Disaggregating Residential Shower Warm-Up Waste:

An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Labs

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A History Of Understanding Warm-Up Waste

Lawrence Berkeley National Laboratory (LBNL), under the direction of Jim Lutz, has a history of analyzing the water and energy waste associated with the wait for cooled-off hot water to be purged from the pipes connecting the hot water heater to the shower - referred to herein as warm-up waste. LBNL has published two known papers on this topic.

Feasibility Study and Roadmap to Improve Residential Hot Water Distribution Systems, published in 2004 used a mathematical formula derived by Lutz to analyze more than 26,000 shower events within the REUWS database (Mayer et al. 1999). Lutz summarized his calculations from the 2004 Feasibility Study paper in the background section of a 2011 paper, *Water and Energy Wasted During Residential Shower Events,* by stating the average waste volume for the examined showers was 3.48 gallons - which equates to 20% of the total volume of water used for showering (Lutz 2011).

As a follow-on paper Lutz (2011) was written to discuss the analysis of actual field data collected by LBNL in a pilot study of 3 single-family California homes. This analysis was based on water flow measured with an inline turbine meter and temperature measured with a thermistor probe inserted into the water flow deployed at the showerhead point-of-use.

Although the data set was limited to only five unique shower events, it suggested the average volume of wasted shower water was closer to 30% of the total shower volume. Lutz concluded, "When Lutz (2004) performed a rough calculation using data from the REUWS report and found an average of 20 percent of the volume of shower water was wasted, the approximation probably was low. Based on the data recorded for this study, the average volume of wasted shower water for showers is closer to 30 percent."

It is important to note the Lutz (2011) calculations include an additional volume of water that's wasted while users modify the shower to a comfortable bathing temperature after stepping in. As recognized by Lutz, this occurs because users typically turn the shower to full hot during the warm up to get hot water to the showerhead quickly. Once they've entered the shower they lower the water to a comfortable bathing temperature prior to using the water for showering, herein referred to as temperature throttling.

It should also be noted that neither paper attempted to disaggregate shower waste into its two main components: structural waste and behavioral waste. However, Lutz (2011) recognized their distinctions. Lutz states, "In the case of showers, waiting for cooled-off hot water to clear from the pipe that connects the water heater to the shower represents structural waste. Water that is hot enough, but runs down the drain before the user makes use of the shower, represents behavioral waste." (Lutz 2011)

Disaggregating And Quantifying Behavioral Waste

In the fall of 2013 Evolve Technologies LLC became aware that Lutz had installed the second generation of the LBNL monitoring system described in *Water and Energy Wasted During Residential Shower Events* in 19 homes throughout California. Significant amounts of data had been collected including time, temperature and flow rates at the showerhead point of use, but had not been analyzed. Recognizing an opportunity to disaggregate and quantify the behavioral waste component of shower warm-ups based on primary field research, Evolve Technologies LLC asked for and received permission to analyze the LBNL database.

Analysis Method

Applying the fundamentals of a method developed by Lutz, Evolve Technologies was able to analyze the shower events captured by the LBNL monitoring system from December 1 – December 31, 2013. The method consists of plotting the time, temperature and flow rate data collected by the LBNL monitoring

system at each showerhead and then determining the point at which the user actually entered the shower - herein referred to as the “entry point”.

The entry point is indicated by a rapid reduction and subsequent stabilization of the shower’s temperature after the shower’s peak temperature has been achieved. It is caused by the typical user behavior of turning the shower to full hot to speed the shower’s warm up and then adjusting to a comfortable bathing temperature upon entering the shower.

An illustration of a shower temperature plot from the database containing an identifiable entry point can be seen in the Figure 1 below.

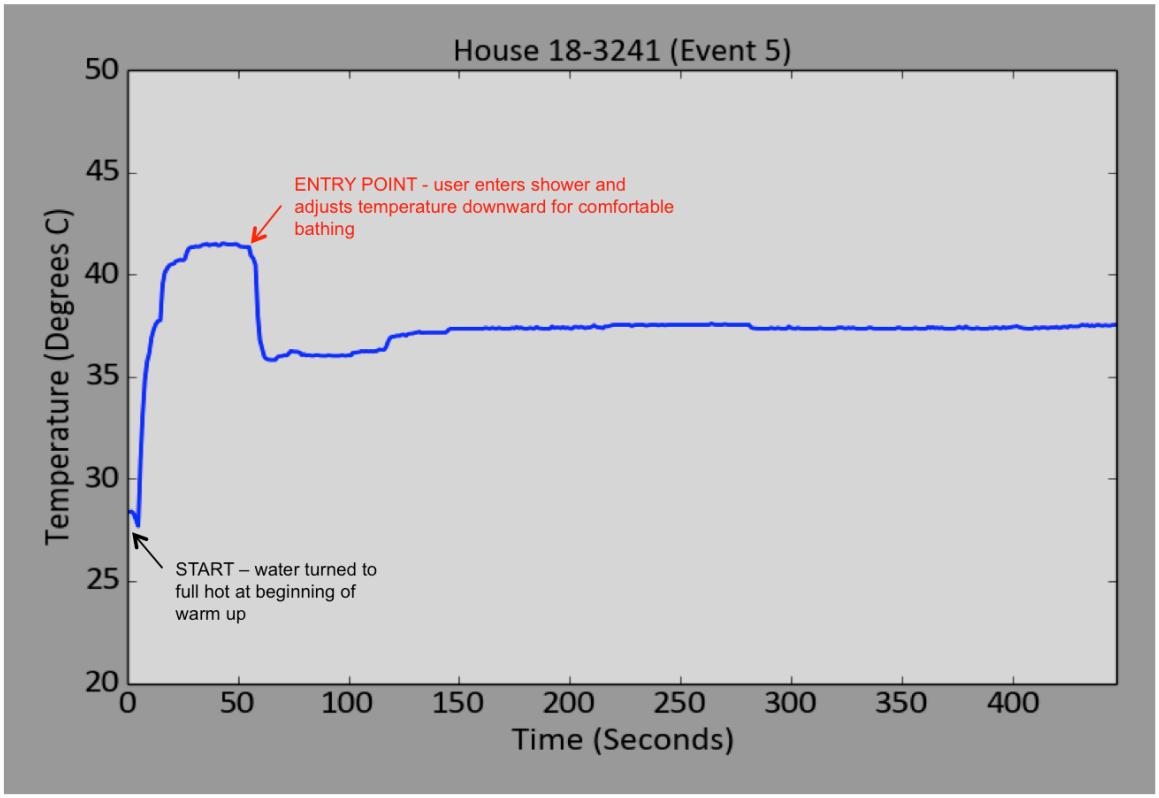

Figure 1

Once the shower temperature is plotted it is possible to identify the unique structural waste and behavioral waste components of the shower event. The structural waste occurs from the point at which the shower is turned on to the point at which the water approaches bathing temperature. The behavioral waste occurs from the point at which the shower approaches bathing temperature to the point at which the user enters the shower, the entry point. For the purpose of this analysis, the demarcation between structural waste and behavioral waste occurs at 95F/35C. An illustration of a shower temperature plot with unique structural waste and behavioral waste components can be seen in Figure 2.

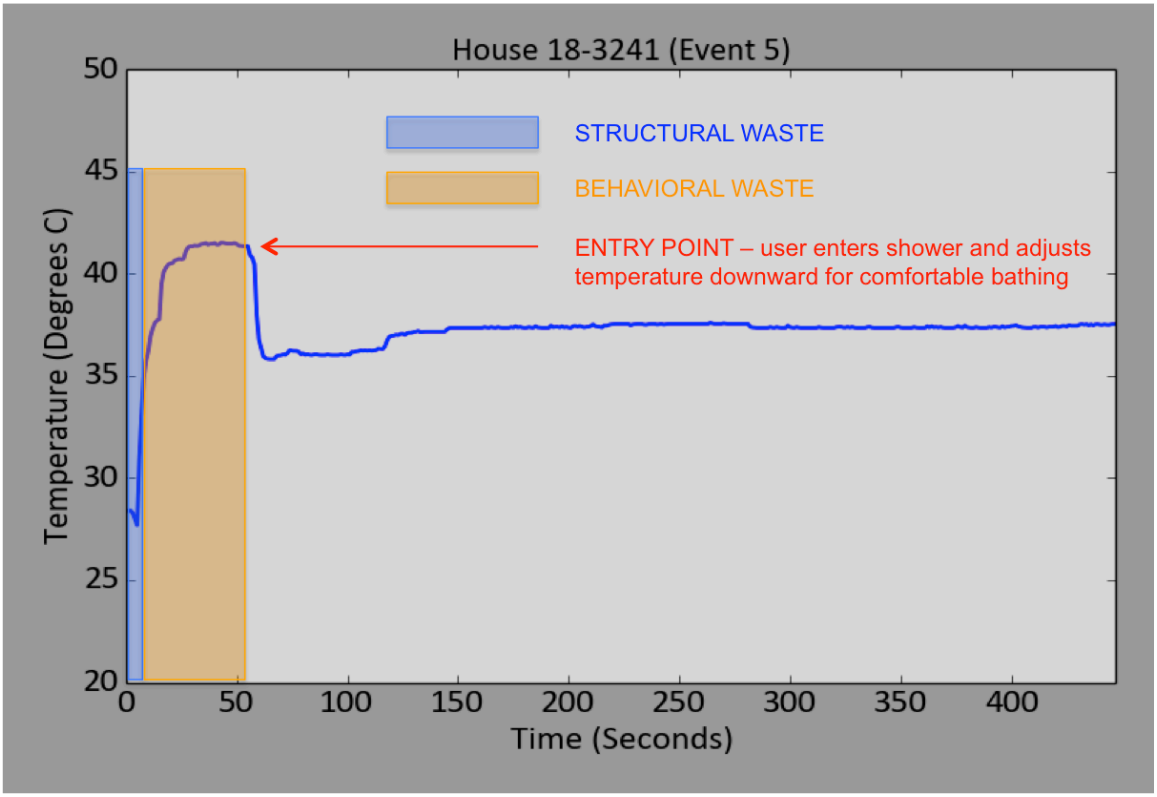

Figure 2

In total this method was applicable to 58% (283 out of 528) of the shower events captured by the LBNL monitoring system during the prescribed time period.

Monitored Residence Characteristics

Of the 19 monitored California homes, 11 produced shower data applicable to the previously described analysis method. In total 283 unique shower events were analyzed.

Total occupancy of the 11 homes, as reported by study participants, was 34 individuals.

The 11 homes represent 18 unique bathrooms with dedicated showers (44%) and tub/shower combos (56%), based on the assumption that a "master bath" contains a dedicated shower and an "other bath" contains a tub/shower combo. The distribution of shower type is similar to the results of a survey conducted by Evolve Technologies LLC (Sherman 2014) that found 38% of people typically shower in a dedicated shower and 62% typically shower in a tub/shower combo.

Home size distributions were: 1001 – 1500 SF (27%), 1501 – 2000 SF (27%), 2001 – 3000 SF (36%) and more than 3000 SF (9%).

One of the homes contained both an on-demand hot water recirculation system and a gas fueled tankless hot water heater.

Based on the above, the 283 shower event sample appears to contain a good distribution of both home sizes and shower types (dedicated and tub/shower combo).

A table of home characteristics can be seen in Table 1 below.

Home	Year Built	Square Footage	# Of Floors	# Of Residents	# Of Bathrooms	# Of Showers	Hot Water Heating Type	Recirculation System	Master Bath Data Analyzed	Other Bath Data Analyzed
HWDS_h3 (beagle2)	1904	1501-2000	2	2	2.5	2	Gas	No	Yes	Yes
HWDS_h4 (beagle5)	2011	2001-3000	1	4	2.5	2	Gas Tankless	On Demand	Yes	No
HWDS_h6 (beagle14)	1967	2001-3000	2	2	2.5	2	Gas	No	No	Yes
HWDS_h9 (beagle8)	1968	2001-3000	1	2	2	2	Gas	No	Yes	No
HWDS_h13 (beagle16)	1909	1501-2000	2	3	2	2	Gas	No	No	Yes
HWDS_h16 (beagle15)	1951	1001-1500	1	2	1	1	Gas	No	No	Yes
HWDS_h18 (beagle20)	2008	2001-3000	2	5	3	4	Gas	No	Yes	Yes (2 "others")
HWDS_h20 (beagle4)	2000	2001-3000	2	6	2.5	3	Gas	No	Yes	Yes
HWDS_h21 (beagle19)	1975	> 3000	1	3	2	2	Gas	No	Yes (2 "masters")	Yes
HWDS_h22 (beagle17)	1962	1501-2000	1	2	3	3	Gas	No	Yes	Yes
HWDS_h24 (beagle18)	1930	1001-1500	2	3	1	1	Gas	No	No	Yes

Table 1

Data Considerations

When reviewing the analysis of the data captured by the LBNL monitoring system, the following should be considered.

Tub Spout Warm-Ups:

The LBNL monitoring system was not capable of capturing the structural or behavioral waste associated with tub spout warm-ups because it was installed at the showerhead point of use. A tub spout warm-up occurs when the user of a tub/shower combo turns on the water and lets it warm-up by running it through the tub spout prior to diverting it to the showerhead.

According to a recent survey completed by Evolve Technologies LLC, consisting of more than 1,054 participants with at least 250 participants from each of the four major US Census Regions (Sherman 2014 – available in Appendix B), approximately 40% of all tub/shower combo shower events begin with a tub spout warm-up. The survey further reveals that 58% of people who conduct tub spout warm-ups leave the tub spout running on a regular or occasional basis to engage in other activities during the warm-up. This multitasking leads to significant amounts of behavioral waste due to the higher flow rates (4 – 7 gpm) produced by tub spouts.

A tub spout warm-up, as described above, would present in the LBNL field data as a shower event with little to no structural or behavioral waste because the water would have been hot as soon as it reached the showerhead and the user would enter the shower quickly thereafter. As a result of the LBNL monitoring system's design, its data likely under represents actual structural and behavioral waste and it is not necessary to apply additional discounts for tub spout warm-ups.

Inclusive of Cold Starts and Clustered Events:

Results from the LBNL field data are inherently inclusive of the structural and behavioral waste associated with both cold starts and clustered events.

A cold start occurs when someone takes a shower after the previously heated water residing in the hot water line running from the hot water heater to the shower has cooled to an ambient temperature. A cold start typically occurs in the first shower of the day and will contain a maximum amount of structural waste.

Clustered events occur when multiple showers are taken in close time proximity to one another. Clustered events will have a reduced amount of structural waste as the previously heated water residing in the hot water line running from the hot water heater to the shower remains warm and has not yet cooled to an ambient temperature.

Measurement at Showerhead Point of Use:
The structural waste volume derived from the LBNL field data is based on the volume and temperature of water exiting the showerhead. As a result, it includes a portion of water that was introduced into the showerhead's flow by the cold water line connected to the shower's mixing valve. The presence of this water would necessarily increase the measured volume of structural waste and thereby decrease the amount (duration and volume) of behavioral waste.

The impact however appears to be relatively small as users typically turn their showers to full hot during the warm up process. The ratio of hot water to cold water in the post mixing valve flow would be 84% to 16% respectively assuming a 120 F point-of-use temperature, a 130 F hot water heater delivery temperature and 65F cold water temperature.

Likely Biased Towards Conservation:
The flow rate average of the dedicated showers and tub/shower combos participating in the study was 1.79 gpm. This average is significantly below the typical 2.2 gpm flow rates sited in multiple REUWS studies. The lower average flow rates indicate the study's participants are likely more conservation oriented than average and, as a result, could be producing less total warm-up waste than typical.

Temperature Throttling:
The amount of time spent adjusting the shower to a comfortable bathing temperature after entering the shower is not included in the behavioral waste calculations. Behavioral waste in this analysis is measured from the point at which the shower approaches bathing temperature to the first point at which the user could have entered the shower, the entry point.

Weighting:
In order to ensure that no one home or set of behaviors overly influenced the analysis, each unique bathroom was given equal weighting within the analysis.

Given all of the above, the structural and behavioral waste amounts presented in the following results are conservative and, as such, can provide a reasonable basis for making water and energy savings projections.

Results
Analysis of the LBNL monitoring system data produced an average bathroom total warm-up waste (structural waste + behavioral waste) volume of 1.83 gallons. The breakout for the two components was .70 gallons of structural waste and 1.13 gallons of behavioral waste. As they pertain to total warm-up waste, structural waste comprised 38% of the volume and behavioral waste was 62%.

Due to the fact that behavioral waste is marked by the period spent away from the shower after near bathing temperature water has arrived, and that its volume will vary based on the showerhead's flow rate, behavioral waste is most appropriately expressed in time. In this context, the average behavioral waste for each bathroom was 38 seconds. As it pertains to total warm-up waste, structural waste comprised 41% of the time spent away from the shower during warm-up and behavioral waste comprised 59%.

Comprehensive results can be reviewed in Appendix A.

Further Quantifying Behavioral Waste

Establishing A Behavioral Waste Time From Available Data

There are two useful data sets from which to derive a behavioral waste time – Lutz (2004) and the December 2013 analysis. Although a third set exists, Lutz (2011), it will not be used due to its small sample size (5 shower events) and the inclusion of temperature throttling within its measurement. Both of these factors produce a less accurate result.

Lutz (2004) concluded the average warm-up waste volume was 3.48 gallons based on an analysis of the 1999 REUWS database. The average flow rate of showers captured by that database was 2.2 gpm. With this information the following formula can be used to convert the average volume to duration of time: (warm-up waste gallons / avg. flow rate) x 60 seconds. Computing the formula produces 95 seconds of warm-up waste.

Once the 3.48 gallons of warm-up waste has been converted to seconds, the behavioral waste component can be isolated. This is accomplished by multiplying the seconds of warm-up waste (95 sec.) by the percentage of time-based-behavioral-waste derived from the December 2013 analysis (59%). Computing the formula produces 56 seconds of behavioral waste.

Given the available data, is it is likely that behavioral waste exists in a time range that is bound by the December 2013 analysis on the low end and the Lutz (2004) analysis on the high end. This range is 38 – 56 seconds with a mean behavioral waste time of 47 seconds.

Both the low and the high end of the behavioral waste time range were computed using all or part of the results from the December 2013 analysis. As previously stated, that analysis is biased towards producing a conservative result. Accepting this conclusion, it is reasonable to adopt the range's mean, 47 seconds, as a basis for making behavioral waste projections.

The Tub Spout Factor

It is also important to consider the absence of tub spout warm-up data within the December 2013 results. A tub spout warm-up occurs when the user of a tub/shower combo turns on the water and lets it warm-up by running it through the tub spout prior to diverting it to the showerhead.

Based on the results of a recent survey completed by Evolve Technologies LLC, (Sherman 2014), approximately 40% of all tub/shower combo shower events begin with a tub spout warm-up. The survey further reveals that 58% of people who conduct tub spout warm-ups leave the tub spout running on a regular or occasional basis to engage in other activities during the warm-up.

