of 189 million rural households in India. 46 million households (24%)*[2] *have been provided with tap connections as of July 2020.*

- **The National Water Framework Bill of 2016**: *The Bill aims to conserve, manage, regulate and protect the use of water while providing a framework which ensures executive action on water at all levels of governance. It emphasizes access to water as a right of every individual, the protection of ecosystems depending on water, the treatment and use of wastewater, people-centered water management and water security planning.*

2.3.2 WATER EFFICIENCY STANDARDS AND LABELING PROGRAMS

- **Bureau of Indian Standards (BIS)**: *BIS is working on a Water Efficiency standard expected to be finalized in early 2021. A draft of the standard was distributed in July 2020 for public view and comments. Figure 1, below, summarizes the key sections of the draft standard.*

FIGURE 1: BIS WATER EFFICIENCY STANDARD FOR FAUCETS AND SHOWERHEADS (SANITARY FITTINGS)

PARAMETER	SUMMARY
Label Type	*Comparative*
Program Type	*Voluntary*
Scope	*This standard covers requirements for assessment and star rating of sanitary fittings, such as faucets (taps) and showerheads, for their performance based on water efficiency, which are in addition to the requirements specified in relevant Indian Standards as applicable.*
Active since	*To be released in early 2021*
Implementing body	*Bureau of Indian Standards*
Parameter graded	*Flow rates in liter per minute or per use*
Grading	*Draft standard—to be determined*

PARAMETER	SUMMARY
Label information	*Draft standard—to be determined*

Figure 2, below, lists finalized BIS National standards on sanitary fittings that address product design and safety.

FIGURE 2: BIS STANDARDS FOR WATER FITTINGS

IS 1795:1982	*For pillar taps for water supply purposes*
IS 1781:1984	*For cast copper alloy screw down bib taps and stop valves for water services*
IS 1172:1993	*Demonstrates code of basic requirements for water supply, drainage and sanitation*
IS 2064: 1993	*Delineates selection, installation and maintenance of sanitary appliances - code of practice*
IS 8931: 1993	*For copper alloy fancy single taps, combination tap assembly and stop valves for water services - specification*
IS 9763: 2000	*For plastics bib taps, pillar taps, angle valves and stop valves for hot and cold-water services — specification*

- **Water Efficient Products – India (WEP-I):** *A voluntary labeling program by the industry associations aligned with the national interest of reducing water usage focusing on efficient fittings. IAPMO India and IPA jointly developed WEP-I in 2011 (Figure 3).*

FIGURE 3: WEP-I WATER EFFICIENCY STANDARD FOR FAUCETS AND SHOWERHEADS (SANITARY FITTINGS)

PARAMETER	SUMMARY
Label Type	*Comparative*
Program Type	*Voluntary (certification by IAPMO)*
Scope	*WEP-I includes a set of recommendations for selection, manufacturing, engineering and installation of efficient plumbing systems in India, along with flow rates for faucets, showerheads, water closets and urinals*
Active since	*2011, revised in 2013 and 2017.*
Implementing body	*IAPMO India and Indian Plumbing Association*
Parameter graded	*Flow rates in liters per minute*
Grading	

L/min	Conventional	1 Star	2 Star	3 Star
Faucets	8 L/min	8 L/min	5.7 L/min	5 L/min
Showerheads	10 L/min	9.5 L/min	7.5 L/min	5.7 L/min

Label information	

PARAMETER	SUMMARY
	
Implementation	*Steps to implement product certification[3]:* *I. Complete a product certification (listing) application* *II. Test* the fitting at an IAPMO recognized testing laboratory* *III. Submit the test report and supporting data to IAPMO for review* *IV. Request pre-listing audit of the manufacturing plant(s)* *V. Receive the certificate of listing upon full compliance confirmation* **Products must be tested at an IAPMO recognized testing laboratory*
User information	*A product-registry is available for the certified products on the IAPMO website: https://www.iapmoindia.org/hidden/water-efficient/*

2.3.3 PLUMBING CODES

- *IAPMO's* **Uniform Illustrated Plumbing Code or UIPC – I (2014)** *is based on IAPMO's globally acknowledged flagship document and supersedes previous Uniform Plumbing Code (UPC – I) versions (2008 and 2011).*

- *Along with this, IAPMO India and IPA jointly released* **Green Plumbing Code Supplement – India (GPCS – I)** *and in 2011 they developed WEP – I to respond to the need for a comprehensive water-efficient rating scheme. It was developed for the products which were not certified under UIPC-I but complied to their performance test standards (IS)4 (mentioned in appendix C[5]) as WEP – I products are classified based on flow rates only, while the UIPC – I code incorporates the technical standards for design, materials, workmanship and maintenance of the complete plumbing system. Hence, every WEP-I product does not comply with UIPC-I, but the performance standards for flow rates are the same.*

2.3.4 STANDARDS AND LABELING FOR WATER HEATERS

BIS has established four water heaters standards in India, listed in Figure 4 below:

FIGURE 4: INDIAN STANDARDS FOR WATER HEATERS

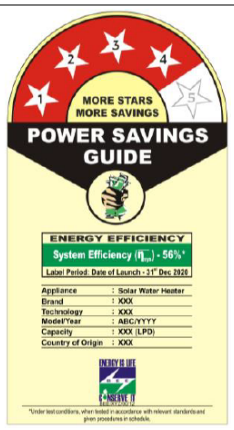
PARAMETER	SOLAR WATER HEATER	GAS WATER HEATERS (STORAGE TYPE)	GAS WATER HEATER (INSTANTANEOUS TYPE)	INSTANT ELECTRIC WATER HEATERS	STORAGE ELECTRIC WATER HEATERS
Standard Number	*IS 16544*	*IS 5115*	*IS 15558*	*IS 8978*	*IS 2082*
Scope of standard	*Domestic thermosiphon type of solar water heater*	*Domestic storage type water heaters for use with liquefied*	*Instantaneous and continuous production of hot water for*	*Electric instantaneous water heaters up to 3 liters capacity for*	*Storage water heaters for household and similar purposes and*

PARAMETER	SOLAR WATER HEATER	GAS WATER HEATERS (STORAGE TYPE)	GAS WATER HEATER (INSTANTANEOUS TYPE)	INSTANT ELECTRIC WATER HEATERS	STORAGE ELECTRIC WATER HEATERS
		petroleum gases. Having nominal capacities between 6 and 100 liters.	*domestic use, of nominal useful less than 25 kW (based on gross calorific value), for use with liquefied petroleum gases (LPG)*	*heating water to a temperature below the boiling point.*	*intended for heating water below boiling temperature*
Performance grading parameter	*System efficiency*	*Thermal efficiency*	*Thermal efficiency*	*Not mentioned*	*Standing loss in kWh/day for maintaining 45K temperature difference*
Energy efficiency requirement as per BIS[6]	*35% system efficiency*	*70%*	*84% for water heaters with a nominal heat input exceeding 10 kW, and 82% for water heaters with a nominal heat input not exceeding 10 kW.*	*Not mentioned*	*Maximum standing loss for different capacities*
Energy efficiency requirement as per BEE	*40% system efficiency (voluntary)*	*Not covered under BEE labeling program*	*Not covered under BEE labeling program*	*Not covered under BEE labeling program*	*Refer BEE star label table in the Gazette Notification*

