



Energy efficient Washing Machines

Country

India

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1 Subtypes and markets

Washing machines have continuously and growingly been finding their way into Indian households. It has become a necessity in the daily lives of many people and is no longer considered only as luxury good. Its demand has been fuelled, like other consumer durables in the country, by the availability of innovative models from domestic and global brands, increasing disposable incomes, increasing investment by the government in infrastructure and a changing household arrangement. Washing machines in India are available in three major segments: semi-automatic, fully automatic front loading and fully automatic top-loading. Dryers, i.e. machines for the sole purpose of drying clothes are virtually non-existent in the Indian market as of now. The Bureau of Energy Efficiency has put washing machines under the voluntary scheme of its energy star rating program.

Washing machines are available in a large range in terms of their load capacity in kilograms. Semi-automatic washing machines have a lower capacity range, from about 5 kg to a maximum of 9 kg. On the other hand, fully automatic washing machines' load capacity varies from 6 kg to 11 kg, and going up to 17 kg in some brands. The semi-automatic range has a lower price point due to older technology and lower capacities.

Washing machines in India are broadly classified under two categories: semi-automatic and fully automatic. The difference between the two is that all the operations, i.e. washing, spinning, rinsing etc., happen automatically through a program in a fully automatic machine. In a semi-automatic machine, the clothes have to be shifted manually for different operations.

The fully automatic segment is further classified into two sub-segments: front loading fully automatic and top loading fully automatic. The semi-automatic and top-loading fully automatic machines are vertical axis systems, whereas the front loading machines are horizontal axis systems. These are further available in a range of loading capacities.

Most machines available in the market today have a water heater included in the system. Semi-automatic machines have shorter wash cycles but use more water, while fully automatic machines consume less water but have longer wash cycles. For this reason, if hot water is used for washing, semi-automatic machines will consume more power. Common features include auto-restart and auto-drainage.

Fully automatic machines have a range of pre-set programs already stored in its memory when shipped. Additional features in the top-of-the-line machines include a drive that washes clothes using

six types of drum motion, direct transmission of power from motor to the drum for a quieter operation (direct drive technology), inverter technology for optimum speed of the drum based on load, auto-lint filter and NFC tag, amongst others. Another difference is also in terms of durability. Most semi-automatic machines have high-grade plastic drums, while many fully automatic machines have stainless steel drums.

Due to the changing structure of the Indian household where increasingly women are working, the usage of washing machines has also correspondingly increased significantly. Bureau of Energy Efficiency's schedule for star rating of washing machines specifies 317 wash cycles a year for the calculation of annual energy consumption of domestic washing machines. Further, for the specified sample of soiled clothing the schedule states that three wash cycles are needed for satisfactory soil removal from the cloth. For cold wash cycles the water temperature is maintained at $27\pm 1^{\circ}\text{C}$. For all tests except the energy consumption test the water temperature is maintained at $48\pm 2^{\circ}\text{C}$ for semi-automatic and top-loading fully automatic washing machines. For front-loading fully automatic washing machines the corresponding temperature is maintained at $50\pm 2^{\circ}\text{C}$. Wash cycles in Indian households are generally carried out as cold wash cycles due to warmer climate.

The market for washing machines in India grew from about 600,000 units in 1996-97 to almost 1.4 million units in 2005-06, with a predicted market of 1.6 million units in the consecutive year. This would register a CAGR (Compound annual growth rate) of over 10%. In 2007-08 the estimated market for washing machines is between 2.0 to 2.3 million units. For the 5-year period between 2006-07 and 2011-12 the market for washing machines was estimated to grow at 9.3% (Indiastat, n.d.). The stock of all washing machines in India in 2011 stood at 16.5 million units, out of which rural and urban India contribute 2.2 and 14.3 million units respectively (The World Bank, 2008). According to a DuPont report published in 2013, "Indian Consumer Laundry Study", only 8.8% of all Indian households owned a washing machine.

Since India is a highly price-sensitive market the semi-automatic variant of washing machines has enjoyed a much higher market share than the more expensive fully automatic variant. A 2005 estimate suggests that the share was 85% and 15% in favour of the semi-automatic variant. The market share for fully automatic washing machines was estimated to increase to 39% by 2010 and become the dominant segment by 2020 with 69% of the washing machine sales (The World Bank, 2008). In the fully automatic segment in 2007 only about a third were front loading units (Virginie E. Letschert, 2007). In terms of capacity machines below 4 kg capacity had a 20% market share; machines in the range of 4-5 kg had the maximum market share at nearly 75%; and machines above the 5 kg capacity had a 5% market share (Indiastat, n.d.).

In 2011 washing machines consumed about 672 GWh of energy in India, which was only about 4.6% of the energy consumption by washing machines in the same year. In the year 2021 this figure is estimated to go up to 2,742 GWh. The average per unit energy consumption is considered to be 40.7 kWh in 2011 (The World Bank, 2008).