This multitasking leads to significant amounts of behavioral waste due to the higher flow rates (4 – 7 gpm) through tub spouts. For example, 47 seconds (the behavioral waste range mean) of tub spout behavioral waste produces 4.3 gallons of discarded hot water assuming an average 5.5 gpm tub spout flow rate. The same 47 seconds would generate 1.6 gallons of behavioral waste with a 2.0 gpm showerhead. The tub spout behavioral waste volume is 2.7 times greater than that which is generated through the showerhead.

Based on the Evolve Technologies survey (Sherman 2014) approximately 14% off all showers begin with a tub spout warm-up that includes multitasking (62% tub shower combos x 40% tub spout warm-ups x 58% multitasking = 14.4%). Multiplying this result (14.4%) by the projected volume of behavioral waste generated via a tub spout warm-up (4.3 gallons) produces .61 gallons of behavioral waste. This .61 gallons of behavioral waste is a "tub spout factor" that can be added to our general behavioral waste projections to compensate for the absence of tub spout warm-ups in the December 2013 data.

Behavioral Waste Table And Calculation Considerations

As previously discussed, behavioral waste is a time driven event and as such, the volume of hot water

wasted will vary depending the showerhead's flow rate. Table 2 illustrates the volume of behavioral waste by showerhead flow rate and includes, as a separate component, the tub spout factor.

		Showerhead Behavioral Waste		Tub Spout Factor	Total Behavioral Waste
		Seconds	Gallons	Gallons	Gallons
Showerhead Flow Rate GPM	2.5	47	2	0.61	2.6
	2.25	47	1.8	0.61	2.4
	2	47	1.6	0.61	2.2
	1.75	47	1.4	0.61	2
	1.5	47	1.2	0.61	1.8

Table 2

When making calculations from Table 2 it is important to understand people use one of two methods to warm-up their shower. One method is a showerhead warm-up. This type occurs when users run water through the showerhead for their warm-up. The other method is a tub spout warm-up. This type occurs when the user of a tub/shower combo turns on the water and lets it warm-up by running it through the tub spout prior to diverting it to the showerhead.

Showerhead warm-ups occur in 75% of all showers taken when considering warm-up events in both dedicated showers and tub/shower combos (Sherman 2014). They occur 60% of the time in a tub/shower combo (Sherman 2014).

Tub spout warm-ups occur in 25% of all showers taken when considering warm-up events in both dedicated showers and tub/shower combos (Sherman 2014). They occur 40% of the time in a tub/shower combo (Sherman 2014).

When making calculations regarding the average behavioral waste for all shower warm-up types (showerhead warm-ups + tub spout warm ups), the Total Behavioral Waste Gallons column should be used.

When making calculations regarding the average behavioral waste for showerhead only warm-ups, the Showerhead Behavioral Waste Gallons column should be used.

When making calculations regarding the average behavioral waste for tub spout only warm-ups, the Showerhead Behavioral Waste Seconds column should first be converted to minutes (47 seconds / 60 seconds per minute = .78 minutes). Once the conversion has been made it (.78 minutes) can be multiplied by an average tub spout flow rate (5.5 gpm) to complete the calculation. For example, assuming an average tub spout flow rate of 5.5 gpm, the behavioral waste for a tub spout warm-up would be 4.3 gallons (.78 minutes x 5.5 gpm).

Behavioral Waste Characteristics

The December 2013 data reveals that behavioral waste varies widely. As is shown in Figure 3, some bathrooms/individuals consistently produce little to no behavioral waste while others consistently generate a lot - almost no one is "average".

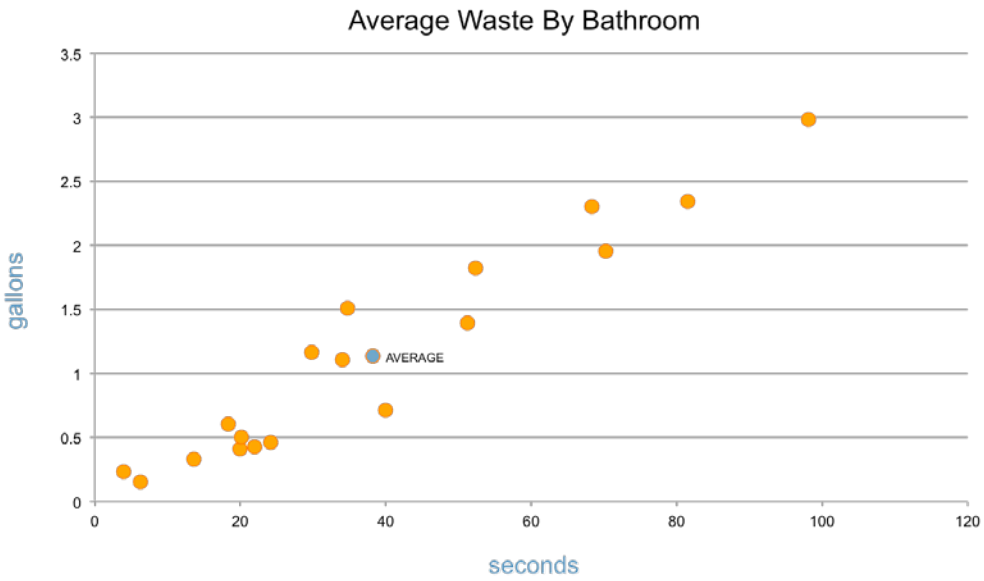

Figure 3

Plotting all 283 individual events, as seen in Figure 4, produces similar results, but further illustrates the large impact highly wasteful events have on the average.

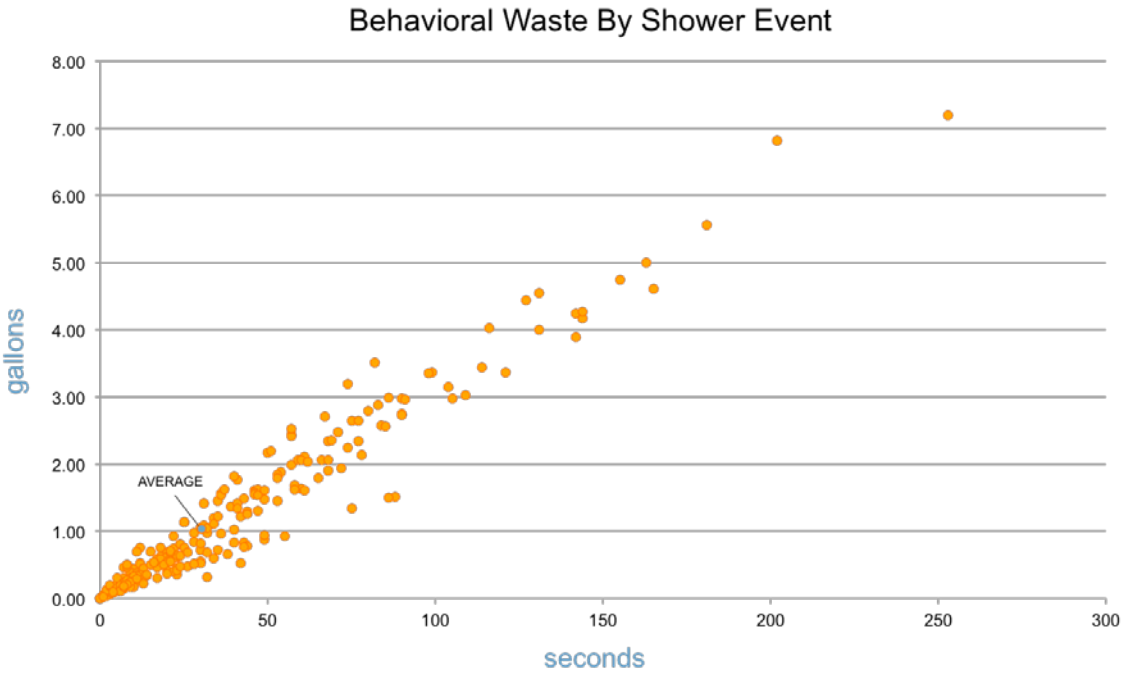

Figure 4

Additional Observations – Relationship Between Structural And Behavioral Waste

No Correlation Between Consistently Fast Hot Water Delivery And Reduced Behavioral Waste
It is commonly believed that the growing volumes of structural waste due to larger average home sizes (longer plumbing runs) and plumbing code requirements (larger diameter pipes) have given rise to the existence of behavioral waste. Namely, in the interest of using time efficiently people develop a habit of multitasking while waiting for their showers to become warm (Evolve Technologies 2008). As such, it is also generally assumed that homes with small amounts of structural waste would have reduced amounts of behavioral waste.

However, data collected from the LBNL monitoring system suggests there is no correlation between consistently fast hot water delivery times (low structural waste) and reduced amounts of behavioral waste. Specifically 50% of the bathrooms monitored by the LBNL system throughout December 2013 exhibited average hot water wait times less than 20 seconds, yet these bathrooms also exhibited higher than average amounts of behavioral waste (43 seconds of behavioral waste vs. the 38 second average). See Figure 5.

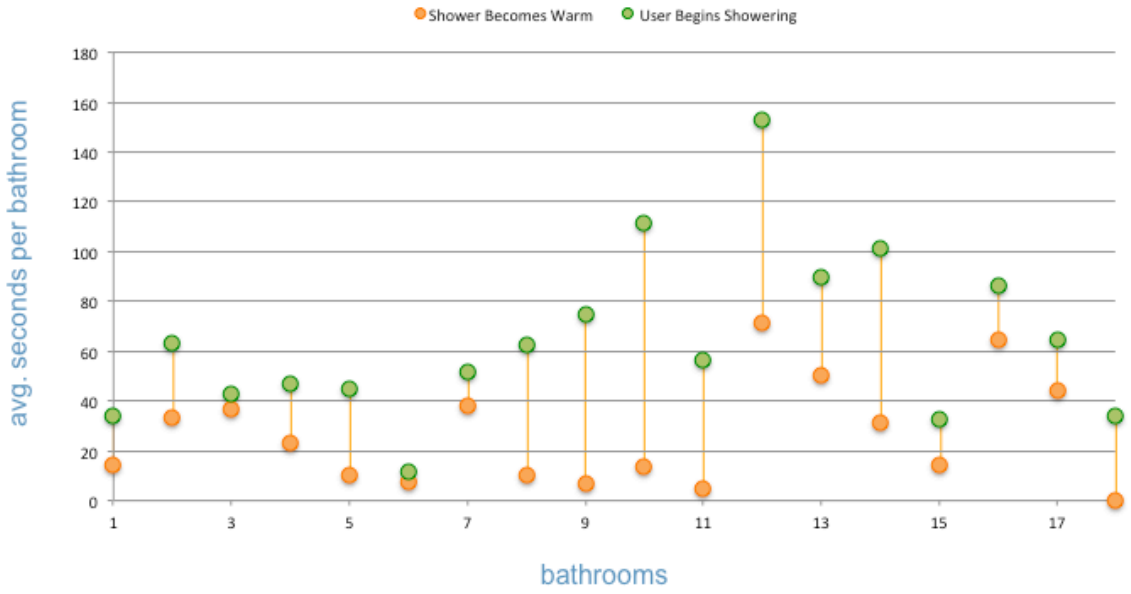

Figure 5

Fast Hot Water Delivery Has Minimal Impact On Lowering Warm-Up Waste
Consistently fast hot water delivery (defined as 20 seconds or less) does not appear to produce a statistically significant reduction in the total amount of warm-up waste. As illustrated in Figure 6 the variance between the average volumes of warm-up waste for all bathrooms vis-a-vis those with hot water wait times of 20 seconds or less is .15 gallons – less than 10%. Rather than reducing warm-up waste volume, fast hot water delivery appears to primarily shift the percentage of structural waste to behavioral waste within the volume.

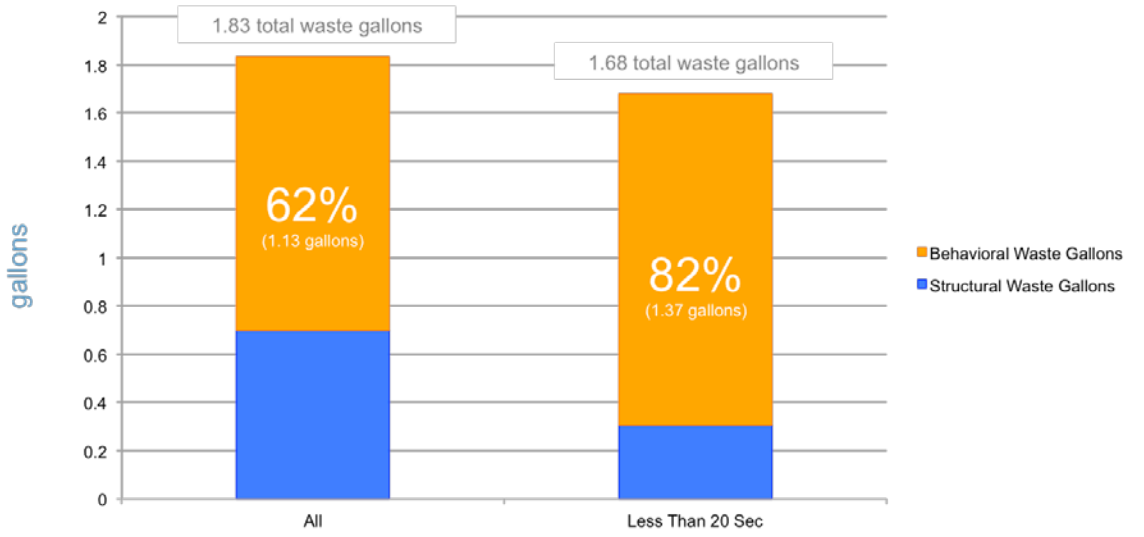

Figure 6

Summary And Conclusions

The previous efforts of Jim Lutz and his team at Lawrence Berkeley National Labs have created a solid foundation for understanding and quantifying shower-based warm-up waste. However, until recently, a main component of that waste, behavioral waste, has not been individually analyzed and quantified.

Due to the fact that behavioral waste is marked by the period spent away from the shower after near bathing temperature water has arrived, and that its volume will vary based on the showerhead's flow rate, behavioral waste is most appropriately expressed in time.

The data suggests behavioral waste exists within a 38 – 56 second range. The low end of the range, 38 seconds, is derived from the analysis of data collected by the LBNL monitoring system in December 2013 – a data set that is believed to be conservative. The high end of the behavioral waste range, 56 seconds, is computed by multiplying the percentage of behavioral waste generated from the conservative December 2013 data (59%) by the total warm-up waste time derived from Lutz (2004) (95 seconds). As such, it is reasonable to accept the entire behavioral waste range as conservative. Given the range's moderate nature it is recommended to adopt the range's mean (47 seconds) as the basis for calculating behavioral waste volumes.

Behavioral waste must ultimately be converted to gallons for the purpose of making water and energy savings calculations. When making this conversion the showerhead flow rate and a "tub spout" factor must be considered (see Table 2). Given these two variables behavioral waste ranges from 1.2 to 1.8 gallons to as much as 2.0 to 2.6 gallons per shower.

From an individual standpoint, behavioral waste varies widely. Some people consistently produce little to no behavioral waste while others regularly generate large amounts - almost no one is "average".

From an conservation industry standpoint, it is commonly believed that reducing structural waste and delivering hot water quickly to the point of use will produce a behavior change in users resulting in a significant reduction in behavioral waste. However, analysis of the data suggests that there is no

correlation between low structural waste and low behavioral waste. In fact, bathrooms with consistently fast hot water delivery times (20 seconds or less) showed more behavioral waste than average.

In general it appears as if the desire by users to multitask as part of their shower warm-up routine is strong and established habits may be difficult to break regardless of how quickly hot water arrives to the point-of-use.

Technologies such as the thermostatic showerhead valve produced by Evolve Technologies LLC can be an effective tool in eliminating behavioral waste without requiring behavior changes. As such, a thermostatic shower valve is also essential for guaranteeing the deemed savings commonly attributed to efficient plumbing configurations and products capable of reducing structural waste i.e. hot water recirculation systems.

While the work within this paper is the most comprehensive (blend of primary and secondary data) analysis of behavioral waste to date, further study is recommended. Future study should include new primary research techniques to more consistently determine the point at which the user enters the shower with the goal of greatly increasing the percentage of analyzable shower events. The techniques within this analysis were valid for 50% - 58% of the shower event data collected. Primary research to collect field data for tub spout warm ups is also recommended.

References:

Mayer et al. (1999) Mayer, Peter W., William B. DeOreo, Eva M. Opitz, Jack C. Kiefer, William Y. Davis, Benedykt Dziegielewski, and John Olaf Nelson. 1999. Residential End Uses of Water. Denver: AWWA Research Foundation.

Lutz (2004) Feasibility Study and Roadmap to Improve Residential Hot Water Distribution Systems

Lutz (2011) Water and Energy Wasted During Residential Shower Events: Findings from a Pilot Field Study of Hot Water Distribution Systems. Lawrence Berkeley National Laboratory.

Sherman (2014) Warming Your Shower Survey. Evolve Technologies LLC.

Evolve Technologies (2008) Shower Behavior: Awareness, Attitudes and Usage Survey. Evolve Technologies LLC.

APPENDIX A – Individual Shower Event Data By Bathroom

Raw data, individual event plotting and Excel analysis are readily available upon request.