Of all the products mentioned above, only electric storage water heaters and solar water heaters are covered under the BEE labelling program, as detailed in Figure 5 below.[7]

FIGURE 5: OVERVIEW OF BEE'S S&L PROGRAM FOR ELECTRIC STORAGE AND SOLAR WATER HEATERS

PARAMETER	ELECTRIC STORAGE WATER HEATER	SOLAR WATER HEATER
Label type	*Comparative Star Rating*	*Comparative Star Rating*
Program type	*Mandatory*	*Voluntary*
Active since	*Mandatory program in-place since 2016*	*Voluntary program in-place since 2019*
Scope	*Star labeling requirements for stationary storage type electric water heaters up to rated*	*The energy-labelling requirement for Solar Water Heaters (SWH) imported or sold in India for water heating and similar use. The scope*

PARAMETER	ELECTRIC STORAGE WATER HEATER	SOLAR WATER HEATER
	capacity of 200 liters being manufactured, imported or sold in India	*covers all types of thermosyphon based solar water heaters up to 500 liters storage capacity*
Parameter graded	*Standing Losses (kWh/24 hour/45°C)*	*System efficiency*
Relevant document	*Refer Gazette Notification No. 7 in the link: http://www.beestarlabel.com/Home/EquipmentSchemes?type=M*	*Refer Schedule No. 23 in the link: http://www.beestarlabel.com/Home/EquipmentSchemes?type=V*
Label		
Market	*Recent interviews conducted with industry experts reported that consumers prefer energy efficient water heaters[8], and a study conducted by GfK showed that presently mostly 4 and 5 star rated storage water heaters are being sold in the market.[9]*	*The Indian market has witnessed a rise in demand for solar water heaters in the past few years. Indeed, they are considered reliable, efficient, cost effective and ensure environmental benefits.[10] To comply with IS 16544:2015 the domestic thermosiphon based solar water systems are required to meet a minimum of 35% system efficiency for evacuated tube collector type (ETC) based solar water heater.[11] Under this BEE standards and labeling program both Flat Plate Collectors (FPC) and ETC type water heaters are required to meet a minimum of 40% efficiency.[12]*

Additionally, the Indian water heater market also includes immersion rods which are used as a low-cost, portable heating method for heating water in a container. These are portable rods that have an electrical resistance heating element which is directly placed in cold water. However, their use is declining due to safety concerns. Indian Standard IS368: 1992 covers performance requirements for electric immersion water heaters.[13.]

2.3.5 BUILDING CODES AND INITIATIVES

- **The National Building Code (NBC)** *of India, developed by the Bureau of Indian Standards in 1970, is a comprehensive building code with detailed guidelines for construction, safety and maintenance of building structures. In terms of water efficiency, it provides guidelines on the water supply, drainage and sanitation requirements for all building typologies. It broadly classifies the water fitting requirements on the basis of the number of people using the building facilities. It also delineates provision for hot water supply and hot water temperature requirement for various purposes like sink, hot bath and warm bath,[14] though not all faucets and*

showerheads sinks are connected to hot water. The testing and maintenance requirements for hot water systems along with their design considerations and storage capacity are also mentioned. The latest revision of NBC was released in 2016. However, it is important to note that the NBC does not specify the requirements for water-efficient use of plumbing systems.

- *Finally, the efficiency of water fittings and technologies is addressed by* **Green Building Rating Systems**, *including LEED, GRIHA and IGBC.*[15] *The buildings following the rating systems constitute less 5% of total new construction in the country. These rating systems provide comprehensive and internationally adopted guidelines and define methods for reducing indoor and outdoor water consumption by specifying various innovative strategies. This could lead to the development of a stringent water efficiency standard inspired by these rating systems in the growing Green Building industry that could be followed universally throughout India and not just by the buildings that go for the Green Building Certifications. The flow rate requirements for each rating systems appear in Figure 8.*

FIGURE 6: FLOW RATE REQUIREMENTS FOR FAUCETS AND SHOWERHEADS IN BUILDING EFFICIENCY PROGRAMS

FLOW RATE (L/min)	LEED	GRIHA	IGBC
Showerhead	*9.5*	*10*	*10*
Lavatory Faucet	*8.3*	*8*	*6*
Kitchen Faucet	*8.3*	*8*	*6*

Roadmap to Introducing Water Efficiency Policies

There are no stringent water efficiency requirements for faucets and showerheads in India. While the plumbing industry and BIS are working on a new standard, additional opportunities exist.

3.1 OPPORTUNITIES

While meaningful water efficiency efforts in India have been limited, the upcoming BIS standards pose an immediate opportunity to achieve impact. EDS's conversations indicate that water efficiency standards would be accepted, not only by consumers, but even by manufacturers. IAPMO reports that manufacturers have the ability to meet standards requirements without increasing the cost of fittings, as several leading companies in the Indian market already export products to countries like UAE, Saudi Arabia, and China—countries with existing water efficiency standards.

While several leading housing developers in India prefer efficient plumbing fittings in their buildings, the green building rating systems mentioned previously are not widely followed. If the national building code—which is widely followed—were updated with flow rate requirements, it could have a transformational impact on water efficiency in new buildings.

Finally, the upcoming BIS label will contain a comparative categorization, allowing consumers to differentiate levels of efficiency across product models. Although the currently proposed 1-star requirement is not particularly ambitious, the label criteria will likely increase in stringency over time. Additional reductions can be achieved by making the labeling mandatory. The procedure to transition the label from voluntary to mandatory is quite streamlined. After a thorough analysis of responses to the label from the public and the stakeholders, the national committee of BIS will sit for a discussion and propose any changes, if required, to the existing standard. In this process, BIS does not involve any external bodies beyond their stakeholders for the purpose of seeking inputs or support.

After several stakeholder consultations, and analysis of the current policy opportunities, it is evident that impactful and standardized water efficiency policies are only possible through a government-led body like BIS. Below, we discuss potential barriers to this opportunity and propose solutions.