2 Efficiency range and user savings

The stock of semi-automatic machines remains the largest amongst all washing machines in India due to a lower price factor. But as disposable incomes of middle-class households are increasing, and due to improving technology and energy efficiency of fully automatic washing machines and significantly lower water consumption per washing cycle, top-loading fully automatic machines' sales are growing. Fully automatic machines also clean soiled clothes much better than semi-automatic machines. Front-loading fully automatic machines give the best soil removal from amongst all three variants.

Table 1: Efficiency range and user savings of washing machines

Level	Typical appliance in the stock (over all appliances in use)	Typical Inefficient appliance. If MEPS is implemented: Appliance just complying to minimum requirement (MEPS)	Typical appliance purchased (BAU – Business As Usual)	Best Available Technology (BAT)	Expected future BAT (Best not yet Available Technology)
Typical Capacity / Size	4 - 5 kg				
Category	Semi-automatic machine	Semi-automatic machine	Top-loading fully automatic machine	Front-loading fully automatic machine	Front-loading fully automatic machine direct drive technology
Type	Vertical axis	Vertical axis machine	Vertical axis	Horizontal axis	Horizontal axis

	machine		machine	machine	machine
Lifetime (years)	10	10	10	10	10
Qualitative classification of the provided service (e.g.: washing performance /etc.)	<input type="checkbox"/> Poor <input checked="" type="checkbox"/> Low <input type="checkbox"/> Average <input type="checkbox"/> Good <input type="checkbox"/> Excellent <input type="checkbox"/> No information	<input type="checkbox"/> Poor <input checked="" type="checkbox"/> Low <input type="checkbox"/> Average <input type="checkbox"/> Good <input type="checkbox"/> Excellent <input type="checkbox"/> No information	<input type="checkbox"/> Poor <input type="checkbox"/> Low <input type="checkbox"/> Average <input checked="" type="checkbox"/> Good <input type="checkbox"/> Excellent <input type="checkbox"/> No information	<input type="checkbox"/> Poor <input type="checkbox"/> Low <input type="checkbox"/> Average <input type="checkbox"/> Good <input checked="" type="checkbox"/> Excellent <input type="checkbox"/> No information	<input type="checkbox"/> Poor <input type="checkbox"/> Low <input type="checkbox"/> Average <input type="checkbox"/> Good <input checked="" type="checkbox"/> Excellent <input type="checkbox"/> No information
Yearly energy consumption: Electricity(kWh)	125	125	153	295	206
Yearly energy cost (INR)	687.5	687.5	841.5	1,622.5	1133
If applicable: yearly water consumption	120 litres	120 litres	100 litres	40 litres	NA
Yearly water cost (INR)	NA	NA	NA	NA	NA
Purchase cost in (INR)	13,000	13,000	23,000	28,000	NA
Operation & Maintenance cost (INR)	800 (lifetime)	800 (lifetime)	1,200 (lifetime)	1,200 (lifetime)	1,200 (lifetime)
Labeling class (for the aforementioned labels)	No star	2 star	3 star	5 star	-

3 Performance and information requirements

The standards and labeling scheme (S&L) introduced by the BEE in 2006 included washing machines under the voluntary scheme. BEE's schedule-12 specifies testing procedures and criteria for obtaining star labeling for both semi-automatic and fully automatic washing machines (Bureau of Energy Efficiency, 2016). This schedule has not been revised to make the criteria stricter like the schedules for appliances in the mandatory scheme. Compliance with these standards is rare due to the scheme being voluntary. Virtually none of the washing machines in the market presently have opted to obtain the star label. There are no mandatory requirements or MEPS for washing machines.

Traditionally in India women have been in-charge of household chores. In recent years with growth in affordability an increasing trend of hiring domestic help for these chores was observed. In the pre-liberalisation market in India a few players like Kelvinator, Allwyn, Godrej, and Voltas controlled 90% of the market. Post-liberalisation major global like LG, Sony, Samsung, Whirlpool etc. players also entered the market.

A changing household structure in urban areas, increasing disposable incomes, and innovative technology from these manufacturers have fuelled the market growth of this market. The market penetration for these appliances though is still less than refrigerators and televisions. Increasing demand led to voluntary requirements being introduced in 2006 by BEE. The standard adopted to draw the schedule specifying the testing procedures and star label criteria is IS 14155. The referred standard is IEC 60456.

The voluntary criteria for energy star rating of washing machines is given in the tables below:

Table 2: Semi-automatic washing machines, Schedule-12, BEE

Energy Consumption (kWh/kg)		
Semi-automatic		
MAX.	MIN.	STAR RATING
0.0173 ≥	≥ 0.0157	1 STAR
0.0157 >	≥ 0.0143	2 STAR
0.0143 >	≥ 0.0130	3 STAR
0.0130 >	≥ 0.0117	4 STAR
	< 0.0117	5 STAR