	Time To Reach 95 F (Seconds)	Time To Enter Shower (Seconds)	Avg Flow Rate During Whole Shower (Gallons Per Minute)	Structural Waste (Seconds) - time to reach 95 F	Structural Waste (Gallons)	Behavioral Waste (Seconds)	Behavioral Waste (Gallons)	Total Shower Length (Minutes)	Water Consumption for Whole Shower (Gallons)
House 3-32ff									
Event 3	19.00	26.00	1.30	19.00	0.41	7.00	0.15	13.48	17.55
Event 7	16.00	39.00	0.93	16.00	0.25	23.00	0.36	11.43	10.67
Event 8	7.00	37.00	1.46	7.00	0.17	30.00	0.73	13.92	20.26
AVG.	14.00	34.00	1.23	14.00	0.28	20.00	0.41	12.94	16.16
House 3-3497									
Event 1	49.00	69.00	2.07	49.00	1.69	20.00	0.69	10.82	22.35
Event 7	46.00	68.00	2.54	46.00	1.95	22.00	0.93	8.95	22.72
Event 8	0.00	22.00	2.03	0.00	0.00	22.00	0.74	11.63	23.64
Event 10	26.00	44.00	2.52	26.00	1.09	18.00	0.76	19.37	48.81
Event 11	47.00	114.00	2.43	47.00	1.90	67.00	2.71	25.10	60.95
AVG.	33.60	63.40	2.32	33.60	1.33	29.80	1.17	15.17	35.69
House 4-325C									
Event 1	37.00	44.00	1.45	37.00	0.90	7.00	0.17	9.50	13.80
Event 2	53.00	64.00	1.43	53.00	1.27	11.00	0.26	19.33	27.74
Event 5	62.00	76.00	1.49	62.00	1.54	14.00	0.35	5.70	8.49
Event 6	37.00	45.00	1.45	37.00	0.89	8.00	0.19	9.38	13.60
Event 7	34.00	40.00	1.46	34.00	0.83	6.00	0.15	9.58	14.04
Event 8	32.00	37.00	1.46	32.00	0.78	5.00	0.12	7.92	11.57
Event 9	33.00	39.00	1.45	33.00	0.80	6.00	0.15	8.87	12.87
Event 10	40.00	45.00	1.48	40.00	0.99	5.00	0.12	6.50	9.63
Event 11	30.00	36.00	1.45	30.00	0.73	6.00	0.15	7.87	11.44
Event 12	43.00	52.00	1.53	43.00	1.09	9.00	0.23	13.43	20.49
Event 15	52.00	63.00	1.55	52.00	1.34	11.00	0.28	10.03	15.54
Event 16	34.00	38.00	1.48	34.00	0.84	4.00	0.10	5.12	7.55
Event 17	38.00	44.00	1.44	38.00	0.91	6.00	0.14	13.93	20.03
Event 18	36.00	43.00	1.43	36.00	0.86	7.00	0.17	13.78	19.65
Event 19	36.00	41.00	1.42	36.00	0.85	5.00	0.12	9.43	13.39
Event 21	43.00	50.00	1.44	43.00	1.03	7.00	0.17	8.97	12.89

Event 22	42.00	49.00	1.46	42.00	1.02	7.00	0.17	5.05	7.38
Event 23	42.00	49.00	1.49	42.00	1.04	7.00	0.17	10.47	15.61
Event 25	55.00	64.00	1.47	55.00	1.35	9.00	0.22	13.95	20.47
Event 26	53.00	58.00	1.50	53.00	1.32	5.00	0.12	9.02	13.49
Event 27	36.00	38.00	1.41	36.00	0.85	2.00	0.05	8.70	12.31
Event 28	34.00	41.00	1.44	34.00	0.81	7.00	0.17	7.05	10.12
Event 29	37.00	43.00	1.43	37.00	0.88	6.00	0.14	11.35	16.25
Event 30	38.00	46.00	1.40	38.00	0.88	8.00	0.19	6.42	8.97
Event 31	29.00	42.00	1.42	29.00	0.68	13.00	0.31	6.32	8.95
Event 32	54.00	66.00	1.41	54.00	1.27	12.00	0.28	17.15	24.21
Event 34	38.00	43.00	1.40	38.00	0.89	5.00	0.12	9.30	13.00
Event 35	38.00	47.00	1.40	38.00	0.89	9.00	0.21	11.58	16.24
Event 37	34.00	40.00	1.45	34.00	0.82	6.00	0.14	9.02	13.04
Event 38	33.00	37.00	1.46	33.00	0.80	4.00	0.10	6.72	9.78
Event 40	27.00	30.00	1.47	27.00	0.66	3.00	0.07	5.28	7.78
Event 42	28.00	33.00	1.46	28.00	0.68	5.00	0.12	4.48	6.54
Event 43	31.00	35.00	1.45	31.00	0.75	4.00	0.10	7.87	11.42
Event 44	33.00	35.00	1.47	33.00	0.81	2.00	0.05	4.82	7.08
Event 45	6.00	15.00	1.44	6.00	0.14	9.00	0.22	7.93	11.39
Event 46	32.00	34.00	1.45	32.00	0.78	2.00	0.05	4.97	7.22
Event 47	28.00	32.00	1.39	28.00	0.65	4.00	0.09	7.18	10.02
Event 48	41.00	48.00	1.37	41.00	0.93	7.00	0.16	17.23	23.57
Event 49	41.00	49.00	1.42	41.00	0.97	8.00	0.19	9.70	13.76
Event 50	67.00	78.00	1.38	67.00	1.54	11.00	0.25	15.82	21.86
Event 51	39.00	46.00	1.43	39.00	0.93	7.00	0.17	5.25	7.49
Event 52	33.00	37.00	1.40	33.00	0.77	4.00	0.09	14.12	19.72
Event 53	29.00	33.00	1.39	29.00	0.67	4.00	0.09	17.00	23.56
Event 55	34.00	38.00	1.39	34.00	0.79	4.00	0.09	13.05	18.19
Event 56	27.00	30.00	1.42	27.00	0.64	3.00	0.07	5.52	7.85
Event 57	6.00	10.00	1.41	6.00	0.14	4.00	0.09	7.23	10.23
Event 58	36.00	41.00	1.39	36.00	0.83	5.00	0.12	12.95	18.00
Event 59	32.00	37.00	1.41	32.00	0.75	5.00	0.12	9.23	13.00
Event 60	35.00	40.00	1.38	35.00	0.81	5.00	0.12	14.75	20.38
Event 61	26.00	29.00	1.36	26.00	0.59	3.00	0.07	20.08	27.32
Event 64	50.00	57.00	1.41	50.00	1.18	7.00	0.16	12.65	17.86
Event 65	31.00	33.00	1.36	31.00	0.70	2.00	0.05	4.92	6.68
Event 67	39.00	48.00	1.42	39.00	0.93	9.00	0.21	1.62	2.30
AVG.	36.87	43.17	1.43	36.87	0.88	6.30	0.15	9.72	13.88

House 7-32ad

Event 1	31.00	45.00	1.46	31.00	0.75	14.00	0.34	5.45	7.96
Event 2	6.00	46.00	1.25	6.00	0.12	40.00	0.83	4.45	5.55
Event 4	21.00	41.00	1.68	21.00	0.59	20.00	0.56	3.83	6.44
Event 6	24.00	50.00	1.11	24.00	0.45	26.00	0.48	5.42	6.03
Event 10	28.00	60.00	0.60	28.00	0.28	32.00	0.32	7.87	4.71
Event 21	27.00	40.00	1.02	27.00	0.46	13.00	0.22	5.45	5.58
AVG.	22.83	47.00	1.19	22.83	0.44	24.17	0.46	5.41	6.05

House 9-353e

Event 3	16.00	57.00	2.60	16.00	0.69	41.00	1.77	6.70	17.39
Event 7	16.00	51.00	2.50	16.00	0.67	35.00	1.46	3.43	8.59
Event 9	23.00	48.00	2.74	23.00	1.05	25.00	1.14	5.98	16.37
Event 10	10.00	60.00	2.61	10.00	0.43	50.00	2.17	3.02	7.87
Event 11	9.00	91.00	2.57	9.00	0.39	82.00	3.51	4.37	11.21
Event 13	3.00	13.00	2.63	3.00	0.13	10.00	0.44	3.72	9.78
Event 14	10.00	67.00	2.57	10.00	0.43	57.00	2.45	3.60	9.27
Event 16	17.00	68.00	2.59	17.00	0.73	51.00	2.20	3.83	9.91
Event 17	3.00	10.00	2.64	3.00	0.13	7.00	0.31	3.60	9.50
Event 18	9.00	45.00	2.60	9.00	0.39	36.00	1.56	5.28	13.74
Event 19	0.00	12.00	2.66	0.00	0.00	12.00	0.53	2.90	7.71
Event 20	9.00	66.00	2.54	9.00	0.38	57.00	2.42	3.05	7.76
Event 21	2.00	11.00	2.53	2.00	0.08	9.00	0.38	2.05	5.19
Event 24	11.00	68.00	2.66	11.00	0.49	57.00	2.53	3.55	9.44
Event 25	4.00	16.00	2.59	4.00	0.17	12.00	0.52	1.75	4.53
Event 31	5.00	14.00	2.62	5.00	0.22	9.00	0.39	3.07	8.04
Event 32	14.00	50.00	2.57	14.00	0.60	36.00	1.54	5.98	15.35
Event 35	9.00	46.00	2.64	9.00	0.40	37.00	1.63	3.02	7.95
Event 37	14.00	88.00	2.59	14.00	0.60	74.00	3.19	6.73	17.43
Event 38	18.00	49.00	2.74	18.00	0.82	31.00	1.42	3.22	8.82
Event 40	21.00	61.00	2.72	21.00	0.95	40.00	1.81	5.35	14.56
Event 42	11.00	16.00	2.62	11.00	0.48	5.00	0.22	4.77	12.51
Event 43	7.00	32.00	2.74	7.00	0.32	25.00	1.14	4.10	11.24
AVG.	10.48	45.17	2.62	10.48	0.46	34.70	1.51	4.05	10.62

House 14-32C3

Event 1	13.00	15.00	3.31	13.00	0.72	2.00	0.11	2.95	9.76
Event 3	13.00	13.00	3.02	13.00	0.66	0.00	0.00	2.45	7.41
Event 4	14.00	15.00	3.01	14.00	0.70	1.00	0.05	12.18	36.70
Event 5	14.00	14.00	3.33	14.00	0.78	0.00	0.00	2.42	8.05

Event 7	4.00	4.00	2.14	4.00	0.14	0.00	0.00	1.47	3.13
Event 9	6.00	8.00	3.25	6.00	0.32	2.00	0.11	2.68	8.72
Event 11	11.00	13.00	2.93	11.00	0.54	2.00	0.10	3.32	9.73
Event 13	9.00	12.00	3.53	9.00	0.53	3.00	0.18	2.95	10.41
Event 14	12.00	13.00	2.64	12.00	0.53	1.00	0.04	10.10	26.70
Event 15	10.00	12.00	2.52	10.00	0.42	2.00	0.08	9.10	22.89
Event 16	3.00	4.00	2.93	3.00	0.15	1.00	0.05	4.03	11.82
Event 17	11.00	13.00	3.66	11.00	0.67	2.00	0.12	3.25	11.90
Event 18	3.00	4.00	3.12	3.00	0.16	1.00	0.05	3.02	9.43
Event 20	13.00	28.00	2.78	13.00	0.60	15.00	0.70	4.87	13.54
Event 21	14.00	14.00	2.89	14.00	0.67	0.00	0.00	3.00	8.67
Event 22	4.00	6.00	3.86	4.00	0.26	2.00	0.13	7.75	29.93
Event 23	9.00	17.00	3.79	9.00	0.57	8.00	0.51	12.08	45.80
Event 24	3.00	10.00	4.02	3.00	0.20	7.00	0.47	5.35	21.49
Event 25	0.00	8.00	3.51	0.00	0.00	8.00	0.47	7.52	26.39
Event 26	11.00	16.00	3.66	11.00	0.67	5.00	0.31	4.83	17.71
Event 27	0.00	8.00	3.78	0.00	0.00	8.00	0.50	3.63	13.72
Event 28	4.00	7.00	3.79	4.00	0.25	3.00	0.19	6.70	25.40
Event 29	5.00	8.00	4.02	5.00	0.33	3.00	0.20	2.72	10.92
Event 30	3.00	15.00	3.78	3.00	0.19	12.00	0.76	9.70	36.62
Event 31	6.00	17.00	3.83	6.00	0.38	11.00	0.70	7.48	28.69
AVG.	7.80	11.76	3.32	7.80	0.42	3.96	0.23	5.42	18.22

House 16-33f8

Event 4	74.00	74.00	1.48	74.00	1.82	0.00	0.00	8.42	12.42
Event 8	6.00	38.00	1.29	6.00	0.13	32.00	0.69	3.63	4.67
Event 14	32.00	55.00	1.61	32.00	0.86	23.00	0.62	5.62	9.07
Event 16	7.00	20.00	1.57	7.00	0.18	13.00	0.34	3.15	4.95
Event 18	72.00	72.00	1.53	72.00	1.83	0.00	0.00	10.05	15.34
AVG.	38.20	51.80	1.49	38.20	0.96	13.60	0.33	6.17	9.29

House 18-3241

Event 1	8.00	88.00	2.09	8.00	0.28	80.00	2.79	7.40	15.49
Event 2	0.00	11.00	2.09	0.00	0.00	11.00	0.38	3.98	8.33
Event 5	9.00	55.00	2.11	9.00	0.32	46.00	1.62	7.45	15.72
Event 7	0.00	47.00	2.05	0.00	0.00	47.00	1.61	8.43	17.30
Event 9	9.00	84.00	2.12	9.00	0.32	75.00	2.66	9.15	19.43
Event 10	11.00	138.00	2.10	11.00	0.38	127.00	4.44	9.42	19.76
Event 11	23.00	57.00	2.12	23.00	0.81	34.00	1.20	5.75	12.18

Event 12	9.00	80.00	2.10	9.00	0.31	71.00	2.48	9.50	19.91
Event 13	9.00	95.00	2.08	9.00	0.31	86.00	2.98	9.30	19.37
Event 14	14.00	60.00	2.08	14.00	0.49	46.00	1.60	6.07	12.63
Event 18	18.00	149.00	2.08	18.00	0.62	131.00	4.54	11.50	23.94
Event 21	21.00	56.00	2.09	21.00	0.73	35.00	1.22	5.25	10.96
Event 22	9.00	92.00	2.08	9.00	0.31	83.00	2.88	8.50	17.68
Event 24	15.00	72.00	2.10	15.00	0.52	57.00	1.99	9.90	20.77
Event 25	16.00	70.00	2.09	16.00	0.56	54.00	1.88	8.83	18.43
Event 26	9.00	39.00	2.10	9.00	0.32	30.00	1.05	6.07	12.75
Event 27	15.00	76.00	2.08	15.00	0.52	61.00	2.11	6.77	14.06
Event 28	13.00	43.00	2.11	13.00	0.46	30.00	1.06	7.68	16.22
Event 30	16.00	75.00	2.09	16.00	0.56	59.00	2.06	7.10	14.86
Event 31	11.00	64.00	2.09	11.00	0.38	53.00	1.85	7.62	15.93
Event 32	8.00	36.00	2.11	8.00	0.28	28.00	0.98	7.53	15.87
Event 33	10.00	28.00	2.07	10.00	0.35	18.00	0.62	5.65	11.70
Event 34	10.00	49.00	2.10	10.00	0.35	39.00	1.36	9.10	19.10
Event 35	3.00	16.00	2.07	3.00	0.10	13.00	0.45	6.60	13.69
Event 36	9.00	56.00	2.07	9.00	0.31	47.00	1.62	8.32	17.23
Event 40	8.00	76.00	2.07	8.00	0.28	68.00	2.34	7.52	15.55
Event 42	5.00	65.00	2.06	5.00	0.17	60.00	2.06	6.95	14.34
Event 43	8.00	39.00	2.11	8.00	0.28	31.00	1.09	6.73	14.18
Event 45	11.00	52.00	2.08	11.00	0.38	41.00	1.42	8.83	18.37
Event 46	4.00	13.00	2.06	4.00	0.14	9.00	0.31	6.38	13.16
AVG.	10.37	62.70	2.09	10.37	0.36	52.33	1.82	7.64	15.96

House 18-3309

Event 3	7.00	97.00	1.99	7.00	0.23	90.00	2.98	5.80	11.53
Event 4	10.00	59.00	1.97	10.00	0.33	49.00	1.61	8.25	16.28
Event 5	8.00	107.00	2.04	8.00	0.27	99.00	3.36	6.50	13.25
Event 8	6.00	30.00	2.03	6.00	0.20	24.00	0.81	6.73	13.68
Event 9	7.00	24.00	2.08	7.00	0.24	17.00	0.59	4.27	8.88
Event 10	8.00	54.00	2.05	8.00	0.27	46.00	1.57	5.07	10.41
Event 11	6.00	75.00	2.05	6.00	0.20	69.00	2.36	4.55	9.33
Event 12	7.00	84.00	2.07	7.00	0.24	77.00	2.65	6.95	14.37
Event 13	6.00	104.00	2.05	6.00	0.21	98.00	3.35	8.15	16.72
Event 17	6.00	208.00	2.02	6.00	0.20	202.00	6.82	10.07	20.38
Event 18	7.00	31.00	2.01	7.00	0.23	24.00	0.80	5.10	10.24
Event 19	6.00	26.00	1.88	6.00	0.19	20.00	0.63	4.33	8.16
Event 20	5.00	71.00	1.88	5.00	0.16	66.00	2.07	5.28	9.93
Event 21	4.00	47.00	2.08	4.00	0.14	43.00	1.49	10.35	21.56

Event 22	6.00	97.00	1.96	6.00	0.20	91.00	2.97	5.70	11.16
Event 23	4.00	57.00	2.03	4.00	0.14	53.00	1.80	5.33	10.85
Event 24	7.00	123.00	2.08	7.00	0.24	116.00	4.03	11.72	24.41
Event 26	8.00	54.00	2.03	8.00	0.27	46.00	1.55	5.42	10.97
AVG.	6.56	74.89	2.02	6.56	0.22	68.33	2.30	6.64	13.45

House 18-33b6

Event 4	11.00	43.00	1.84	11.00	0.34	32.00	0.98	10.77	19.84
Event 5	8.00	82.00	1.83	8.00	0.24	74.00	2.25	6.70	12.24
Event 6	10.00	124.00	1.81	10.00	0.30	114.00	3.44	10.27	18.60
Event 8	4.00	72.00	1.83	4.00	0.12	68.00	2.07	9.67	17.66
Event 10	0.00	28.00	1.81	0.00	0.00	28.00	0.85	6.11	11.09
Event 12	70.00	251.00	1.84	70.00	2.15	181.00	5.56	12.27	22.60
Event 20	13.00	117.00	1.81	13.00	0.39	104.00	3.14	8.98	16.29
Event 25	8.00	57.00	1.81	8.00	0.24	49.00	1.48	6.70	12.15
Event 27	12.00	96.00	1.84	12.00	0.37	84.00	2.57	5.70	10.48
Event 28	11.00	101.00	1.83	11.00	0.34	90.00	2.74	7.78	14.23
Event 29	8.00	139.00	1.83	8.00	0.24	131.00	4.00	7.25	13.29
Event 30	11.00	174.00	1.84	11.00	0.34	163.00	5.01	10.07	18.55
Event 31	8.00	98.00	1.83	8.00	0.24	90.00	2.74	8.20	14.97
Event 33	9.00	94.00	1.81	9.00	0.27	85.00	2.56	8.58	15.54
Event 35	9.00	151.00	1.80	9.00	0.27	142.00	4.25	9.17	16.46
Event 36	23.00	178.00	1.84	23.00	0.70	155.00	4.74	7.88	14.47
Event 37	12.00	89.00	1.83	12.00	0.37	77.00	2.35	8.98	16.44
AVG.	13.35	111.41	1.83	13.35	0.41	98.06	2.99	8.53	15.58

House 20-3227

Event 1	6.00	74.00	1.68	6.00	0.17	68.00	1.90	5.42	9.10
Event 3	3.00	45.00	1.74	3.00	0.09	42.00	1.22	4.42	7.69
Event 4	26.00	46.00	1.25	26.00	0.54	20.00	0.42	6.67	8.36
Event 6	18.00	19.00	1.68	18.00	0.50	1.00	0.03	4.22	7.09
Event 9	2.00	146.00	1.74	2.00	0.06	144.00	4.17	6.53	11.35
Event 10	3.00	24.00	1.70	3.00	0.08	21.00	0.59	6.67	11.31
Event 13	3.00	63.00	1.64	3.00	0.08	60.00	1.64	3.27	5.36
Event 15	3.00	38.00	1.24	3.00	0.06	35.00	0.72	3.95	4.90
Event 16	4.00	257.00	1.71	4.00	0.11	253.00	7.20	12.87	21.96
Event 18	2.00	25.00	1.20	2.00	0.04	23.00	0.46	2.83	3.41
Event 19	2.00	24.00	1.64	2.00	0.05	22.00	0.60	12.25	20.04
Event 20	2.00	32.00	1.64	2.00	0.05	30.00	0.82	5.92	9.69