3.2 BARRIERS

- **Low awareness:** *For any new scheme or standard implemented, consumer awareness and education are essential to informed behavioral change. Currently, a majority of Indian consumers are unaware of water fitting specifications i.e. flow rates, desirable water pressure, effect of water quality on fittings and their maintenance. Bathroom fittings are usually decided by contractors based on the type of dwelling unit, cost, and the interior design. Since there is no demand from the users, premium brands have not been competing to adopt the existing WEP - I labeling.*

  In addition to proper education toward purchase of efficient fittings, consumer awareness efforts should extend to fitting maintenance—otherwise risking reduced water flow rates and thus, shortened lifespan. For example, aerators tend to clog supply water is turbid. Users can easily fix, or prevent, clogs with frequent cleaning. However, in the majority of cases, users will remove the aerators altogether which ultimately results in increased flow rate and much higher water consumption.

- **Limited and expensive testing:** *India has only one independent test facility for water fittings. This laboratory was set up by IAPMO and is currently used for testing of WEP - I products. Leading water fitting manufacturers report that product testing outside the country is expensive. This indicates that the country needs to develop the infrastructure as new policies and standards are introduced, including those currently under development.*

- **Insufficient/inconsistent water pressure:** *For example: Consider an overhead tank supplying water to a 10-story building through a gravitational flow system. In this case, the pressure on the ground floor would be more than the water pressure on the 10th floor. This could be a challenge for fittings with fixed orifices, where flow rate is proportional to pressure, resulting in high flow (and waste) at high pressure, and poor performance at low pressure.*

- **Unmetered connections:** *In India, water meters are absent in most rural households and up to half of urban households. A study found that in metropolitan cities like Bangalore, Delhi, Hyderabad, Mumbai and Pune, 38% of households lack meters, while in smaller states the rate may be as high as 50%.*[16] *This indicates that a large amount of water supply is unaccounted for. The unmetered water is charged at a fixed rate. However, since the consumption cannot be quantified, the lack of metering poses as a drawback for any water conservation measure or policy.*

3.3 POLICY IMPACTS

BIS is currently developing a labeling policy for water efficient fittings that include faucets and showerheads, the label will likely become mandatory overtime. Using the methodology and inputs described in Appendix B, CLASP evaluated the impacts of two requirement levels: minimum energy performance standards (MEPS) set at the 1-star level in the current draft standard and MEPS at the CLASP-recommended level, which is equal to the 2-star level in the draft standard for most fittings.

The 1-star level is roughly aligned with MEPS in the United States that were adopted in 1994. Since then, numerous other standards (mandatory and voluntary) have been adopted worldwide, and global manufacturers have responded with water efficient fittings with even lower flow rates. EDS has found that these are also available on the Indian market, as shown in Figure 7 and Figure 8.

Therefore, while the draft 1-star level would result in some reductions, leapfrogging to the draft 2-star flow rate requirements (roughly equivalent to EPA WaterSense requirements in the United States) would result in significant additional water, energy, and CO_2 reductions. As can be seen in Figure 9, the current BIS draft, as written, would reduce water consumption by 8 trillion liters, and avoid 51 TWh of energy consumption and 51 $MtCO_2$ per year. In contrast, CLASP's more ambitious minimum requirements would reduce water consumption by 10 trillion liters and avoid 71 TWh of energy consumption and 71 $MtCO_2$ per year. All reductions assume that the standard would become mandatory and that 100% of fittings are replaced with compliant models.

FIGURE 7: FLOW RATES OF BATHROOM FAUCETS ON THE INDIAN MARKET COMPARED TO THE DRAFT BIS STAR LABELING REQUIREMENTS. DIFFERENT COLORS REPRESENT DIFFERENT BRANDS, STRAIGHT LINES SHOW LINEAR INTERPOLATION BETWEEN REPORTED PERFORMANCE AT MULTIPLE PRESSURE POINTS, WHERE AVAILABLE.

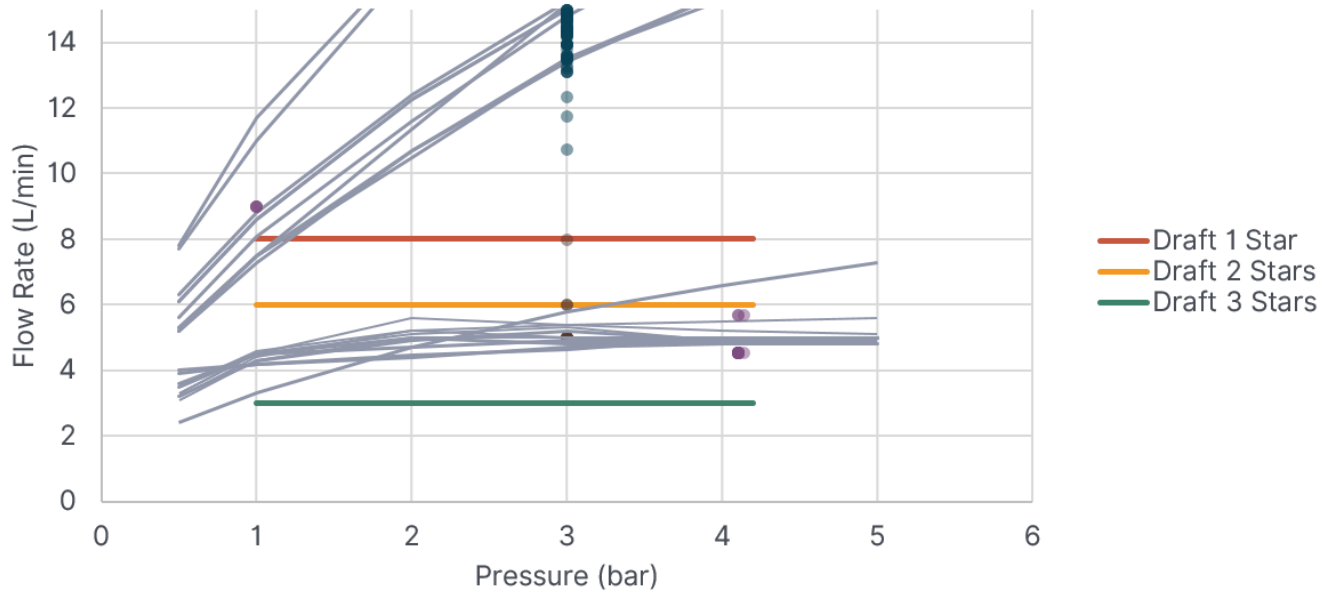


FIGURE 8: FLOW RATES OF SHOWERHEADS ON THE INDIAN MARKET COMPARED TO THE DRAFT BIS STAR LABELING REQUIREMENTS. DIFFERENT COLORS REPRESENT DIFFERENT BRANDS, STRAIGHT LINES SHOW LINEAR INTERPOLATION BETWEEN REPORTED PERFORMANCE AT MULTIPLE PRESSURE POINTS, WHERE AVAILABLE.