Table 3: Fully automatic washing machines, Schedule-12, BEE

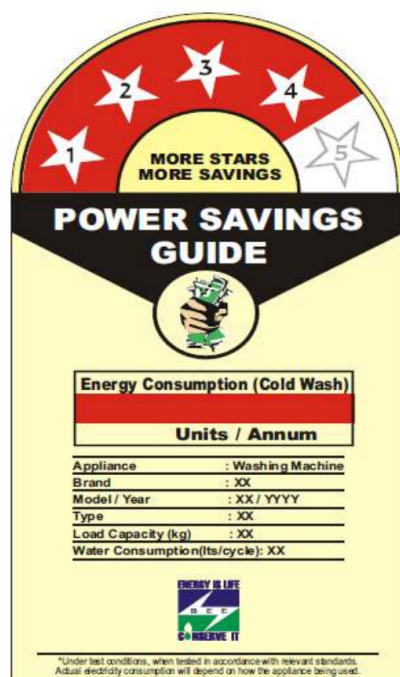
Energy Consumption (kWh/kg)		
Fully Automatic		
MAX.	MIN.	STAR RATING
0.0186 ≥	≥ 0.0169	1 STAR
0.0169 >	≥ 0.0154	2 STAR
0.0154 >	≥ 0.0140	3 STAR
0.0140 >	≥ 0.0126	4 STAR
	< 0.0126	5 STAR

The energy consumption of the appliance is measured in kWh/kg. The value obtained is matched to the energy band limit for the respective categories and the relevant star rating is assigned in terms of units of electricity consumed per annum. The test procedures for calculating the energy consumption value are specified in the next section.

The voluntary star rating scheme for washing machines is under the Standards and Labeling (S&L) scheme. In case of washing machines, it is invoked for domestic semi-automatic washing machines and fully automatic washing machines, i.e. front load and top load washing machines.

A sample star label is shown below:

Figure 1: Sample energy rating label for washing machines



The information included on the label is:

1. Appliance: Washing machine
2. Brand
3. Model/Year
4. Type
5. Load Capacity
6. Water consumption (lts/cycle)
7. Energy consumption (units/annum)

4 Test procedures and standards

The BEE schedule for rating washing machines uses the IS 14155 standard, with all its amendments, for calculating the energy consumption of the appliance in kilowatt per kg of load (kWh/kg). This is further used to assign a star rating to the appliance. The standards specify the test conditions for calculating the energy consumption.

The IS 14155 itself significantly draws upon several other standards. These standards have been mentioned in the foreword of the document. IS 14155 draws upon the requirements of IS 6390 (Part 1): 1983 for machines without tumbler dryers and spin extractors, and IS 6390 (Part 3): 1992 for requirements for spin extractions. For safety requirements of household electrical appliances IS 302-2-4 (1993) and IS 302-2-7 (1993) have been referred. Assistance has been derived from IEC 60456 (1974).

Parameters for initial verification and testing of Domestic washing machines (Bureau of Energy Efficiency, 2016) are as given below:

Performance Tests:

- a. Energy and Water consumption
- b. Determination of Wash Performance
- c. Water Extraction Efficiency
- d. Rinsing efficiency

Safety Tests:

- a. Protection against Electric Shock
- b. Input
- c. Temperature Rise Test
- d. Insulation Resistance and Leakage Current at operating temperatures
- e. Insulation Resistance and Electric Strength
- f. Endurance

The test conditions are:

- i. Water temperature for all performance tests except Energy and water consumption to be maintained as given:

Machine type	Temperature in °C
Semi-automatic	48±2
Top loading fully automatic	48±2
Front loading fully automatic	50±2

- ii. Water temperature for Energy and water consumption test is to be maintained at 27°C .
- iii. For washing performance test, total 3 number of cycles need to be performed to get average soil removal.
- iv. For preparation of soiled strips for carrying out wash performance test, Pig's blood soiling is replaced with Indian Curry soiling considering its practical aspect and day-to-day usability under Indian condition.
- v. Red Wine soiling is to be done with Indian Red Wine 'Riviera' in place of Alicant' s Red Wine.
- vi. Duration of various cycles for semi-automatic machines are as given in table below. The program time for fully Automatic washing machines would be as per the program selection for that machine.

Operation	Cycle time (in minutes)
Wash	15
Rinse	10
Spin	5+5

- vii. Built in water heating system in washing machine is not considered for this program.
- viii. Total number of wash cycles/machine/annum is assumed as 317.

5 Further information

In the pre-liberalization era Kelvinator, Allwyn, Godrej and Voltas were the major players in the Indian consumer durables market. Post liberalization multi-nationals like LG, Whirlpool, Daewoo, Sony and Samsung also entered the Indian market recognizing its huge potential. Today Korean brands like LG and Samsung, and other international brands like Whirlpool, Videocon, and the local IFB Industries are estimated to control over 90% of this segment. LG has a major 24% share in the overall market while in the front-loading washing machine segment IFB remains the market leader with a massive 65% share (Indiastat, n.d.). The Indian washing machine market is estimated to reach a value of almost \$1.5 billion, or Rs.836 crore, by 2017, with still greater potential to grow due to a low penetration rate of consumer durables, especially washing machines (Techsci Research, 2012).

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