Event 29	2.00	111.00	1.66	2.00	0.06	109.00	3.02	5.27	8.77
Event 31	3.00	20.00	1.64	3.00	0.08	17.00	0.46	7.93	12.98
Event 33	3.00	68.00	1.66	3.00	0.08	65.00	1.80	4.55	7.55
Event 34	3.00	10.00	1.64	3.00	0.08	7.00	0.19	7.52	12.31
Event 37	2.00	12.00	1.65	2.00	0.06	10.00	0.28	6.67	11.02
Event 44	2.00	6.00	1.62	2.00	0.05	4.00	0.11	6.25	10.11
Event 45	3.00	46.00	1.17	3.00	0.06	43.00	0.84	3.90	4.55
AVG.	4.84	56.11	1.57	4.84	0.12	51.26	1.39	6.16	9.87

House 20-32fe

Event 1	91.00	149.00	1.74	91.00	2.64	58.00	1.68	10.32	17.96
Event 2	82.00	247.00	1.68	82.00	2.29	165.00	4.61	15.38	25.77
Event 3	18.00	162.00	1.78	18.00	0.53	144.00	4.27	12.17	21.63
Event 4	95.00	139.00	1.76	95.00	2.79	44.00	1.29	12.52	22.09
Event 7	46.00	71.00	1.81	46.00	1.39	25.00	0.76	10.40	18.86
Event 8	97.00	150.00	1.64	97.00	2.66	53.00	1.45	11.98	19.70
AVG.	71.50	153.00	1.74	71.50	2.05	81.50	2.34	12.13	21.00

House 21-3314

Event 1	55.00	77.00	1.11	55.00	1.02	22.00	0.41	8.33	9.28
Event 3	57.00	85.00	1.11	57.00	1.06	28.00	0.52	9.43	10.50
Event 5	51.00	95.00	1.06	51.00	0.90	44.00	0.78	11.57	12.28
Event 6	45.00	100.00	1.02	45.00	0.76	55.00	0.93	13.42	13.67
Event 7	33.00	121.00	1.03	33.00	0.57	88.00	1.52	9.40	9.73
Event 8	50.00	93.00	1.08	50.00	0.90	43.00	0.77	8.32	8.97
Event 9	76.00	106.00	1.12	76.00	1.41	30.00	0.56	10.35	11.55
Event 10	59.00	76.00	1.10	59.00	1.08	17.00	0.31	8.82	9.72
Event 11	29.00	59.00	1.06	29.00	0.51	30.00	0.53	7.75	8.18
Event 13	41.00	127.00	1.05	41.00	0.72	86.00	1.50	15.28	16.02
Event 15	60.00	88.00	1.10	60.00	1.10	28.00	0.51	6.99	7.69
Event 16	57.00	91.00	1.06	57.00	1.01	34.00	0.60	8.57	9.10
Event 18	30.00	53.00	1.09	30.00	0.54	23.00	0.42	9.55	10.39
Event 20	30.00	50.00	1.10	30.00	0.55	20.00	0.37	11.35	12.47
Event 22	62.00	137.00	1.08	62.00	1.12	75.00	1.35	11.65	12.58
Event 23	90.00	100.00	1.06	90.00	1.59	10.00	0.18	8.12	8.58
Event 24	36.00	85.00	1.09	36.00	0.65	49.00	0.89	12.95	14.06
Event 25	39.00	77.00	1.05	39.00	0.68	38.00	0.67	11.50	12.11
AVG.	50.00	90.00	1.08	50.00	0.90	40.00	0.71	10.19	10.94

House 21-3456

Event 6	47.00	94.00	1.68	47.00	1.31	47.00	1.31	9.07	15.20
Event 8	29.00	101.00	1.62	29.00	0.78	72.00	1.94	9.33	15.09
Event 10	42.00	54.00	1.80	42.00	1.26	12.00	0.36	8.05	14.50
Event 18	38.00	180.00	1.65	38.00	1.04	142.00	3.89	9.97	16.40
Event 19	25.00	48.00	1.71	25.00	0.71	23.00	0.65	5.58	9.53
Event 21	26.00	70.00	1.72	26.00	0.75	44.00	1.26	6.77	11.65
Event 22	23.00	128.00	1.71	23.00	0.65	105.00	2.98	6.85	11.68
Event 23	15.00	73.00	1.68	15.00	0.42	58.00	1.63	9.70	16.34
Event 24	23.00	101.00	1.65	23.00	0.63	78.00	2.14	8.00	13.18
Event 26	42.00	163.00	1.67	42.00	1.17	121.00	3.36	11.35	18.93
AVG.	31.00	101.20	1.69	31.00	0.87	70.20	1.95	8.47	14.25

House 21-351a

Event 1	12.00	19.00	1.98	12.00	0.40	7.00	0.23	9.53	18.86
Event 2	14.00	25.00	1.86	14.00	0.43	11.00	0.34	7.20	13.38
Event 3	17.00	27.00	1.98	17.00	0.56	10.00	0.33	9.80	19.40
Event 4	17.00	22.00	1.98	17.00	0.56	5.00	0.17	13.70	27.14
Event 5	15.00	47.00	1.98	15.00	0.50	32.00	1.06	24.02	47.60
Event 6	20.00	41.00	1.98	20.00	0.66	21.00	0.69	9.78	19.34
Event 8	18.00	34.00	2.02	18.00	0.61	16.00	0.54	17.63	35.65
Event 9	26.00	67.00	1.97	26.00	0.85	41.00	1.34	22.95	45.12
Event 13	11.00	19.00	2.00	11.00	0.37	8.00	0.27	7.02	14.05
Event 16	26.00	88.00	1.97	26.00	0.86	62.00	2.04	12.30	24.27
Event 18	17.00	35.00	1.98	17.00	0.56	18.00	0.59	28.65	56.62
Event 19	13.00	20.00	1.98	13.00	0.43	7.00	0.23	7.05	13.98
Event 20	6.00	27.00	1.98	6.00	0.20	21.00	0.69	5.77	11.40
Event 22	10.00	18.00	1.99	10.00	0.33	8.00	0.26	8.57	17.01
Event 24	17.00	38.00	2.03	17.00	0.57	21.00	0.71	6.78	13.76
Event 27	8.00	23.00	2.00	8.00	0.27	15.00	0.50	7.28	14.59
Event 30	10.00	17.00	2.03	10.00	0.34	7.00	0.24	16.05	32.59
Event 31	4.00	12.00	2.01	4.00	0.13	8.00	0.27	5.98	12.02
Event 33	13.00	60.00	1.96	13.00	0.42	47.00	1.54	8.92	17.49
Event 34	18.00	34.00	2.04	18.00	0.61	16.00	0.54	5.60	11.40
Event 35	7.00	23.00	2.01	7.00	0.23	16.00	0.54	7.38	14.87
Event 36	12.00	18.00	2.00	12.00	0.40	6.00	0.20	7.38	14.79
AVG.	14.14	32.45	1.99	14.14	0.47	18.32	0.61	11.33	22.51

House 22-3243

Event 1	108.00	157.00	1.15	108.00	2.08	49.00	0.94	8.13	9.38
Event 5	87.00	96.00	1.17	87.00	1.70	9.00	0.18	7.97	9.31
Event 6	0.00	6.00	1.19	0.00	0.00	6.00	0.12	2.07	2.47
Event 7	63.00	87.00	1.21	63.00	1.27	24.00	0.48	4.52	5.46
AVG.	64.50	86.50	1.18	64.50	1.26	22.00	0.43	5.67	6.66

House 22-3502

Event 2	76.00	85.00	1.61	76.00	2.04	9.00	0.24	3.38	5.46
Event 3	17.00	37.00	1.61	17.00	0.46	20.00	0.54	4.47	7.20
Event 4	68.00	129.00	1.59	68.00	1.80	61.00	1.61	4.30	6.82
Event 5	50.00	92.00	0.76	50.00	0.64	42.00	0.53	7.32	5.58
Event 6	64.00	71.00	1.55	64.00	1.65	7.00	0.18	2.65	4.11
Event 7	14.00	25.00	1.63	14.00	0.38	11.00	0.30	4.57	7.46
Event 8	37.00	73.00	1.61	37.00	0.99	36.00	0.97	5.37	8.63
Event 10	11.00	25.00	1.54	11.00	0.28	14.00	0.36	2.72	4.18
Event 11	15.00	41.00	1.59	15.00	0.40	26.00	0.69	2.93	4.67
Event 13	76.00	80.00	1.61	76.00	2.04	4.00	0.11	6.43	10.36
Event 14	75.00	94.00	1.59	75.00	1.99	19.00	0.50	3.73	5.95
Event 15	72.00	79.00	1.58	72.00	1.89	7.00	0.18	2.32	3.65
Event 16	69.00	76.00	1.59	69.00	1.83	7.00	0.19	8.53	13.61
Event 17	4.00	12.00	1.60	4.00	0.11	8.00	0.21	3.52	5.63
Event 20	53.00	60.00	1.63	53.00	1.44	7.00	0.19	6.53	10.62
Event 21	57.00	81.00	1.60	57.00	1.52	24.00	0.64	11.32	18.08
Event 22	4.00	25.00	1.58	4.00	0.11	21.00	0.55	4.23	6.68
Event 23	35.00	75.00	1.54	35.00	0.90	40.00	1.03	17.27	26.58
AVG.	44.28	64.44	1.55	44.28	1.14	20.17	0.50	5.64	8.63

House 24-32da

Event 21	0.00	34.00	1.96	0.00	0.00	34.00	1.11	3.42	6.68
AVG.	0.00	34.00	1.96	0.00	0.00	34.00	1.11	3.42	6.68

	Avg Time To Reach 95 F (Seconds)	Avg.Time To Enter Shower (Seconds)	Avg. Flow Rate During Whole Shower (Gallons Per Minute)	Avg. Structural Waste (Seconds) - time to reach 95 F	Avg. Structural Waste (Gallons)	Avg.Behavioral Waste (Seconds)	Avg. Behavioral Waste (Gallons)	Avg. Total Shower Length (Minutes)	Avg. Water Consumption for Whole Shower (Gallons)
TOTAL AVG.	26.35	64.61	1.79	26.35	0.70	38.26	1.13	8.04	14.19

APPENDIX B – Warming Your Shower Survey

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Warming Your Shower Survey

Design Survey | Collect Responses | Analyze Results

CURRENT VIEW

+ FILTER | + COMPARE | + SHOW

- FILTER: Q6: Tub/Shower Combo
- FILTER: Q8: Tub Spout Warm Up
- FILTER: Midwest Census Region
- FILTER: South Census Region
- FILTER: West Census Region
- FILTER: Northeast Census Region
- FILTER: Q8: Showerhead Warm Up
- FILTER: Q8: Tub Spout Warm Up

SAVED VIEWS (2)

Original View (No rules applied) Revert

View complete responses only

+ Save as...

EXPORTS

SHARED DATA (1)

Shared Data 1

RESPONDENTS: 1,057 of 1,057 — Export All | Share All

Question Summaries | Data Trends | Individual Responses

All Pages

PAGE 2: Tell Us A Little About Yourself

Q1 — Export

Demographic Info

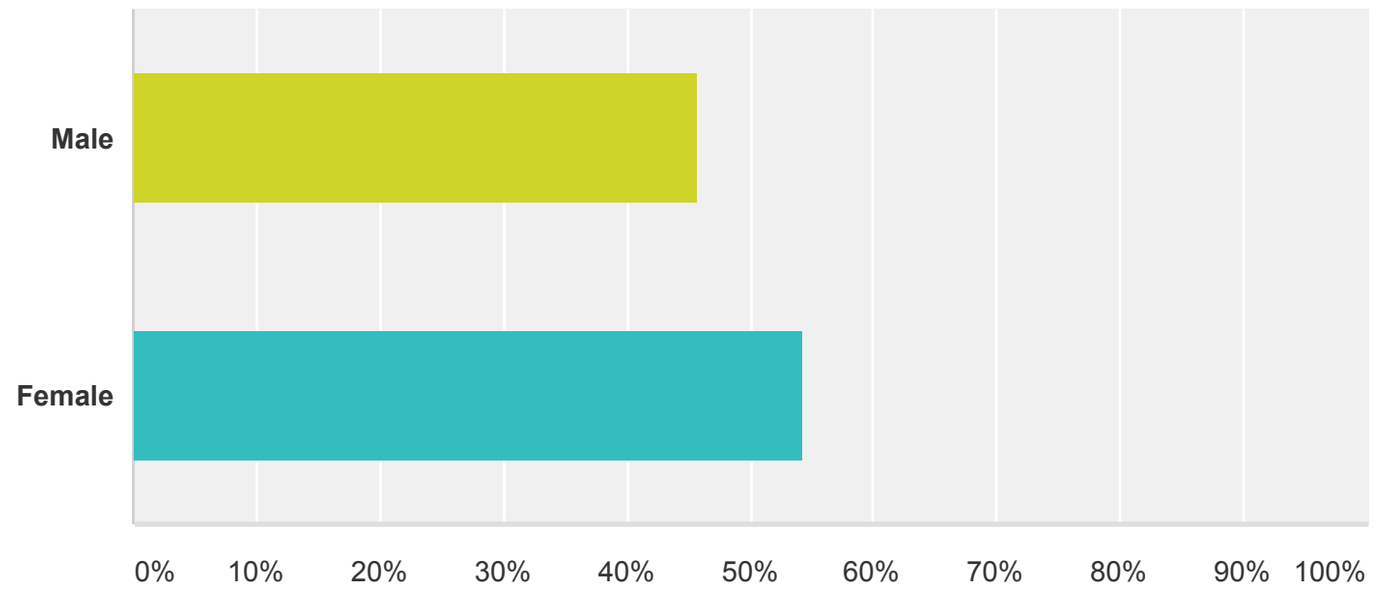
Answered: 1,054 Skipped: 3

Answer Choices		Responses	
Name	Responses	100.00%	1,054
Company	Responses	0.00%	0
Address	Responses	0.00%	0
Address 2	Responses	0.00%	0
City/Town	Responses	0.00%	0
State/Province	Responses	100.00%	1,054
ZIP/Postal Code	Responses	0.00%	0
Country	Responses	0.00%	0
Email Address	Responses	0.00%	0
Phone Number	Responses	0.00%	0

Q2 — Customize | Export

What is your gender?

Answered: 1,054 Skipped: 3



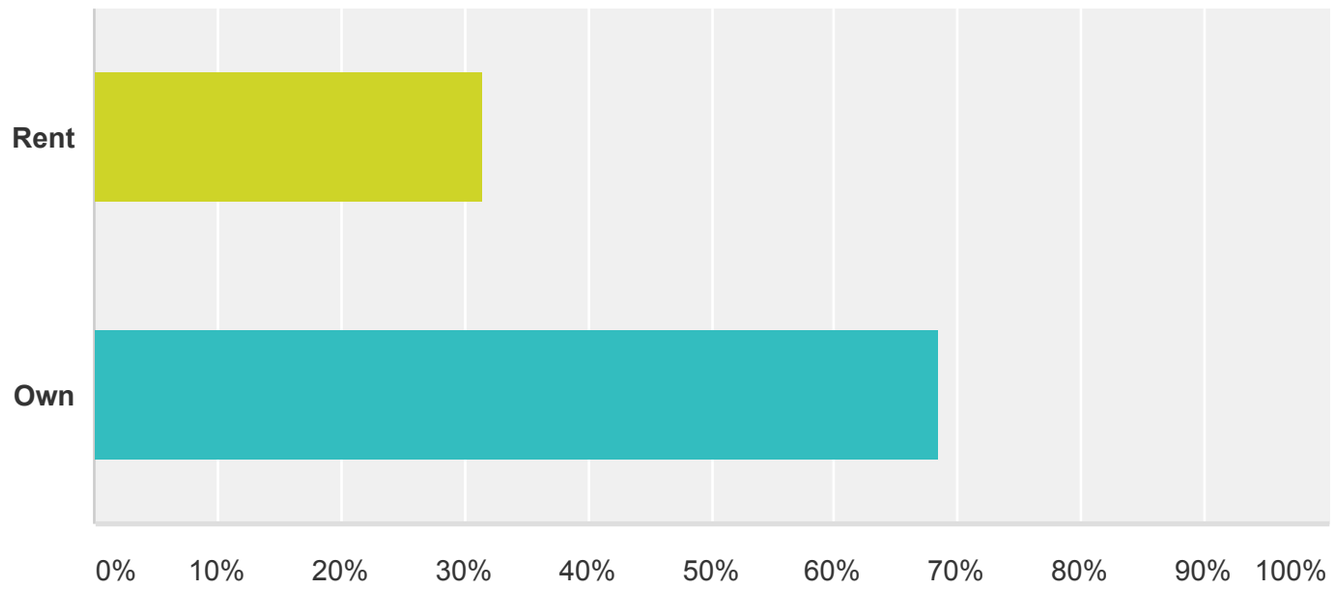
Answer Choices	Responses

Male	45.64%	481
Female	54.36%	573
Total		1,054

Q3 Customize Export

Do you rent or own?

Answered: 1,054 Skipped: 3



Answer Choices	Responses	
Rent	31.59%	333
Own	68.41%	721
Total		1,054

Q4 Customize Export

Do you have a hot water recirculation loop or hot water recirculation system in your residence?