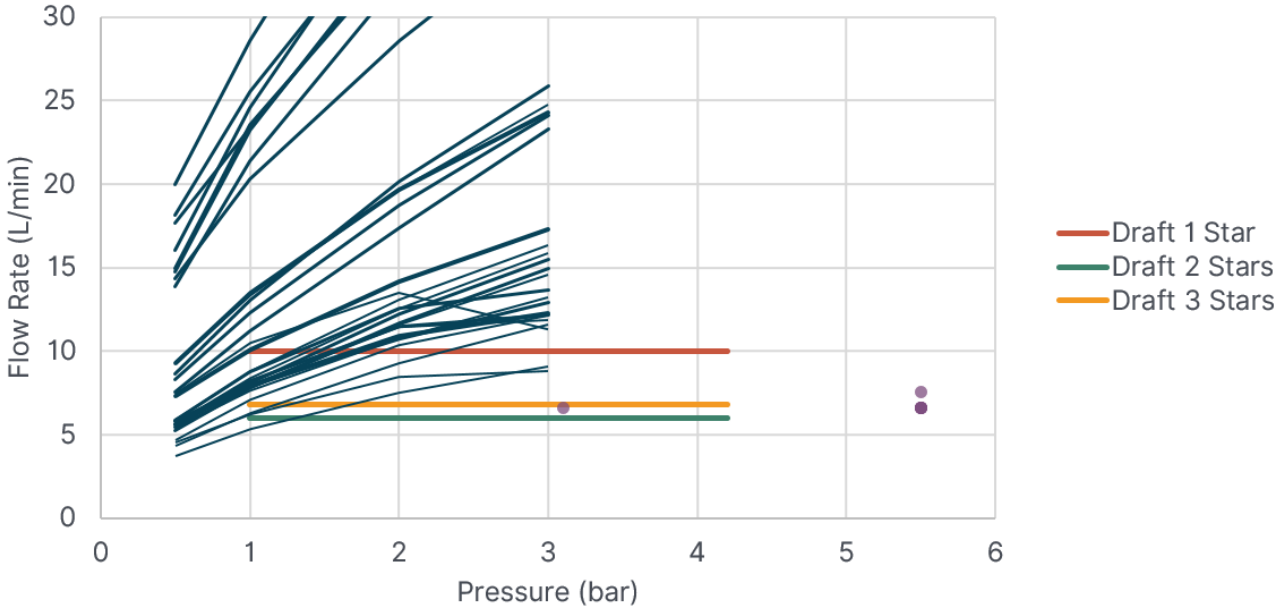


FIGURE 9: ENERGY AND CO_2 EMISSIONS REDUCTION POTENTIAL FROM CLASP RECOMMENDED STANDARDS FOR FAUCETS AND SHOWERHEADS (KITCHEN FAUCET REDUCTIONS BASED ON PERFORMANCE OF BATHROOM FAUCETS IN THE MARKET)

POTENTIAL STANDARD	PRODUCT	MAXIMUM FLOW RATE (L/min)	WATER REDUCTION (trillion L/yr)	ENERGY REDUCTION (TWh/yr)	CO_2 REDUCTION ($MtCO_2$/yr)
Draft BIS Standard	*Bathroom Faucet*	*8*	*3*	*23*	*23*
	Kitchen Faucet	*8*	*1*	*5*	*5*
	Showerhead	*10*	*4*	*23*	*23*
	Total		**8**	**51**	**51**
CLASP Recommended Standard	*Bathroom Faucet*	*6*	*4*	*31*	*32*
	Kitchen Faucet	*6*	*2*	*14*	*15*
	Showerhead	*8*	*4*	*26*	*27*
	Total		**10**	**71**	**71**

3.4 RECOMMENDED NEXT STEPS

3.4.1 SUPPORT BIS IN THE DEVELOPMENT OF WATER EFFICIENCY STANDARDS

The Bureau of Indian Standards (BIS) is finalizing new performance standards for water fittings by the end of this year and has made the draft standard available for public review and comments since July 2020.

CLASP recently commented on the draft standard for faucets and showerheads together with the Appliance Standards Awareness Project and another US expert. Our comments encouraged BIS to increase the ambition of their draft standard and align with the latest global efficiency levels while ensuring fitting performance over time and when installed in a variety of plumbing systems.

The voluntary standard is expected to be finalized in early 2021 and, as written, would avoid 51 $MtCO_2$ per year if all faucets and showerheads replaced with compliant models (median lifetime is 2 years for showerheads up to 10 years for taps). CLASP has recommended more ambitious minimum requirements roughly aligned with the 2-star level in the BIS draft. These more ambitious requirements would avoid 71 $MtCO_2$.

In addition to requiring a lower flow rates, BIS has an opportunity to prevent additional water waste and maintain consumer satisfaction with the performance of water efficient fittings by requiring that fittings maintain those flow rates at a range of pressure conditions representative of typical plumbing systems (from 1 to 7 bar). The current draft standard only requires testing at 1 bar, potentially leading to uncontrolled performance across the range of pressures, as Figure 10 shows. As can be seen in the graph, it is possible for a fitting to meet a flow rate standard at one pressure point, while providing higher flow rates at higher pressures (wasting water) and lower flow rates at lower pressures (poor performance). This kind of linear performance (blue line in Figure 10) is characteristic of fixed-orifice fittings; in contrast pressure-compensated orifices (green line) provide near-constant flow-rate across a range of

pressures, ensuring water reductions and satisfactory performance for customers, regardless where they are installed.

FIGURE 10: PERFORMANCE OF DIFFERENT TYPES OF FITTINGS. THE GREEN LINE SHOWS THE DESIRED PERFORMANCE THAT MAINTAINS A SATISFACTORY FLOW RATE ACROSS A RANGE OF PRESSURES. THE BLUE LINE IS A FITTING TRADITIONAL FIXED-ORIFICE AERATOR WHICH MAY MEET A FLOW-RATE SPECIFICATION AT ONE PRESSURE, BUT DELIVERS UNSATISFACTORY FLOW AT LOWER PRESSURES WHILE WASTING WATER AT HIGHER PRESSURES.[17]

Finally, CLASP recommended that the BIS standard require user messaging that discourages the removal of the aerator during cleaning. Such a requirement could help ensure continued performance of the fittings at the specified flow rate. CLASP plans to continue engaging with BIS so that the standard reflects the current state of the market and water, energy, and CO_2 reduction opportunities.

3.4.2 REVIEW OTHER CODES AND REGULATIONS

To ensure that all customers can benefit from water efficiency, not just those who are well-informed and in a position to purchase the water fitting, the BIS standard would have to be mandatory rather than voluntary. In addition, the national building plumbing codes, state bylaws and green building certification standards are widely followed by builders as discussed above. As a step further, these codes and standards could be potentially aligned with the upcoming BIS standard upon detailed analysis of each.

Appendix A: Stakeholder Interviews

FIGURE 11: STAKEHOLDERS INTERVIEWED FOR DATA COLLECTION

STAKEHOLDER GROUP	STAKEHOLDER NAME	OBJECTIVE AND METHOD
Associations	• *International Association of Plumbing and Mechanical Officials (IAPMO)*	*Semi structured interviews and questionnaires to collect information on policies, labeling methods and certifications that currently exist and industry positioning regarding the introduction of standards in the Indian market.*
Water fitting manufacturers	• *Kohler* • *Jaquar* • *Roca Parryware*	*Cross-validation for secondary research data through a questionnaire.*
Water heater manufacturer	• *Somany*	*Cross-validation for secondary research data through a questionnaire.*
Government policy makers	• *Bureau of Indian Standards, Ministry of Consumer Affairs, Food & Public Distribution* • *Bureau of Energy Efficiency, Ministry of Power*	*Discussion to collect information on water efficiency policy and on past efforts to introduce water efficiency standards, current priorities of the government in terms of water policies, as well as information on other water-using products in addition to faucets and showerheads if deemed important for potential energy savings.*
Plumbing Consultants and Industry Experts	• *KRIM Engineering Services pvt ltd* • *Sanitario India* • *ZSA Engineering Services*	*Cross-validation for secondary research data through a questionnaire and semi structured interviews to collect information on water efficiency policies and on past efforts*
Retailers	• *Interview of 1 retailer store in Delhi NCR region*	*Cross-validation for secondary research data through a questionnaire*

Appendix B: Model Methodology and Inputs

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 fitting under business-as-usual conditions and under an efficiency policy.

EDS collected performance data for showerheads and bathroom faucets from two manufacturers and data for bathroom faucets only from two additional manufacturers. Together with a fifth, these four manufacturers are responsible for 65% of the market for faucets and showerheads and so will be used to represent the current market in India. The average flow rates of the dataset (12.7 L/min for bathroom faucets, and 12.8 L/min for showerheads, at a pressure of 3 bar or higher) are consistent with expert opinion and secondary research (5–18 L for faucets, 10–15 L/min for showerheads).

In addition, EDS collected estimates of the stock of fittings, 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 shares of hot and cold water flowing through the fittings (which reflect the average water temperature coming into the house from the municipal water utility's pipes, as well as the proportion of houses with water heating). CLASP combined these data with assumptions on the efficiency of the various types of water heaters, how much of a fitting's full flow is used, amount of water wasted while waiting for hot water to arrive, and emissions 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 fittings in stock with lower-flow fittings that do meet the standard. Higher-flow fittings that do not meet the standard are assumed to be replaced with fittings 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.

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

- *Number of fittings in use (stock) or shipments and lifetimes to estimate stock*
- *Usage (minutes/fitting/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*
- *Amount of water passing through fitting that is hot water (takes into account mixing of cold and hot water, as well as households with no water heating)*
- *Typical piped water temperature (based on average surface temperature for the country)[18]*
- *Typical water heater temperature (65 °C)*

These are combined with the following assumptions:

- *How much of a fitting's maximum flow is actually used (67% derating factor for faucets[19]; 85% for showerheads[20]; increasing to 75% for low-flow faucets[21], unchanged for showerheads)*
- *Water wasted while waiting for hot water to arrive (additional 272 L/showerhead/yr for low-flow showerheads[22])*
- *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 (0.82 $MtCO_2$/TWh) and liquefied natural gas (0.55 $MtCO_2$/TWh), and electric transmission and distribution losses (23%)*