Answered: 1,054 Skipped: 3

Answer Choices	Responses	
Yes	8.73%	92
No	49.34%	520
Don't know	41.94%	442

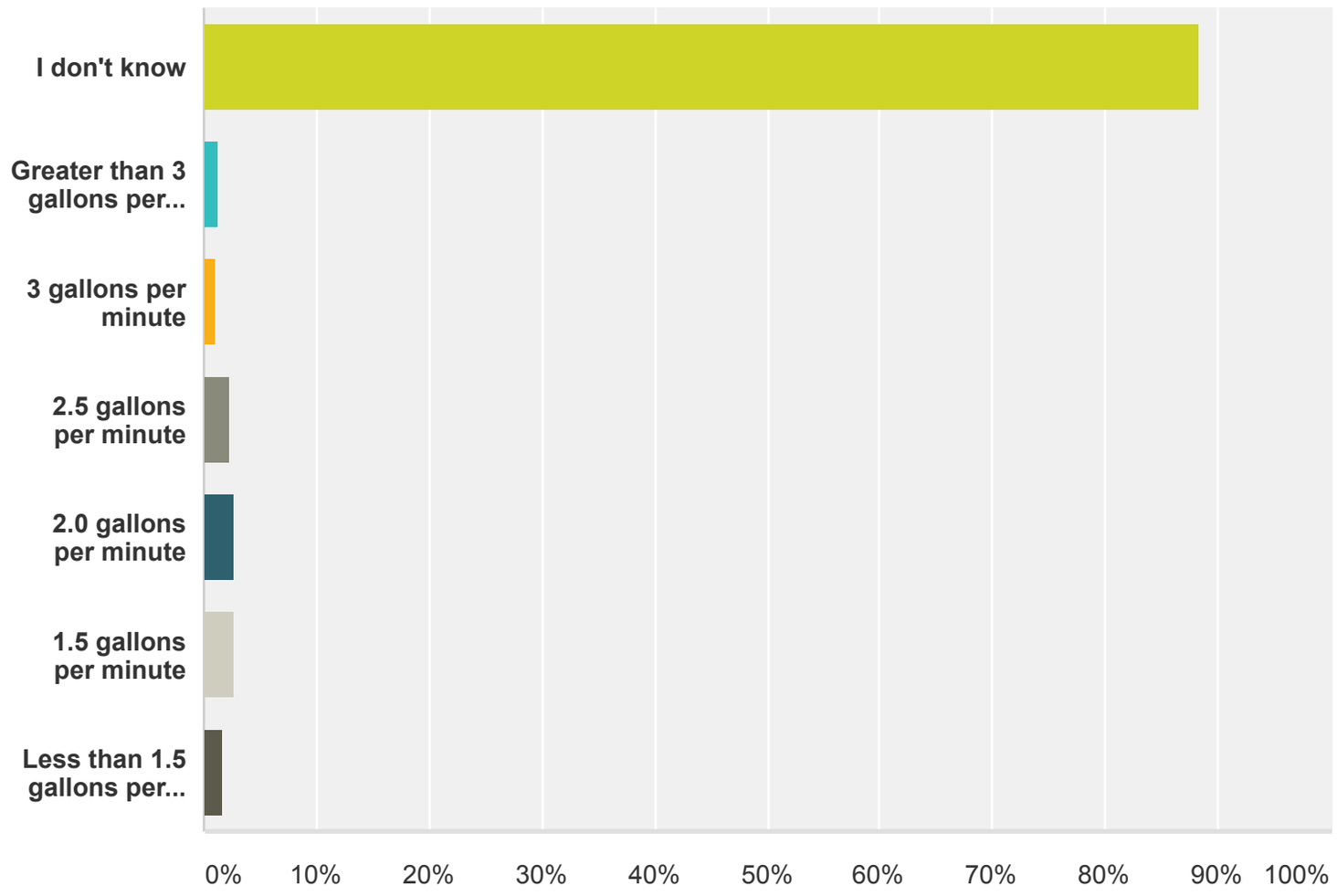
Total	1,054

Q5

Customize | Export

What is the rated flow rate of the showerhead that you typically shower with? Please DO NOT guess. If you don't know, please select "I don't know".

Answered: 884 Skipped: 173



Answer Choices	Responses	
I don't know	88.35%	781
Greater than 3 gallons per minute	1.24%	11
3 gallons per minute	1.13%	10
2.5 gallons per minute	2.26%	20
2.0 gallons per minute	2.71%	24
1.5 gallons per minute	2.71%	24
Less than 1.5 gallons per minute	1.58%	14
Total		884

PAGE 3: Type Of Shower

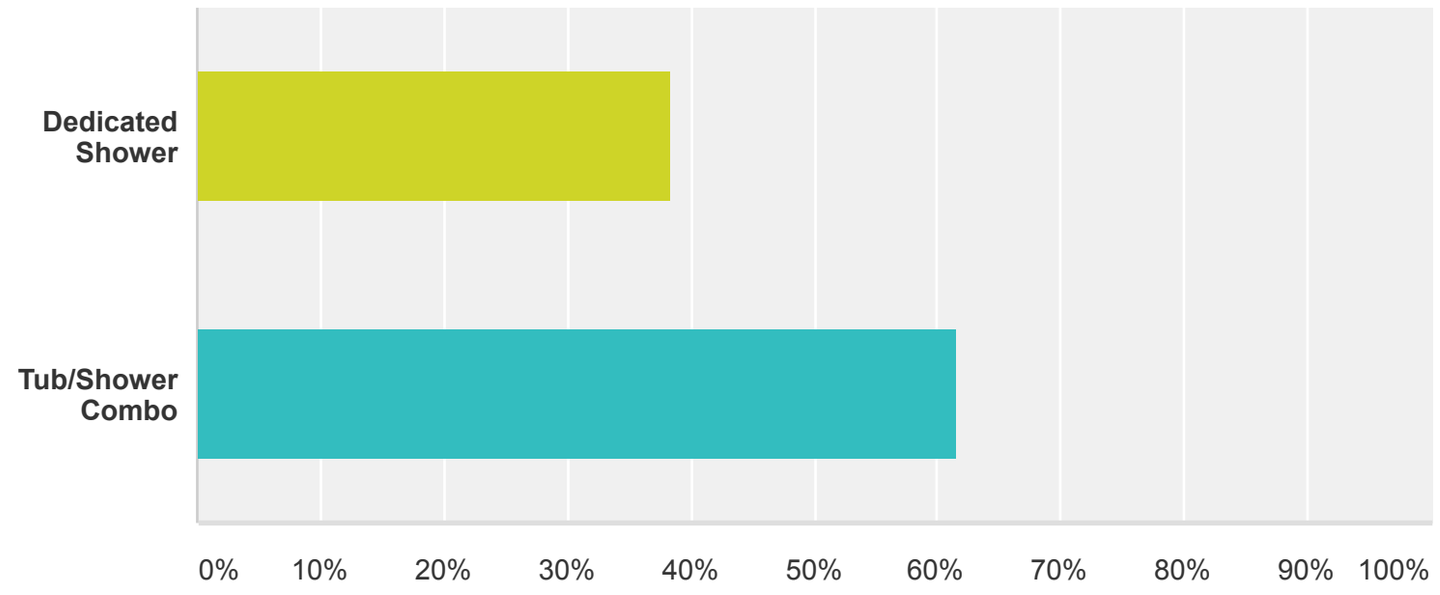
Q6

Customize | Export

In general, there are two types of showers. One type is a "Dedicated Shower". The other is a "Tub/Shower Combo". Dedicated Showers consist of a shower enclosure that only contains a showerhead. Tub/Shower combos consist of a tub and shower combined into a single unit. Do you typically take your shower in a Dedicated

Shower or a "Tub/Shower Combo"?

Answered: 1,052 Skipped: 5



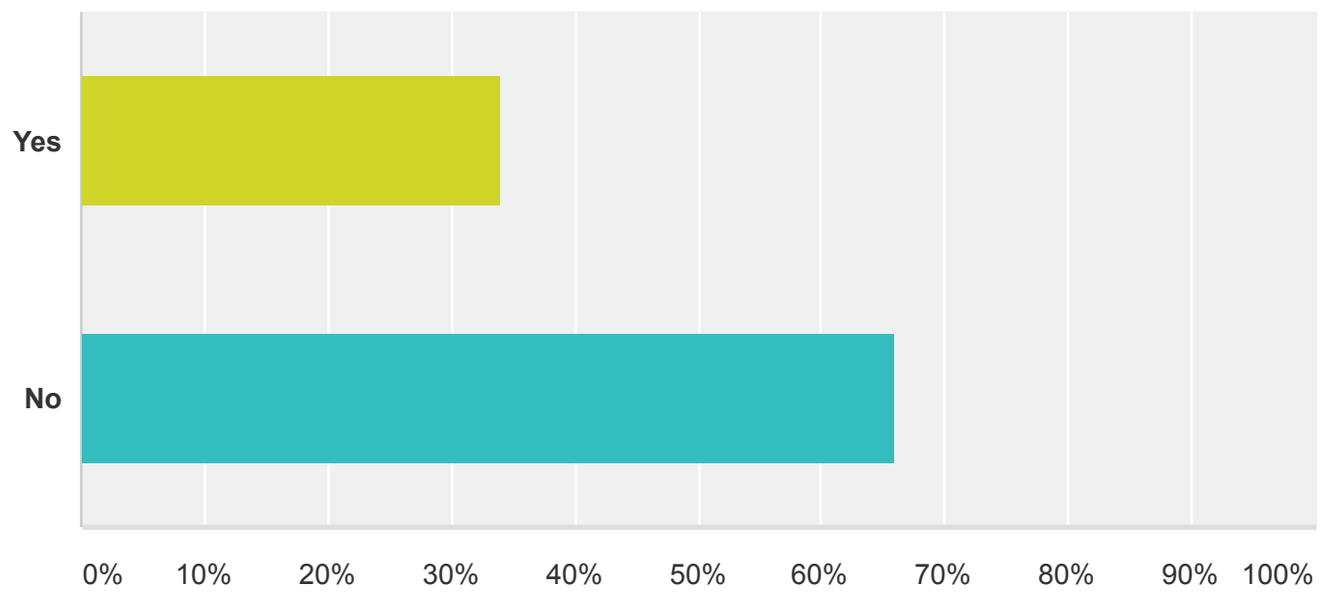
Answer Choices	Responses	
Dedicated Shower	**38.40%**	404
Tub/Shower Combo	**61.60%**	648
Total		1,052

PAGE 4: Tub Shower Combo

Q7 Customize Export

Some tub spouts leak during a shower. To see this kind of leak all you have to do is look down at the tub spout during your shower. If water is coming out of it while you are showering, the tub spout is leaking. Does your tub spout leak while you are showering?

Answered: 646 Skipped: 411

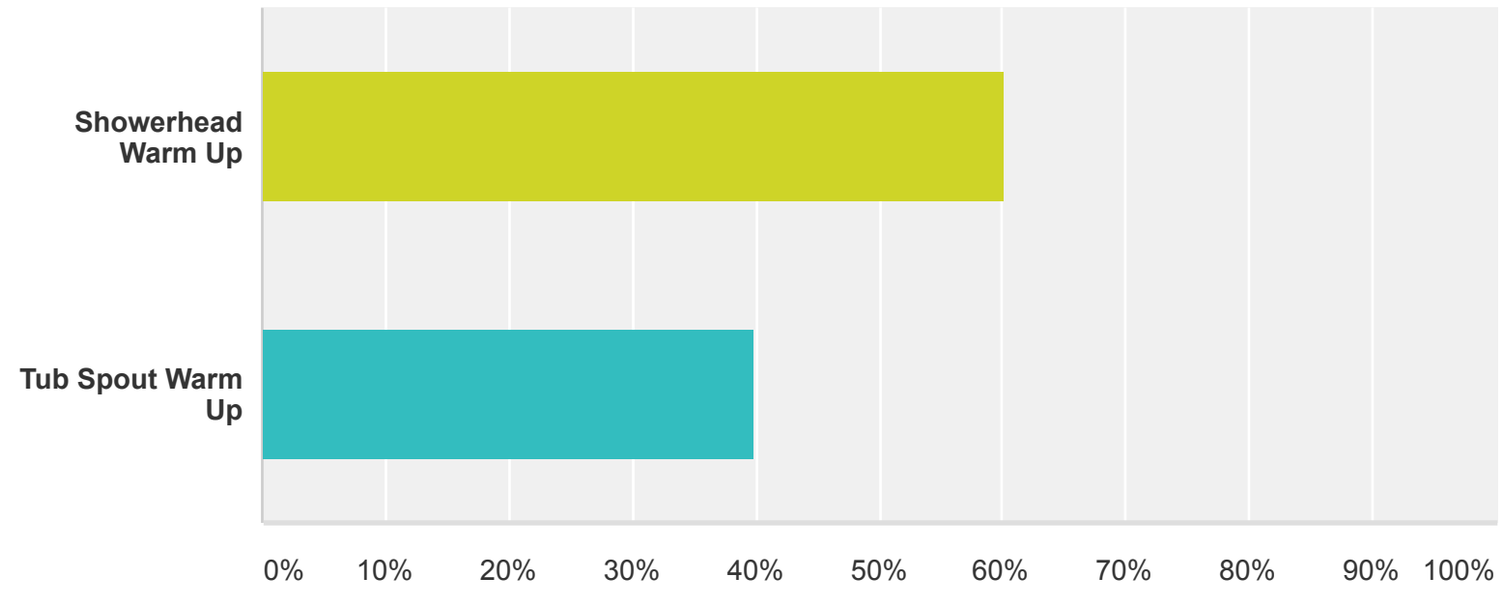


Answer Choices	Responses	
Yes	**34.06%**	220
No	**65.94%**	426
Total		646

Q8 Customize Export

Assuming you are going to take a shower, there are generally two different ways of warming your shower in a Tub/Shower Combo. One way is to turn on the tub and immediately pull up the diverter on the tub spout so the water warms up while running through the showerhead. We call this a “Showerhead Warm Up”. The other method is to turn on the tub and to let the water warm up while running through the tub spout. We call this a “Tub Spout Warm Up.” How do you warm your shower in your Tub/Shower Combo?

Answered: 646 Skipped: 411



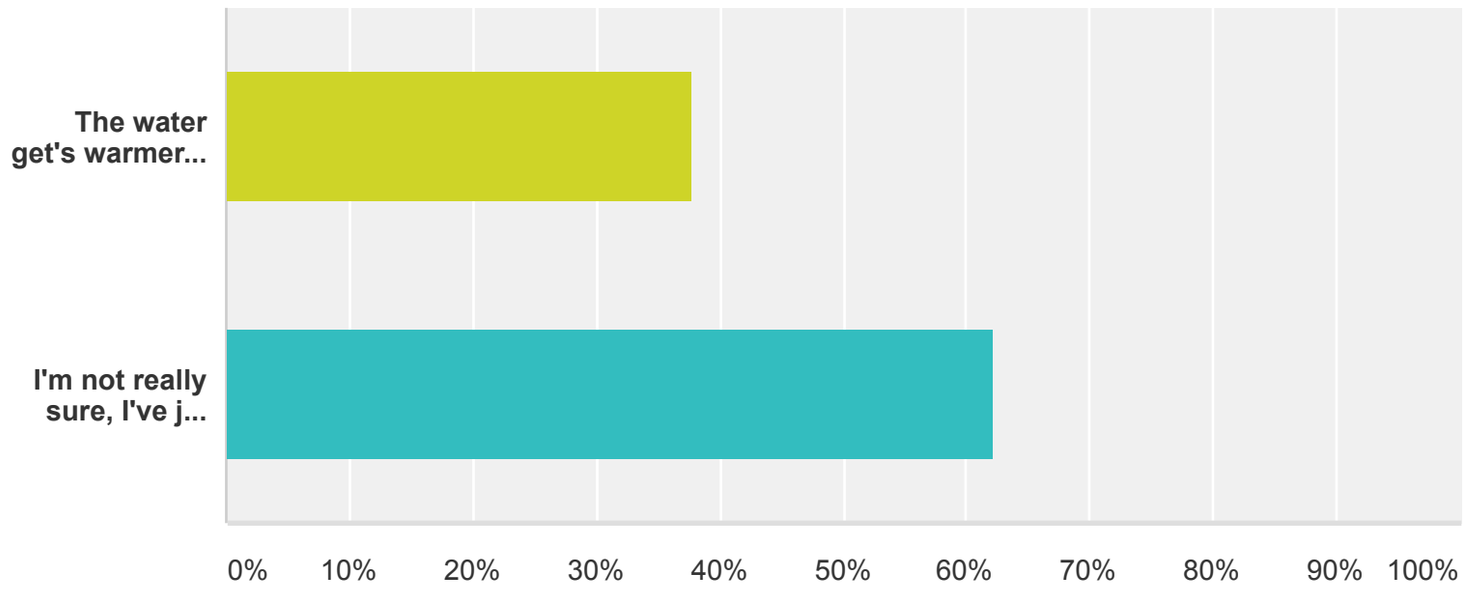
Answer Choices	Responses	
Showerhead Warm Up	**60.06%**	388
Tub Spout Warm Up	**39.94%**	258
Total		646

PAGE 5: Tub Spout Warm Up Reason

Q9 Customize Export

Why do you get the water warm by running it through the tub spout? Pick the best answer from the choices below.

Answered: 256 Skipped: 801



Answer Choices	Responses

The water get's warmer faster.	37.89%	97
I'm not really sure, I've just always done it this way.	62.11%	159
Total		256

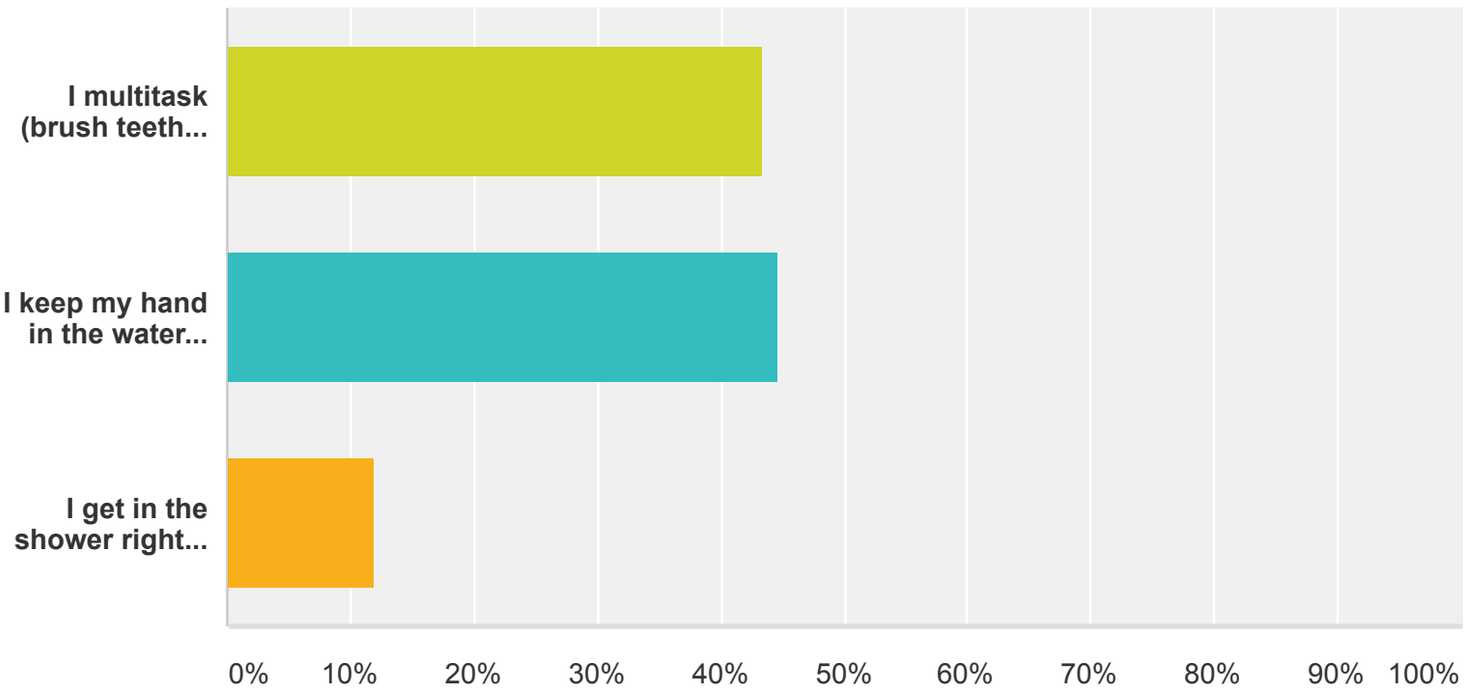
Comments (62)

PAGE 6: Waiting For The Water To Become Warm

Q10 Customize Export

Which answer best describes what you typically do during your warming routine?