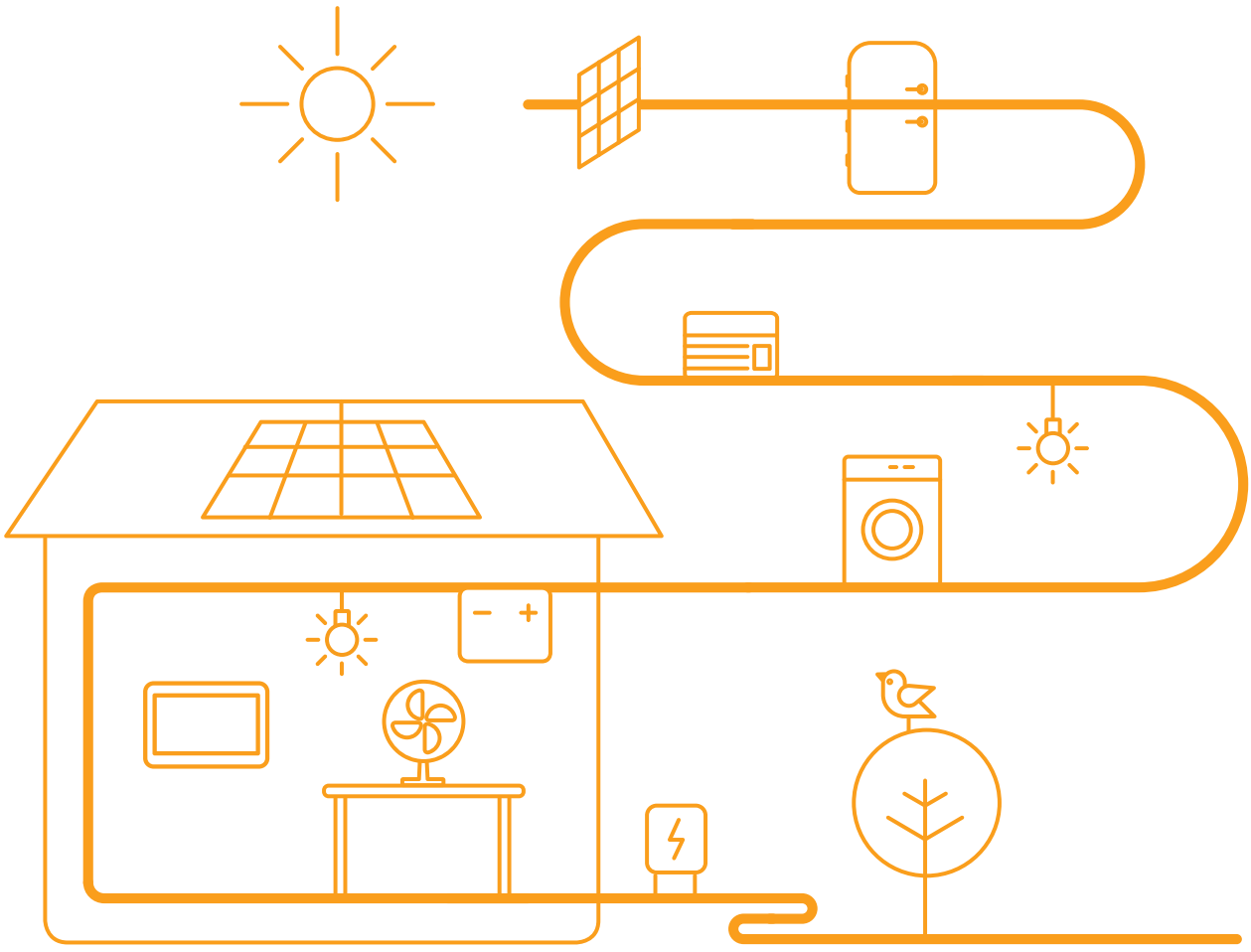
KEY MODEL DATA

DATA	VALUE	SOURCE AND METHOD	NOTES
Current stock (million units)[23]			
Bathroom Faucet	*193*	*Only 193 million households have access to running water*[24]*. Assume that these have one bathroom and one kitchen, per the 2016 National Building Code requirement: "Dwelling with individual convenience shall have at least the following fitments: One bathroom provided with one tap One tap with a floor trap or a sink in kitchens"*	
Kitchen Faucet	*193*		
Public Lavatory Faucet	*N/A*		*Data is not available*
Shower head	*93*		*Lower stock than bathroom and kitchen faucets, as showerheads are not considered a necessary in low-income households.*
Shipments (million units)			
Bathroom Faucet	*N/A*		*USD 65 million annual sales for faucets and showerheads in the organized sector (Jaquar, Roca Parryware, Grohe, Kohler and Delta, responsible for 65% of the market).*
Kitchen Faucet	*N/A*		
Public Lavatory Faucet	*N/A*		
Shower heads	*N/A*		
Lifetime (years)			
Bathroom Faucet	*7.5*	*Primary research (industry association, manufacturers, plumbing consultants and sector experts)*	*5-10 years (depending on maintenance due to hard water degrading performance) The responses received from stakeholders have been cross validated during the discussions.*
Kitchen Faucet	*7.5*		
Public Lavatory Faucet	*10*	*Primary research (plumbing consultant)*	
Shower head	*2*	*Primary research (experienced retailer)*	*Based on the questionnaire filled by experts in the industry*
Flow rates of fittings in the market (L/min)			

DATA	VALUE	SOURCE AND METHOD	NOTES
Bathroom Faucet	*12.7*	*Average of fitting data from major manufacturers (most at 3 bar, one at 4.1 bar)*	*Primary and secondary research[25,26] report flow rates 5–18 L/min, with lower flow fittings below 9 L/min at 3 bar.*
Kitchen Faucet	*9*	*Primary research (plumbing consultant)*	*At 2 bar pressure.*
Public Lavatory Faucet	*8*	*Primary research (plumbing consultant, facility manager)*	
Shower head	*12.8*	*Average of fitting data from two manufacturers (3 bar, 5.5 bar, and unknown (but assumed to be pressure compensating, so should be representative of performance at typical 3 bar pressure)*	*Secondary research reports flow rates around 10—15 L/min[27,28]*
Water heater technologies stock share %	*N/A*		*No data on stock share, so recent market share was used.*
Water heater technologies market share %	*Electric (instant): 25%* *Electric (storage): 59%* *Solar: 13%* *Gas: 3%*	*ADI Media Research, as quoted in TV Veopar Journal, Energy Efficiency Goals Encourage Breakthroughs", October 2018. https://www.tvj.co.in/energy-efficiency-goals-encourage-breakthroughs/*	*2017-2018 data*
Average energy efficiency by type of water heater technology %	*Electric: 99%* *Gas: 82%*		*BEE Star rating for storage type is based on standing losses (kwh/24 hr/45º C) not efficiency, so using typical assumptions for electric resistance and non-condensing gas water heaters.*
Typical use (min/fitting)			
Bathroom Faucet	*15*	*Primary Research (plumbing consultant, industry expert)*	*Based on average urban usage of 135 liters per person per day, multiplied by 5 persons per household and one fitting of each type per household:* *Assumptions (per person):* *Flushing: 45 L/day* *Shower: 40 L per shower (considering 8 L/min for 5 min average)* *Handwash: 24 L (1 min after 3 meals, 15 seconds every time after using WC)* *Washing utensils + vegetables: 27 L (considering 3 meals and 9L per meal)*
Kitchen Faucet	*17*		

DATA	VALUE	SOURCE AND METHOD	NOTES
			Consumption in L was estimated using a 8 L/min fittings, so converted back into minutes to be able to model effects of different flow rates.
Public Lavatory Faucet	*29*	*Primary research (plumbing consultant, facility manager)* *National Building Regulations 2016*	*This data is obtained through on the calculations by a plumbing consultant based on his experience in the industry* *This data is obtained from the facility manager of a commercial facility and it is based on the following calculation:* *Operating Days: 280/Year* *Number of times a person uses faucet/day: 3 times* *Duration: 30 secs each* *NBR 2016 requires one wash basin per 25 office staff*
Shower head	*25*		*Per the list above, 40 L/shower x 5 persons per household; assuming 8 L/min fitting.*
Hot Water Share			
Bathroom Faucet	*16%*	*Primary Research (plumbing consultant)*	*96 L per average bathroom faucet: 16 L hot; 80 L cold*
Kitchen Faucet	*16%*		*Assumed equal to bathroom faucet.*
Public Lavatory Faucet	*20%*	*Primary Research (plumbing consultant, facility manager)*	*20%—40% range (e.g., 2 L/day/person hot water, 8 L/day/person cold water)*
Shower head	*15%*	*Primary Research (plumbing consultant)*	*From the questionnaire filled by experts in the industry*
Price of fitting in the market (USD)			
Bathroom Faucet	*20*	*Primary research (plumbing consultant and manufacturers)*	*USD 7 to 400. The price depends on the material, total weight, type, quality and brands.*
Kitchen Faucet			
Public Lavatory Faucet			
Shower head	*20*	*Primary research (plumbing consultant and manufacturers)*	*INR 8 to 4500.*
Energy embedded in water desalination; treatment; pumping; waste processing (kWh/m3)	*0.98*	*Secondary research*[29,30]	*Estimate based on average energy consumption for groundwater pumping and adding 37% of wastewater treatment consumption:* *Wastewater Treatment (37% of water treated): 0.19 kWh/m^3.*[31] *Groundwater pumping (80%): 0.37-1.44 kWh/m^3* *Desalination (unknown %, so not included in calculation)): 0.86 kWh/m^3 min.*