Answered: 1,044 Skipped: 13



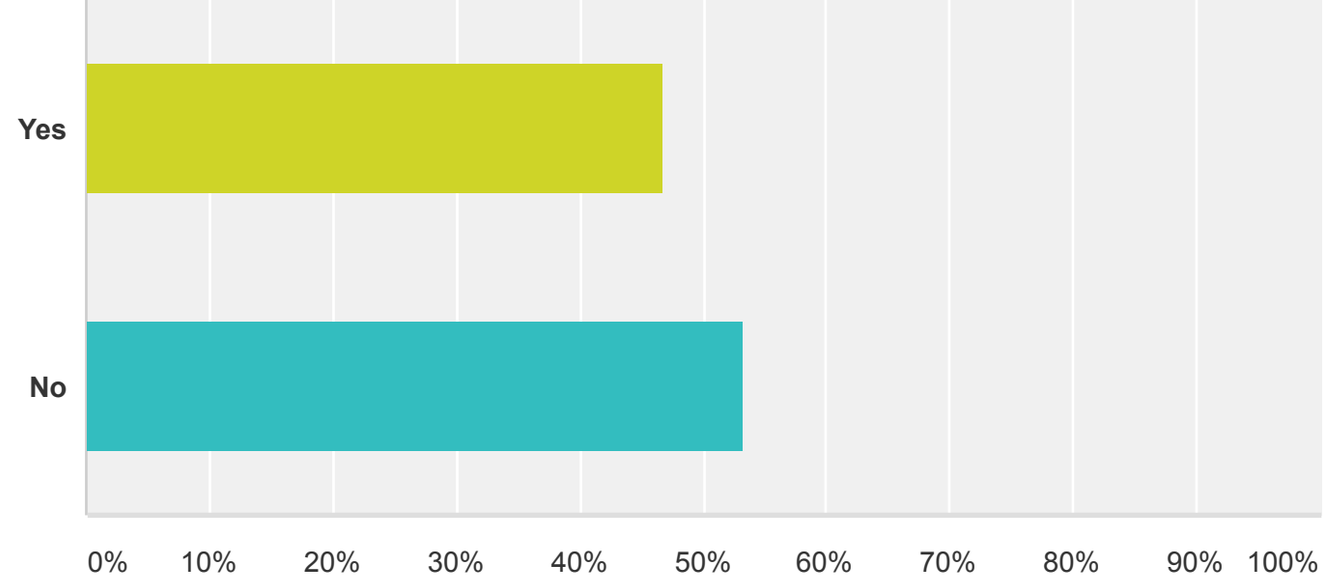
Answer Choices	Responses
I multitask (brush teeth, get a towel, use the washroom, pick out clothes ...) and then return once I know the water is warm.	43.39% 453
I keep my hand in the water to constantly monitor the temperature and get in as soon as it is warm.	44.73% 467
I get in the shower right way regardless of the water temperature.	11.88% 124
Total	1,044

PAGE 7: Further Inquiry

Q11 Customize Export

Even though you typically wait by the shower with your hand in the water or get in right away, are there times when you have multitasked (brush teeth, get a towel, use the washroom, pick out clothes ...) while warming your shower?

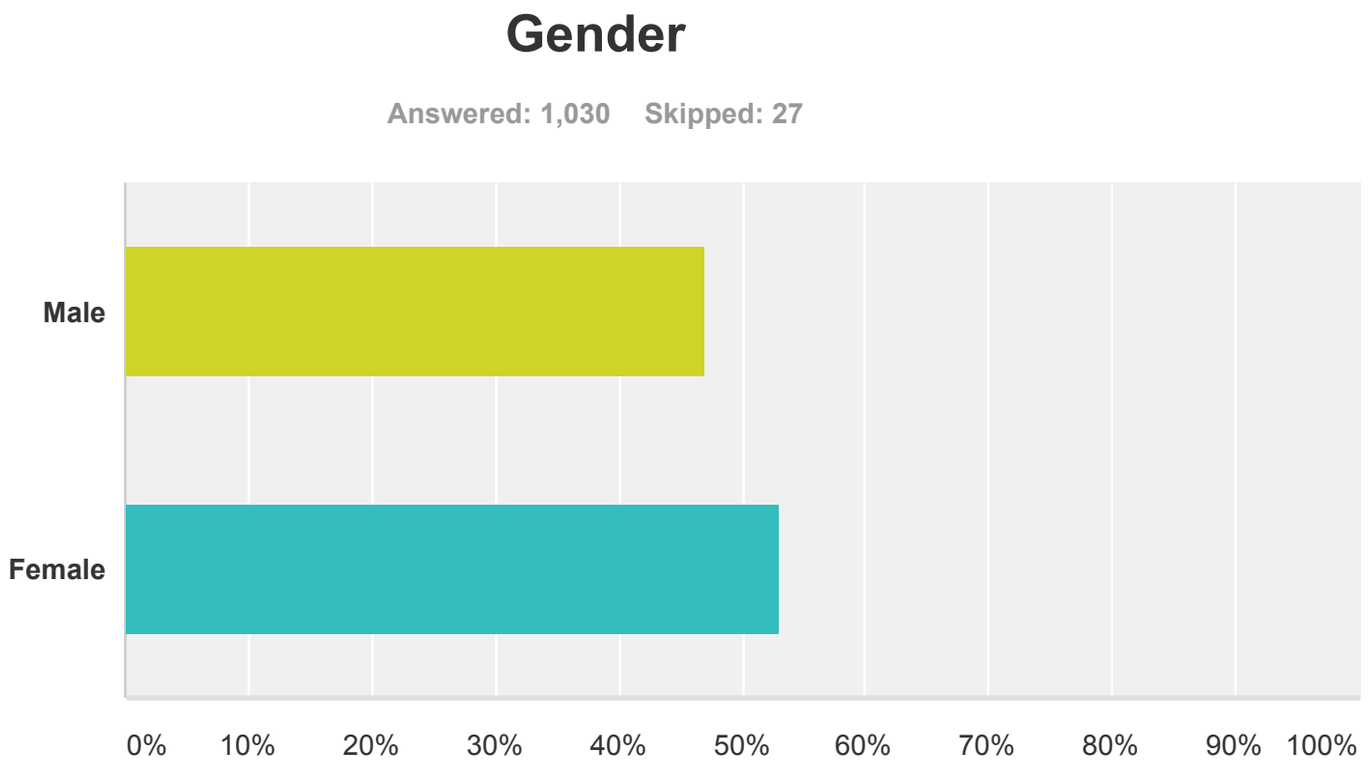
Answered: 591 Skipped: 466



Answer Choices	Responses	
Yes	**46.70%**	276
No	**53.30%**	315
Total		591

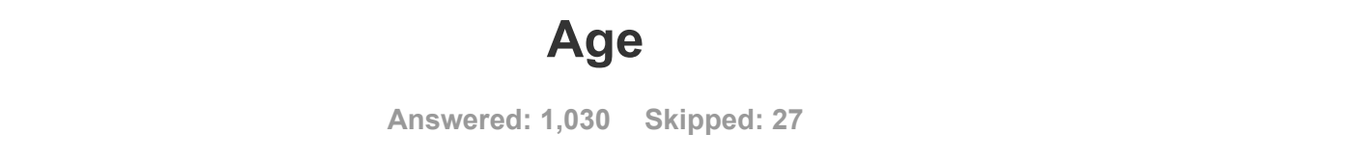
PAGE 8: SurveyMonkey Audience

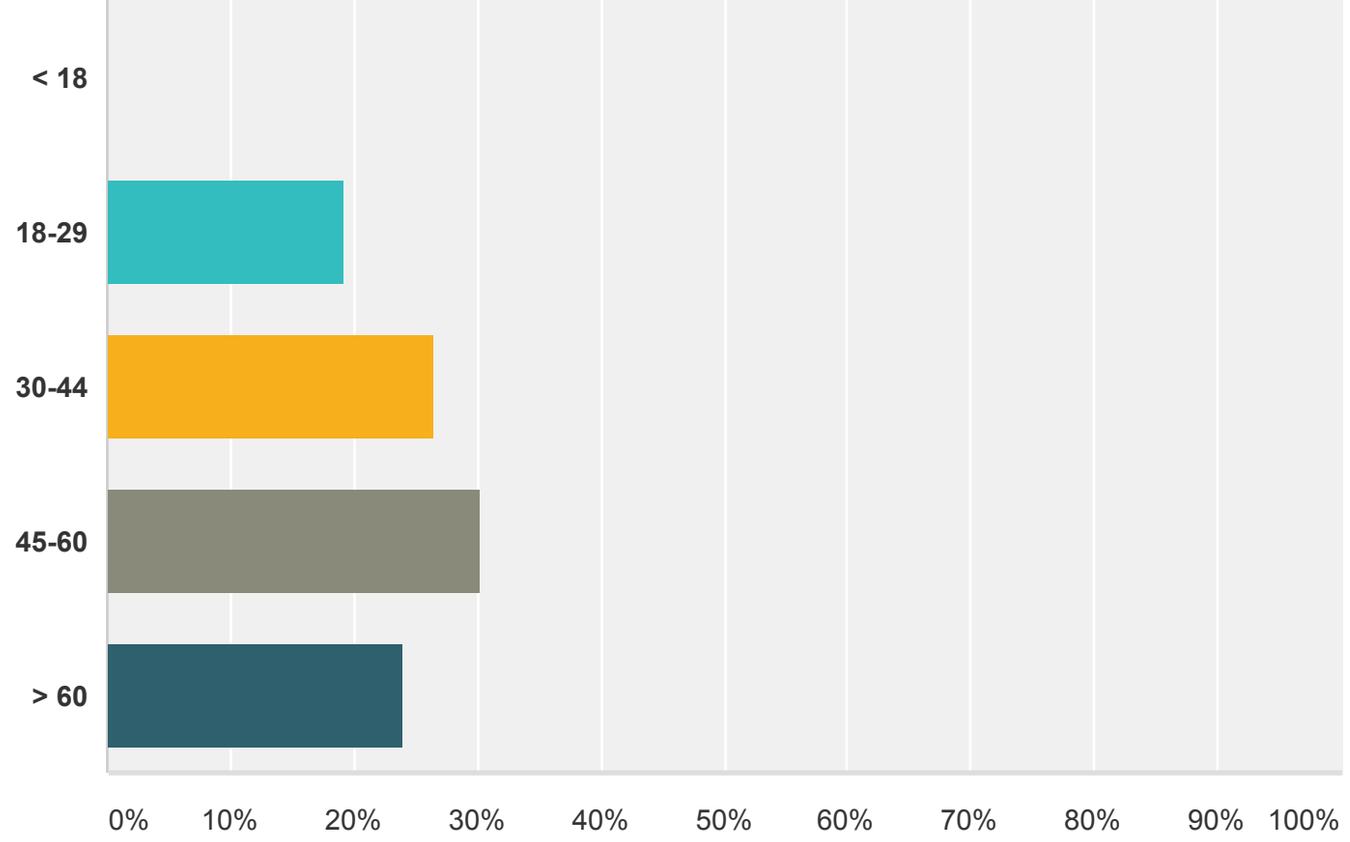
Q12 — Customize — Export



Answer Choices	Responses	
Male	**46.99%**	484
Female	**53.01%**	546
Total		1,030

Q13 — Customize — Export





Answer Choices	Responses	
< 18	**0.00%**	0
18-29	**19.22%**	198
30-44	**26.50%**	273
45-60	**30.19%**	311
> 60	**24.08%**	248
Total		1,030

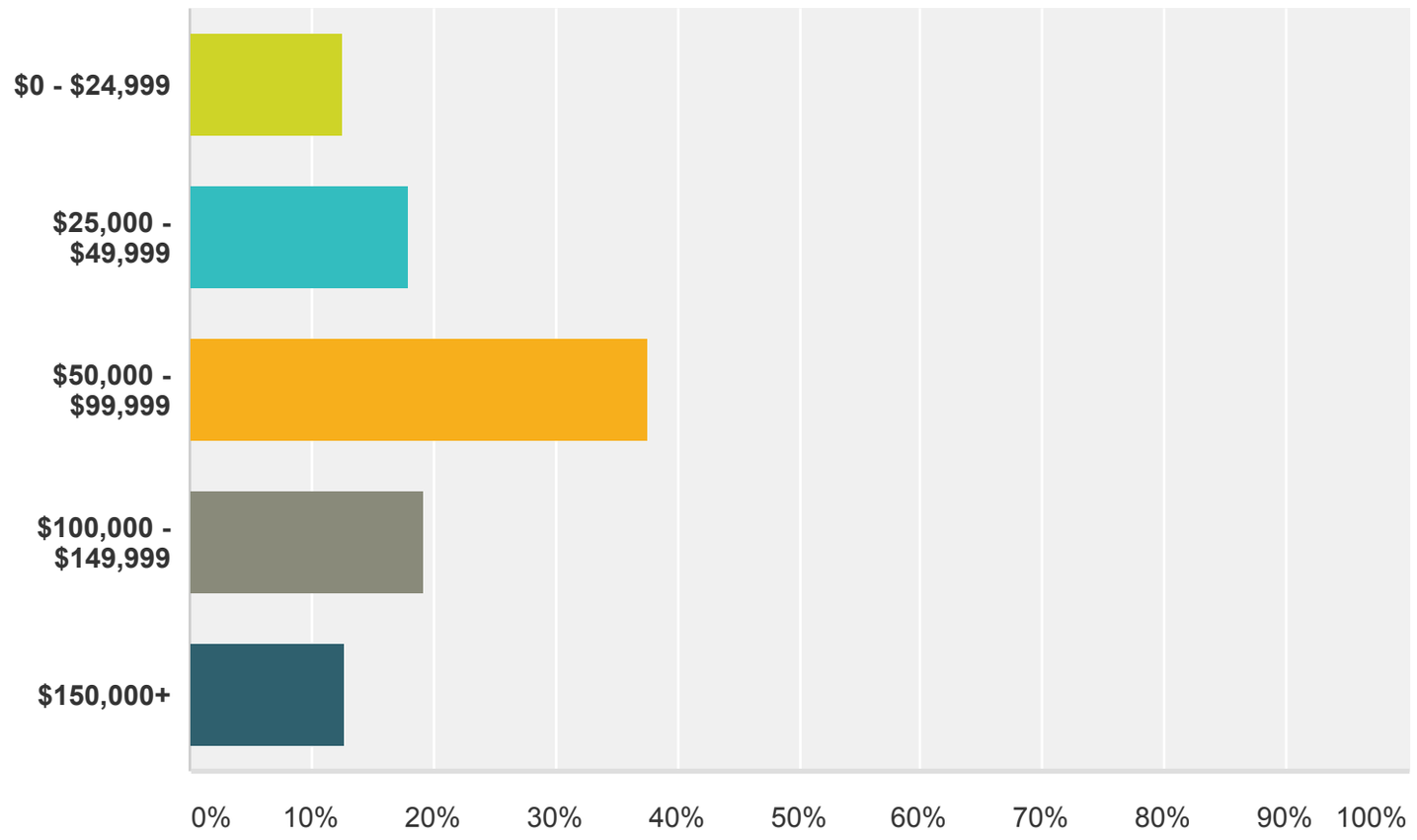
Q14

Customize

Export

Household Income

Answered: 832 Skipped: 225



Answer Choices	Responses	
$0 - $24,999	**12.50%**	104
$25,000 - $49,999	**17.91%**	149
$50,000 - $99,999	**37.62%**	313
$100,000 - $149,999	**19.23%**	160
$150,000+	**12.74%**	106

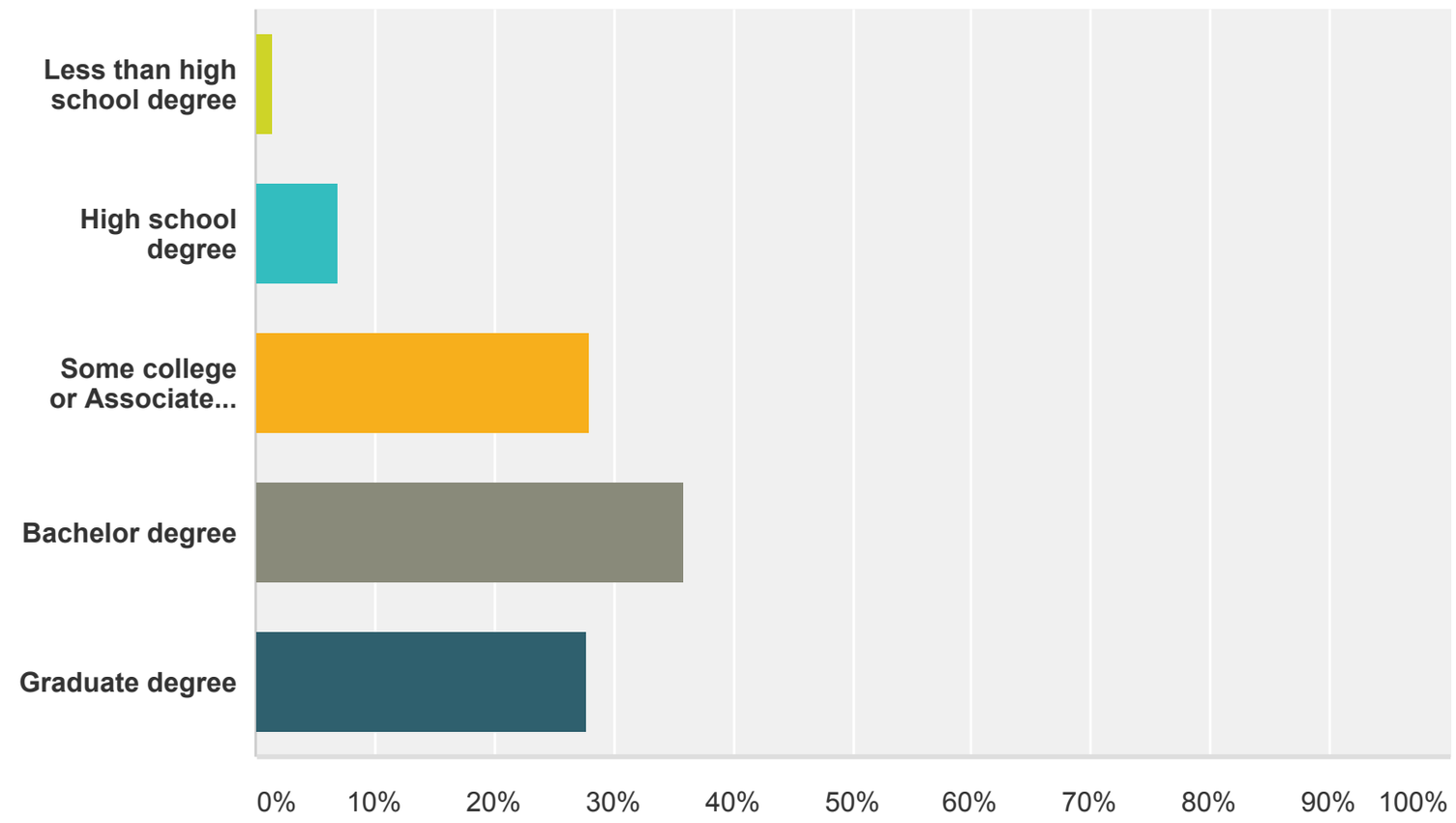
Total	832

Q15

Customize Export

Education

Answered: 1,023 Skipped: 34



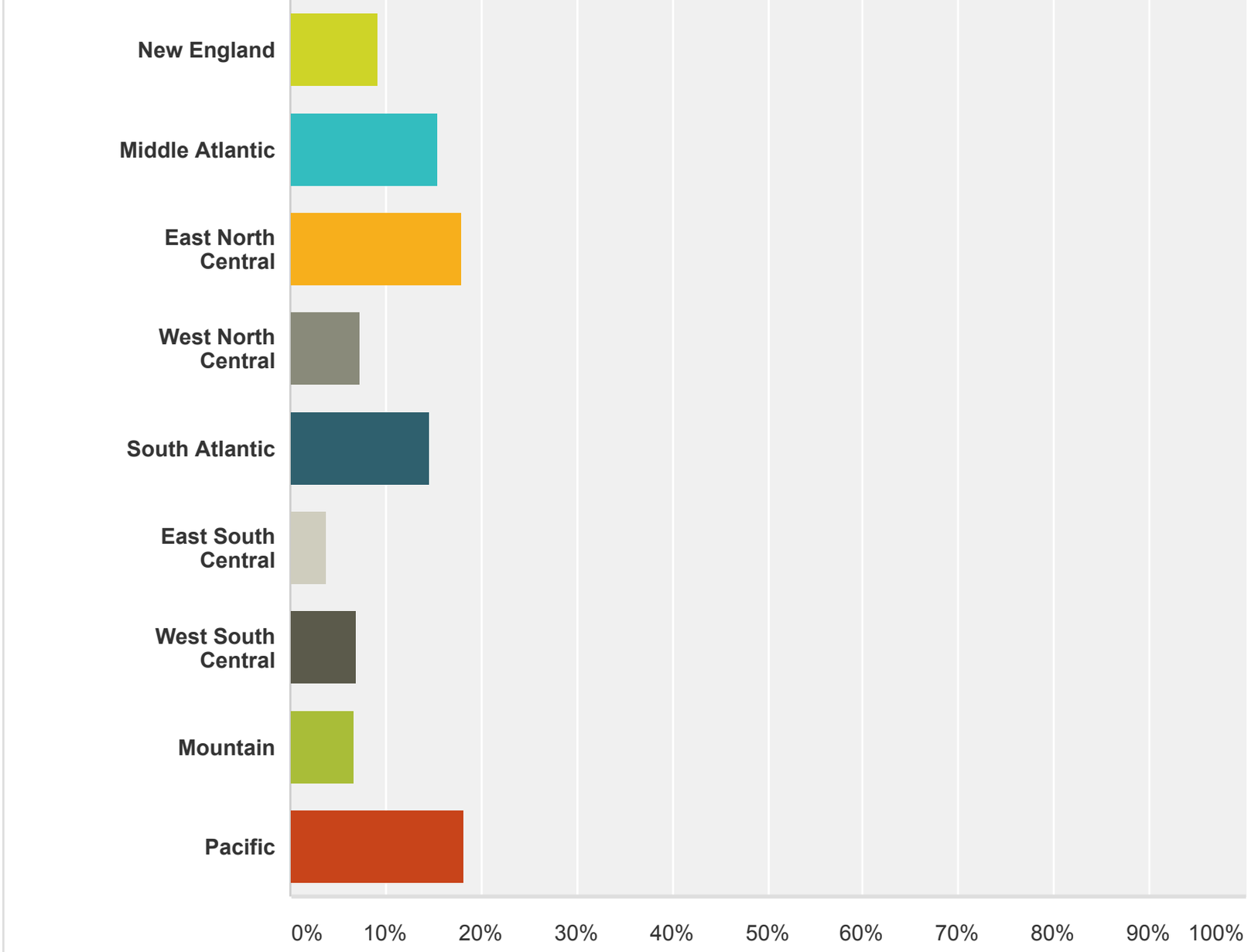
Answer Choices	Responses	
Less than high school degree	**1.37%**	14
High school degree	**6.84%**	70
Some college or Associate degree	**27.96%**	286
Bachelor degree	**35.97%**	368
Graduate degree	**27.86%**	285
Total		1,023

Q16

Customize Export

Location (Census Region)

Answered: 1,030 Skipped: 27



Answer Choices	Responses	
New England	**9.22%**	95
Middle Atlantic	**15.44%**	159
East North Central	**17.96%**	185
West North Central	**7.28%**	75
South Atlantic	**14.66%**	151
East South Central	**3.69%**	38
West South Central	**6.99%**	72
Mountain	**6.60%**	68
Pacific	**18.16%**	187
Total		1,030

Warming Your Shower Survey

FILTERED: 648 of 1,057 respondents — Export All | Share All

Question Summaries | Data Trends | Individual Responses

All Pages

PAGE 2: Tell Us A Little About Yourself

Q1 — Export

Demographic Info

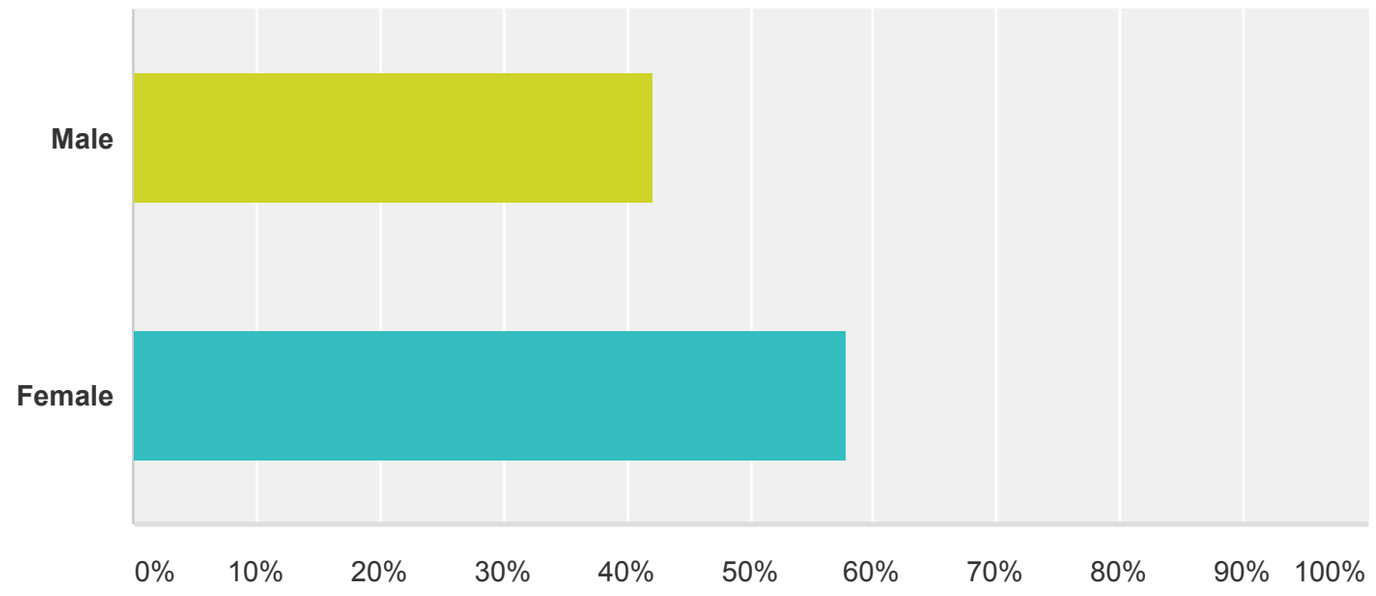
Answered: 648 Skipped: 0

Answer Choices		Responses	
Name	Responses	100.00%	648
Company	Responses	0.00%	0
Address	Responses	0.00%	0
Address 2	Responses	0.00%	0
City/Town	Responses	0.00%	0
State/Province	Responses	100.00%	648
ZIP/Postal Code	Responses	0.00%	0
Country	Responses	0.00%	0
Email Address	Responses	0.00%	0
Phone Number	Responses	0.00%	0

Q2 — Customize | Export

What is your gender?

Answered: 648 Skipped: 0



Answer Choices	Responses

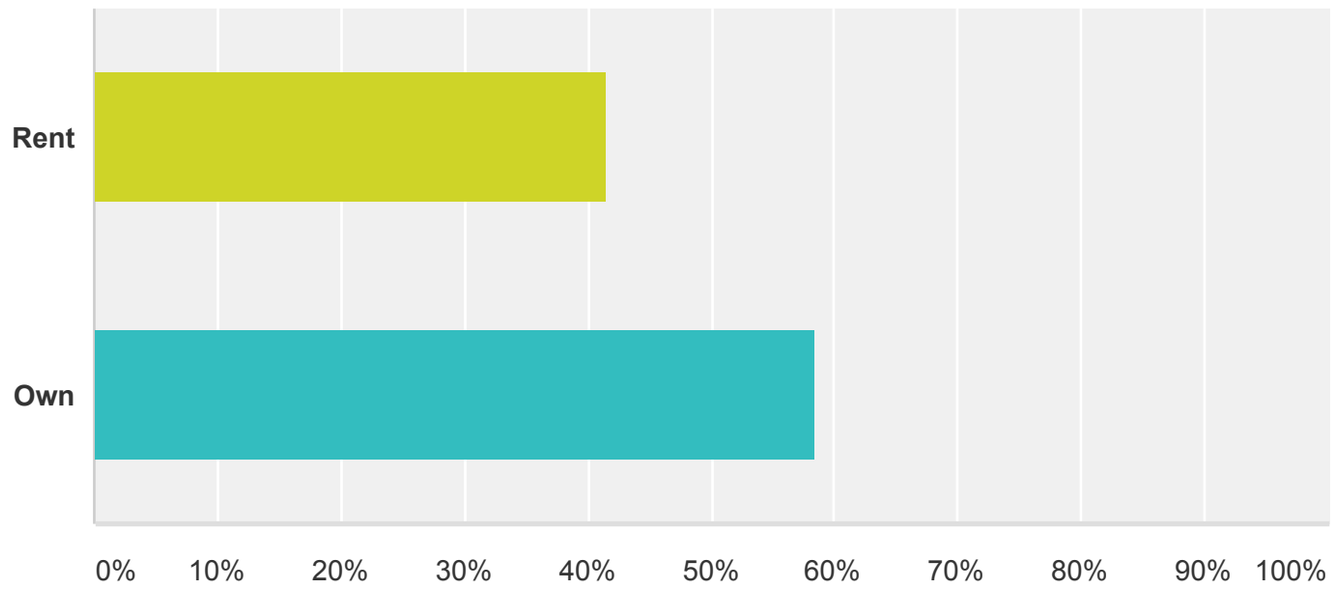
Male	42.13%	273
Female	57.87%	375
Total		648

Q3

Customize | Export

Do you rent or own?

Answered: 648 Skipped: 0



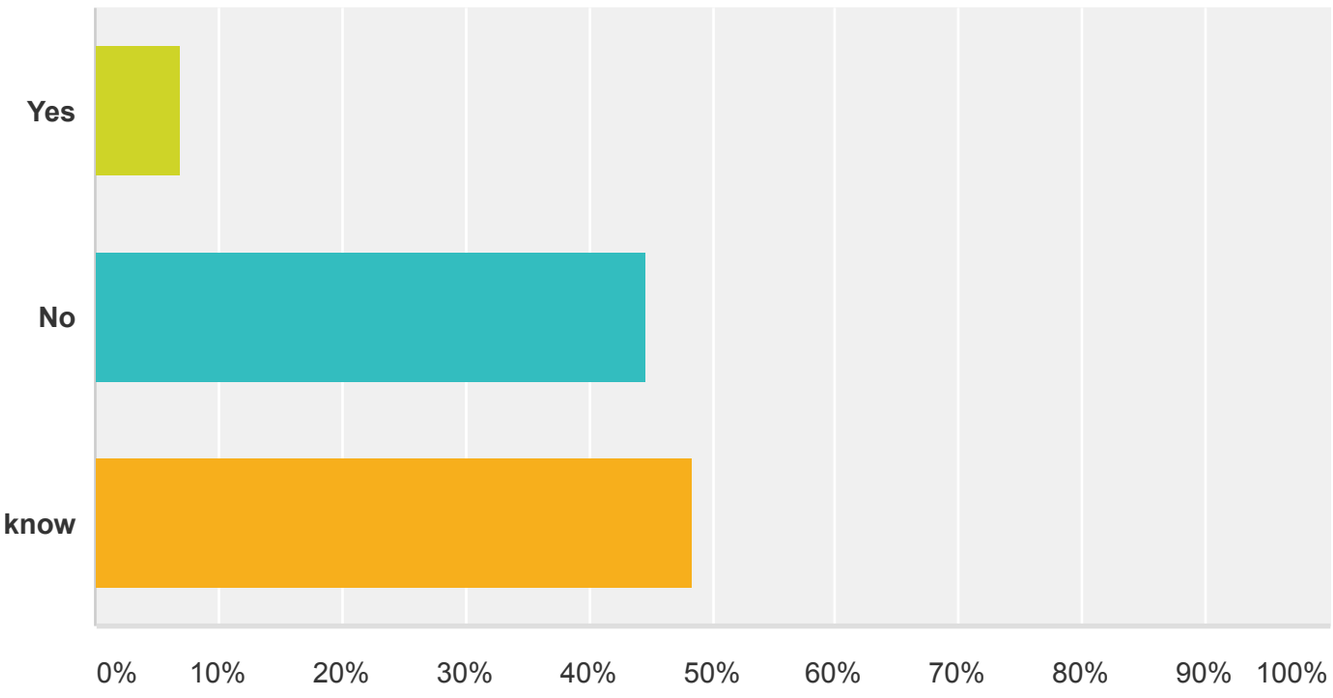
Answer Choices	Responses	
Rent	41.51%	269
Own	58.49%	379
Total		648

Q4

Customize | Export

Do you have a hot water recirculation loop or hot water recirculation system in your residence?

Answered: 648 Skipped: 0



Answer Choices	Responses	
Yes	6.79%	44
No	44.75%	290
Don't know	48.46%	314

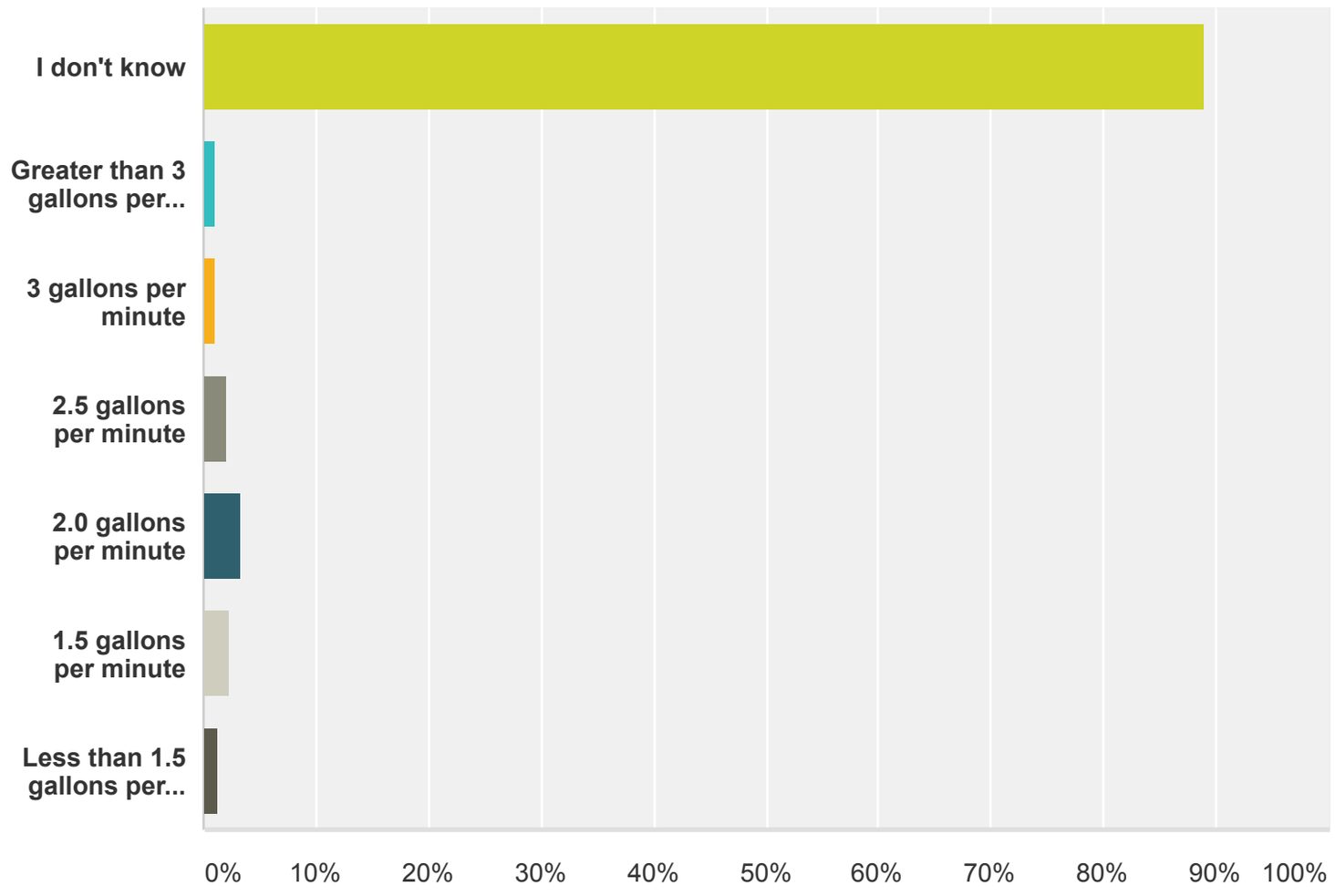
Total	648

Q5

Customize | Export

What is the rated flow rate of the showerhead that you typically shower with? Please DO NOT guess. If you don't know, please select "I don't know".