DATA	VALUE	SOURCE AND METHOD	NOTES
Residential water rates (INR/kL)	*146*	*Delhi Jal Board online portal*[32]	**Used the minimum of 146.41 to 292.82 INR/kL** *(for Delhi only)* *For KL wise consumption, please refer Appendix F* *Water being a state subject, the rates vary from state to state and this data is based on Delhi water rates specifically*
Residential electricity rate (INR/kWh)	*3*	*Bijli Bachao*[33]	**Used the minimum of the ranges 3 to 8 INR/kWh** *(for Delhi only)* *For kW/month wise consumption, please refer Appendix F*
Residential gas rates (INR/14.2kg)	*700-900*	*Good Returns*[34,35]*; Ministry of Petroleum and Natural Gas*[36]	*Indian households are allowed to purchase up to 12 LPG cylinders per year at subsidized rates.* *LPG canisters are the primary form of gas used. In Delhi, the cost of domestic LPG cylinder – 14.2 kgs stands at Rs 820 per month.*



Annex

SUMMARY OF RELEVANT POLICIES AND INSTITUTIONS IN INDIA

POLICY TYPE	SHOWER-HEAD	FAUCET	FLUSHING SYSTEM	WASHING MACHINE	ELECTRIC STORAGE WATER HEATER	SOLAR WATER HEATER	GAS & ELECTRIC INSTANT WATER HEATER
Overarching Policy	*No specific policy in-place presently, which defines performance or promotes application of any specific technology*			*Standards and Labeling policy in-place*			*No policy*
Building Certification Frameworks	*NBC 2016, Certifications: LEED, GRIHA, Indian Green Building Council*			*Not Available*			*No policy*
Standardization and Test Method	*Presently, there is No Standard for Showerheads in India*	*Safety and Dsign Standards from BIS related to faucets and its parts: IS 1795:1982; IS I781:1984; IS 1172:1993; IS 2064:1993; IS 8931:1933; IS 9763:2000*		*Both Safety and Performance Standards are defined*			*Instant electric water heater: IS 8978*
	Performance Standard and respective test method is under development by BIS			*IS 302-7-7:2010 IEC 60456:2010 (Refer BEE Schedule 12: Washing Machine)*	*IS 302-2-21: 2011 IS 2082:1993 With all amendments (Refer BEE Gazette Notification No. 7)*	*IS 16368:2015 IS 16544:2015 (Refer BEE Schedule 23: Solar Water Heater)*	*Gas water heater (storage): IS 5115 Gas water heater (instant): IS 15558*
Voluntary Programs	*1) WEP - I labeling37 2) Draft water fitting efficiency standard for rating the fittings is under development by BIS (expected to be launched in Voluntary regime in early 2021)*			*Voluntary S&L Program in-place (BEE Schedule 12)*	*Not Available*	*Voluntary S&L Program in-place (BEE Schedule) 38*	*No policy*
Standards (MEPS)	*Not Available*			*Yes*	*Yes. Refer Gazette Notification 39*	*Yes*	*No policy*
Comparative Label	*1) WEP – I Label for 3 level Star Rating 2) BIS is also developing a Label for 3 level Star Rating*			*Yes (BEE Star Label)*	*Yes (BEE Star Label)*	*Yes (BEE Star Label)*	*Not Available*
Endorsement Label	*No*			*No*	*No*	*No*	*Not Available*

LIST OF ACRONYMS

ACRONYM	DEFINITION
BCM	*Billions Cubic Meter*
BEE	*Bureau of Energy Efficiency*
BIS	*Bureau of Indian Standards*
CAGR	*Compound annual growth rate*
CO_2	*Carbon dioxide*
COVID 19	*Coronavirus disease 2019*
Delhi NCR	*Delhi National Capital Region*
EDS	*Environmental Design Solutions*
EEP – I	*Energy Efficient Products – India*
ETC	*Evacuated Tube Collector*
FPC	*Flat Plate Collectors*
FY	*Financial Year*
GRIHA	*Green Rating for Integrated Habitat Assessment*
GPCS – I	*Green Plumbing Code Supplement – India*
LEED	*Leadership in Energy and Environmental Design*
IAPMO	*Plumbing Codes and Standards India Private Limited*
IGBC	*Indian Green Building Council*
INR	*Indian Rupee*
IPA	*Indian Plumbing Association*
IS	*Indian Standard*
kg	*Kilogram*
kL	*Kiloliter*
kWh	*kilowatt-hour*
L/d	*Liters Per Day*
LPG	*Liquefied petroleum gas*
LPM	*Liters per minute*
NBC	*National Building Code*
NWP	*National Water Policy*
PNG	*Piped Natural Gas*
SWH	*Solar Water Heaters*
TDS	*Total dissolved solids*
TERI	*The Energy and Resources Institute*
UIPC – I	*Uniform Illustrated Plumbing Code*
UPC – I	*Uniform Plumbing Code – India*
USD	*US Dollars*
WELS	*Water Efficiency Labeling and Standards*
WEP - I	*Water Efficient Products - India*

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[40]

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[41]	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.[42]

Applicability of Requirements

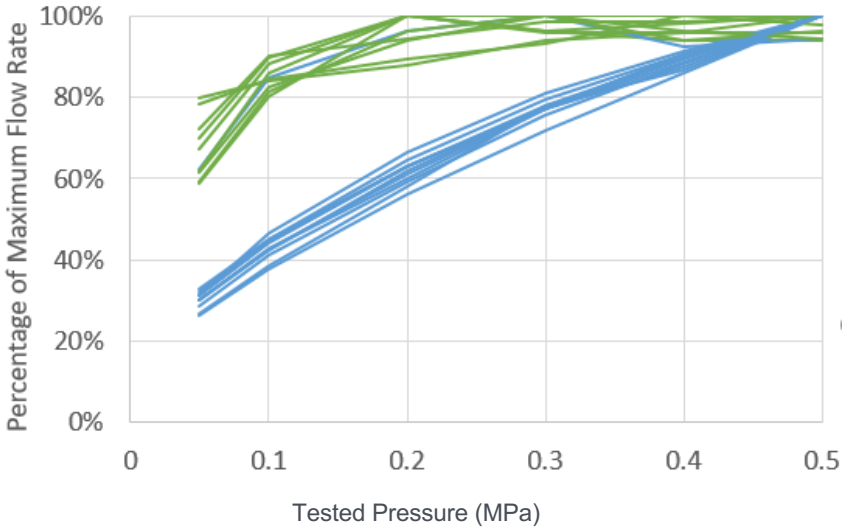
We recommend that fixtures meet requirements over the full range of pressure conditions in plumbing installations, as tested above. In addition to maximum flow rate requirements for water efficiency, requirements should require that fixtures maintain a minimum flow rate to guarantee performance and user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

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[43]*, 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.*
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.*[44]

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*[45]

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.*[46]

clasp Efficient Appliances for People & the Planet

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Endnotes

[1] *Extracted from Press Information Bureau, Government of India: https://pib.gov.in/PressReleasePage.aspx?PRID=1594012*

[2] *Mentioned on Ministry of Jal Shakti online portal that can be accessed here: https://jaljeevanmission.gov.in/*

[3] *Available on IAPMO India website: https://www.iapmo.org/india/product-certification/plumbing-and-mechanical-products*

[4] *Report by IAPMO India: https://www.iapmo.org/media/2336/2016-india-year-in-review.pdf*

[5] *Report by IAPMO India: https://www.iapmo.org/media/2336/2016-india-year-in-review.pdf*

[6] *To note: BIS requirements are mostly considered as a minimum qualification for the BEE's programs*

[7] *Notification no. 7 on BEE website accessible on http://www.beestarlabel.com/Home/EquipmentSchemes?type=M*

[8] *NBM&CW - Infra Construction & Equipment Magazine, "Hot Demand for Hot Water," 2013. [Online]. Available: https://www.nbmcw.com/product/other-products/30934-hot-demand-for-hot-water.html*

[9] *Economic Times India Times (2015). "Indian households spend over Rs 1,164 crore on purchasing electric water heaters," 2015. [Online]. Available: https://economictimes.indiatimes.com/industry/cons-products/durables/indian-households-spend-over-rs-1164-crore-on-purchasing-electric-water-heaters/articleshow/49758632.cms?from=mdr*

[10] *Ibidem*

[11] *S16544:2016; [4]*

[12] *BEE Schedule no. 23 for solar water heaters accessible here: https://beeindia.gov.in/sites/default/files/schedule_solar_water_heater.pdf*

[13] *The BIS standard for immersion water heater can be accessed here: https://law.resource.org/pub/in/bis/S05/is.368.1992.pdf*

[14] *As per NBC, Hot Bath: 43 °C as run, 41 °C for use; Warm Bath: 37 °C*

[15] *For information on water efficiency in Green Building Certifications, refer to the category WE (water efficiency) in their respective guidebooks*

[16] *Raghupati. P.U. and Foster, V. "A Scorecard for India", Water-Tariff & Subsidies in South Asia", 2002.*

[17] *Gary Klein, "Flow Rates for Faucets, Showers and Tub/Shower Combination Valves", ACEEE Hot Water Forum presentation, p. 11. https://www.aceee.org/sites/default/files/pdf/conferences/hwf/2019/1b-klein.pdf*

[18] *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/.*

[19] *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-AAER01/TN203718_20150220T141432_Staff_Analysis_of_Water_Efficiency_Standards_for_Toilets_Urinal.pdf*

[20] *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*

[21] *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*

[22] *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.*

[22] *https://efiling.energy.ca.gov/GetDocument.aspx?tn=205606&DocumentContentId=11922*

[23] *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.*

[24] *The Times of India, "Why Tap Water to Every Home is not a Pipe Dream", https://timesofindia.indiatimes.com/india/why-tap-water-to-every-home-is-not-a-pipe-dream/articleshow/69852764.cms*

[25] *Matheen, D. A. (2017, May 10). Changing Patterns of Water Consumption and Energy Use. Water India Expo 2017. IAPMO. Retrieved March 25, 2020, from https://www.smartcitiesindia.com/images/photo-gallery-2017/Room-C-Water-India/Water-Industry-of-India/Dr.-Abdul-Matheen.pdf*

Endnotes

[26] *Matto, M., Jainer, S., Kumar, M., & Sharda, C. (2017). Water Efficiency and Conservation in Urban India. New Delhi: Centre for Science and Environment.*

[27] *Matheen, D. A. (2017, May 10). Changing Patterns of Water Consumption and Energy Use. Water India Expo 2017. IAPMO. Retrieved March 25, 2020, from https://www.smartcitiesindia.com/images/photo-gallery-2017/Room-C-Water-India/Water-Industry-of-India/Dr.-Abdul-Matheen.pdf*

[28] *Matto, M., Jainer, S., Kumar, M., & Sharda, C. (2017). Water Efficiency and Conservation in Urban India. New Delhi: Centre for Science and Environment.*

[29] *Manju, S. and Sagar, N., "Renewable energy integrated desalination: A sustainable solution to overcome future fresh-water scarcity in India", Renewable and Sustainable Energy Reviews, June 2017, pp. 594-609. Cross referenced with Government of India report on Desalination and Water Purification Technologies, http://www.barc.gov.in/publications/tb/desalination.pdf.*

[30] *Journal Article on "Comparative Analysis of the Energy Consumption of Different Wastewater Treatment Plants" (Soares, Memelli, Roque, & Gonçalves, 2017); accessible here: http://www.sciencepublishinggroup.com/journal/paperinfo?journalid=383&doi=10.11648/j.ijaaa.20170306.11*

[31] *2015 report of the Central Pollution Control Board*

[32] *http://delhijalboard.nic.in/sites/default/files/All-PDF/Revised%2BWater%2BTarif%2Bwef%2B01022018_0.pdf*

[33] *https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in.html*

[34] *https://www.goodreturns.in/lpg-price-in-new-delhi.html#Price+of+LPG+Cylinder+in+Delhi*

[35] *https://www.goodreturns.in/lpg-price.html#Today%27s+LPG+Price+in+Indian+Metro+Cities+%26+State+Capitals*

[36] *https://pib.gov.in/PressReleasePage.aspx?PRID=1603063*

[37] *WEP-I or Water Efficient Products – India is described as a voluntary labeling program jointly developed by IAPMO Plumbing Codes and Standards India Private Limited (IAPMO India) and the India Plumbing Association (IPA). The intended objective of the WEP-I is to reduce water usage through efficient fixtures*

[38] *Refer Schedule No. 23 in the link: http://www.beestarlabel.com/Home/EquipmentSchemes?type=V*

[39] *Refer Gazette Notification No. 7 in the link: http://www.beestarlabel.com/Home/EquipmentSchemes?type=M*

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

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

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

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

[44] *EPA WaterSense, "High-Efficiency Lavatory Faucet Specification", Version 1.0, October 1, 2007, pp. 2-3.*

[45] *California Code of Regulations, Title 20, Section 1605.3, Table H-5.*

[46] *EPA WaterSense, "High-Efficiency Lavatory Faucet Specification", Version 1.0, October 1, 2007, pp. 1-2.*