Answered: 552 Skipped: 96



Answer Choices	Responses	
I don't know	88.95%	491
Greater than 3 gallons per minute	1.09%	6
3 gallons per minute	1.09%	6
2.5 gallons per minute	1.99%	11
2.0 gallons per minute	3.26%	18
1.5 gallons per minute	2.36%	13
Less than 1.5 gallons per minute	1.27%	7
Total		552

PAGE 3: Type Of Shower

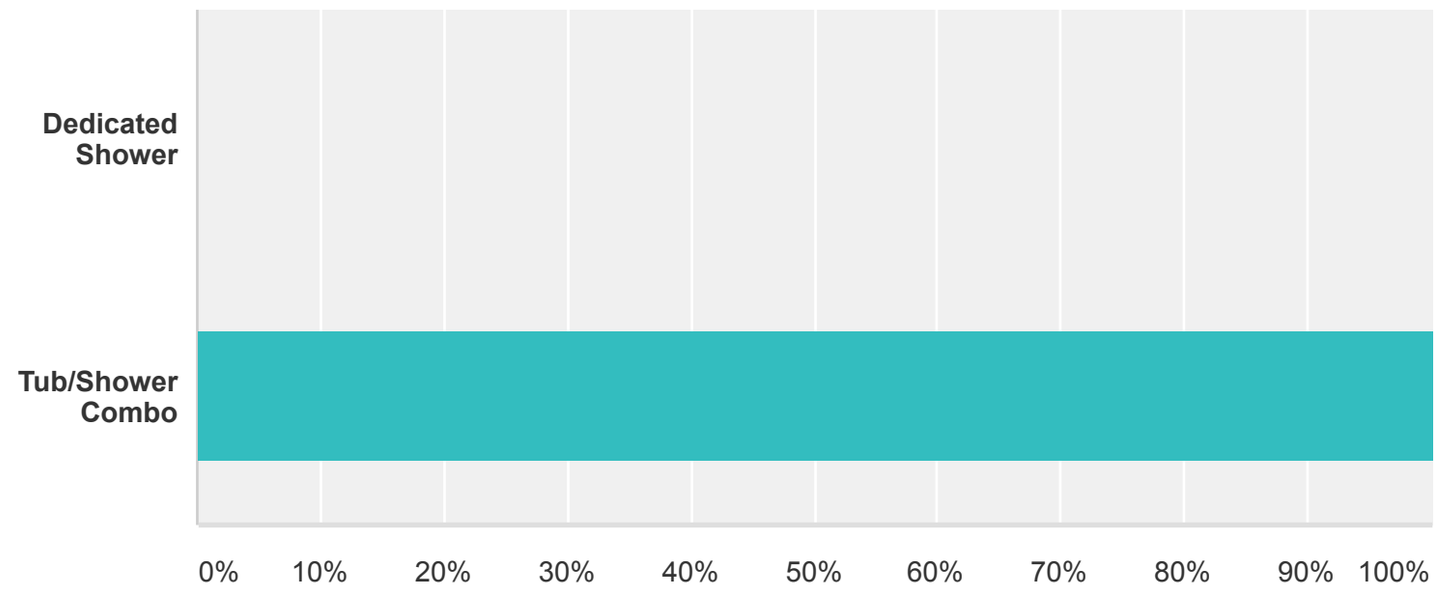
Q6

Customize | Export

In general, there are two types of showers. One type is a "Dedicated Shower". The other is a "Tub/Shower Combo". Dedicated Showers consist of a shower enclosure that only contains a showerhead. Tub/Shower combos consist of a tub and shower combined into a single unit. Do you typically take your shower in a Dedicated

Shower or a "Tub/Shower Combo"?

Answered: 648 Skipped: 0



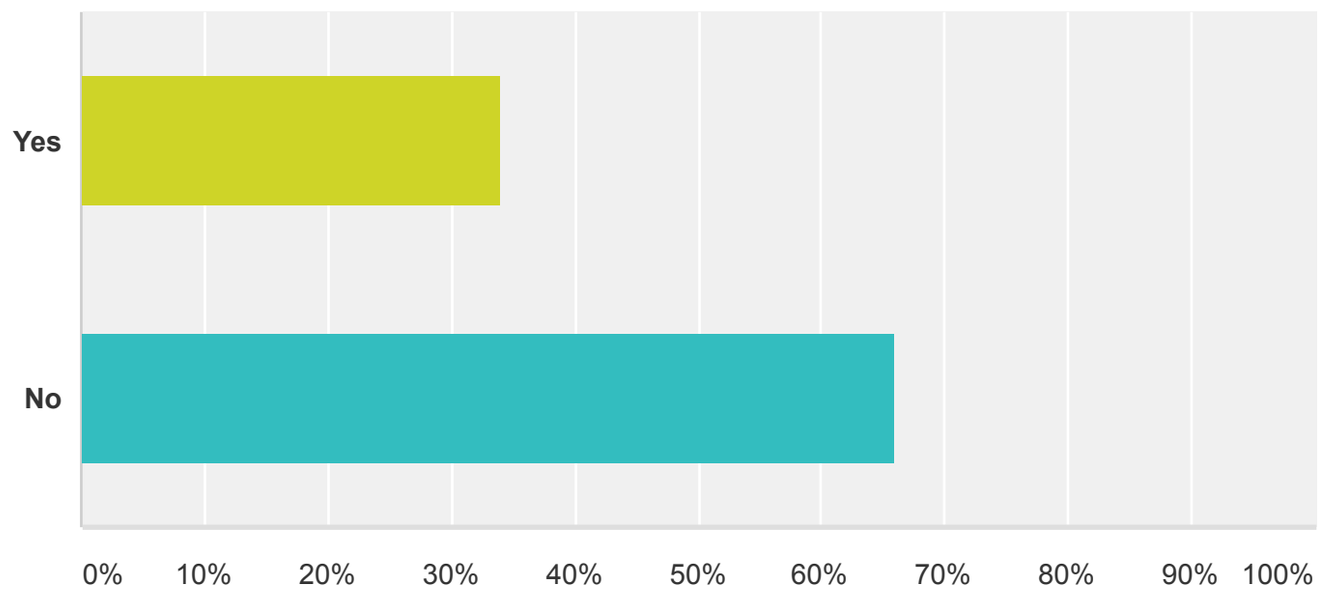
Answer Choices	Responses	
Dedicated Shower	**0.00%**	0
Tub/Shower Combo	**100.00%**	648
Total		648

PAGE 4: Tub Shower Combo

Q7 Customize Export

Some tub spouts leak during a shower. To see this kind of leak all you have to do is look down at the tub spout during your shower. If water is coming out of it while you are showering, the tub spout is leaking. Does your tub spout leak while you are showering?

Answered: 646 Skipped: 2

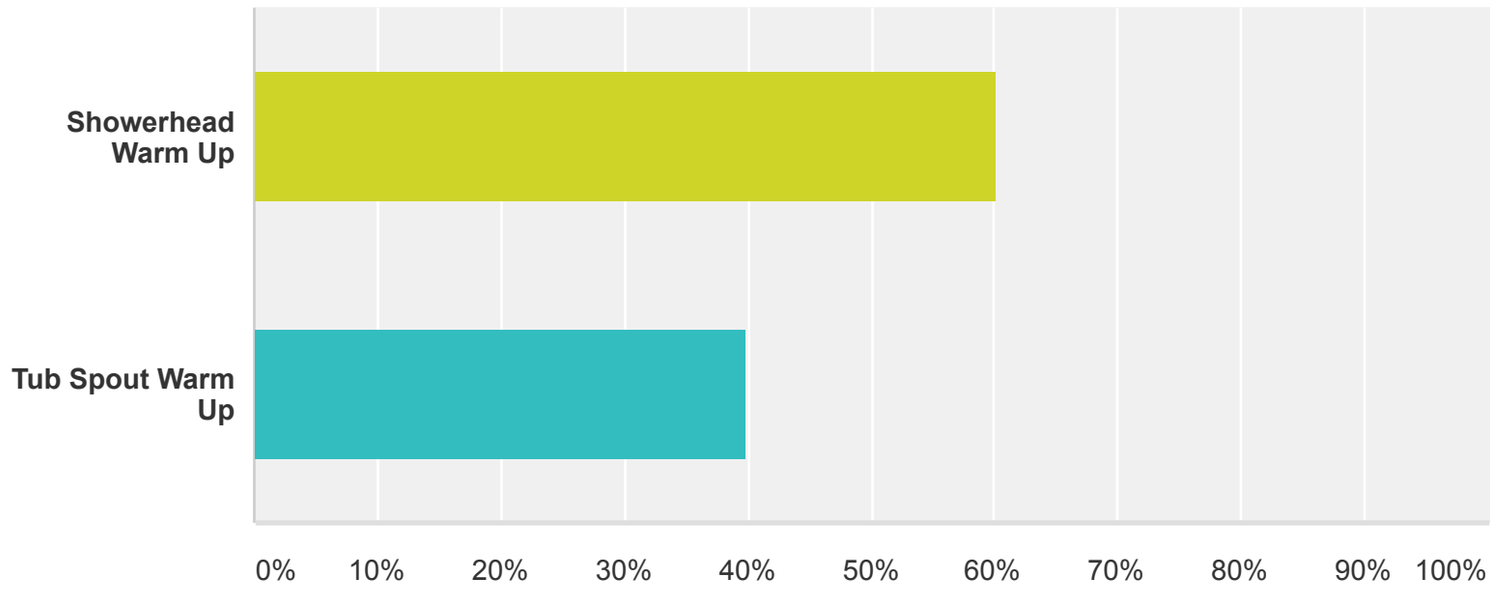


Answer Choices	Responses	
Yes	**34.06%**	220
No	**65.94%**	426
Total		646

Q8 Customize Export

Assuming you are going to take a shower, there are generally two different ways of warming your shower in a Tub/Shower Combo. One way is to turn on the tub and immediately pull up the diverter on the tub spout so the water warms up while running through the showerhead. We call this a “Showerhead Warm Up”. The other method is to turn on the tub and to let the water warm up while running through the tub spout. We call this a “Tub Spout Warm Up.” How do you warm your shower in your Tub/Shower Combo?

Answered: 646 Skipped: 2



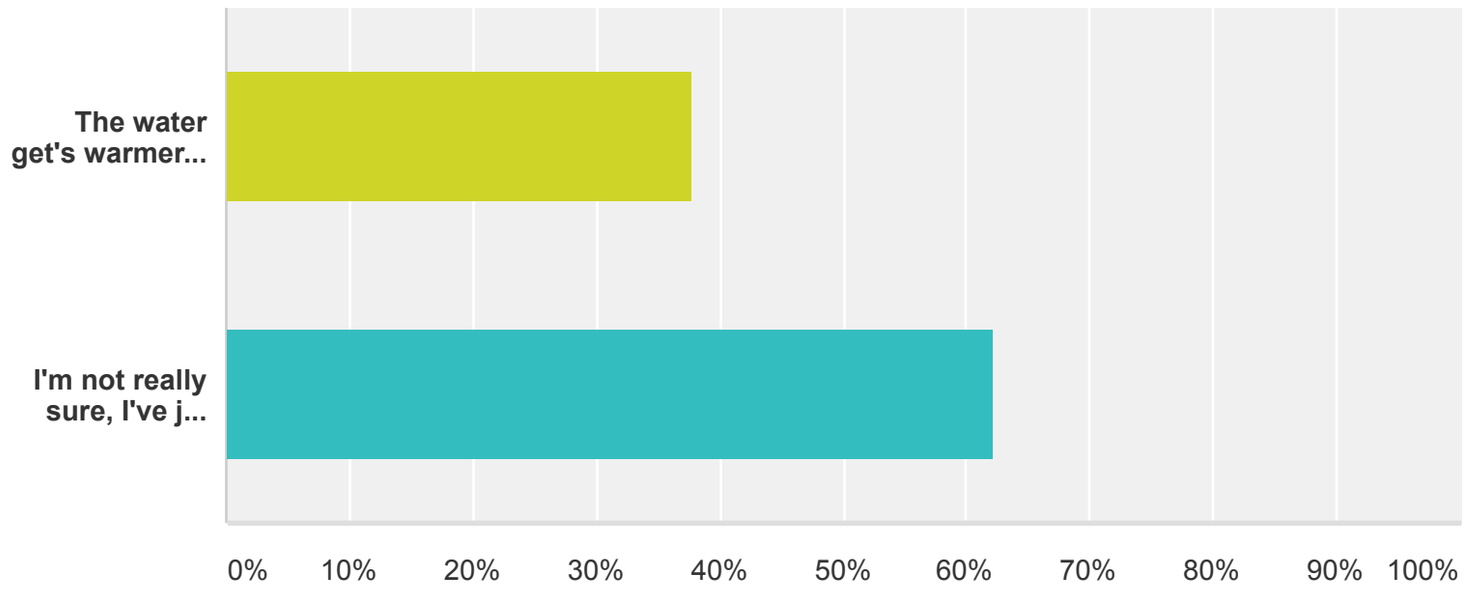
Answer Choices	Responses	
Showerhead Warm Up	**60.06%**	388
Tub Spout Warm Up	**39.94%**	258
Total		646

PAGE 5: Tub Spout Warm Up Reason

Q9 Customize Export

Why do you get the water warm by running it through the tub spout? Pick the best answer from the choices below.

Answered: 256 Skipped: 392



Answer Choices	Responses

The water get's warmer faster.	37.89%	97
I'm not really sure, I've just always done it this way.	62.11%	159
Total		256

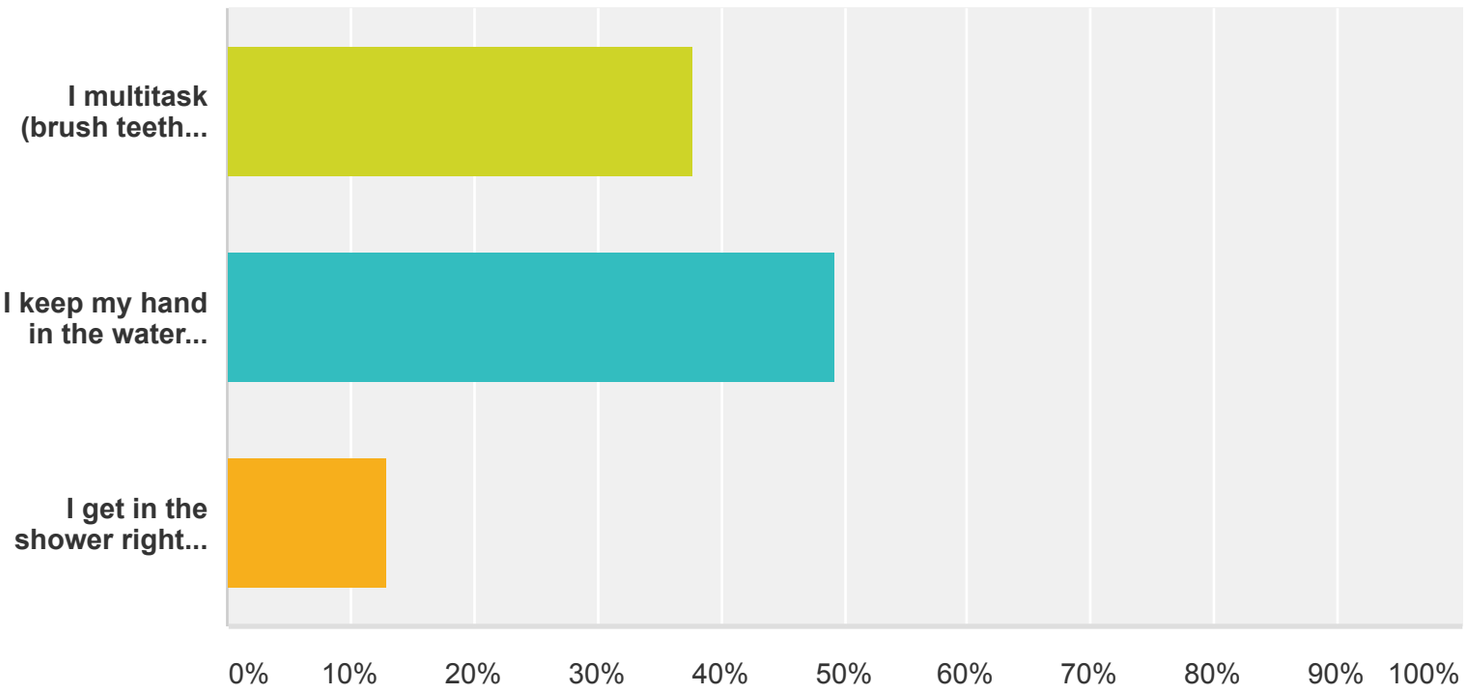
Comments (62)

PAGE 6: Waiting For The Water To Become Warm

Q10 Customize Export

Which answer best describes what you typically do during your warming routine?

Answered: 641 Skipped: 7



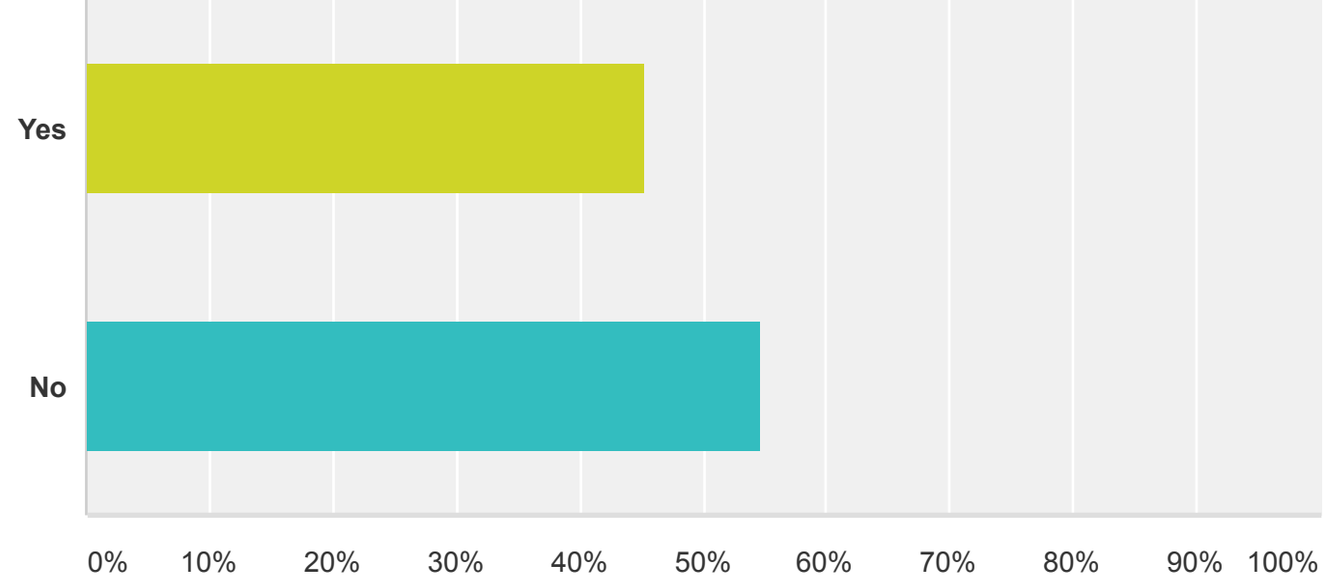
Answer Choices	Responses
I multitask (brush teeth, get a towel, use the washroom, pick out clothes ...) and then return once I know the water is warm.	37.75% 242
I keep my hand in the water to constantly monitor the temperature and get in as soon as it is warm.	49.30% 316
I get in the shower right way regardless of the water temperature.	12.95% 83
Total	641

PAGE 7: Further Inquiry

Q11 Customize Export

Even though you typically wait by the shower with your hand in the water or get in right away, are there times when you have multitasked (brush teeth, get a towel, use the washroom, pick out clothes ...) while warming your shower?

Answered: 399 Skipped: 249



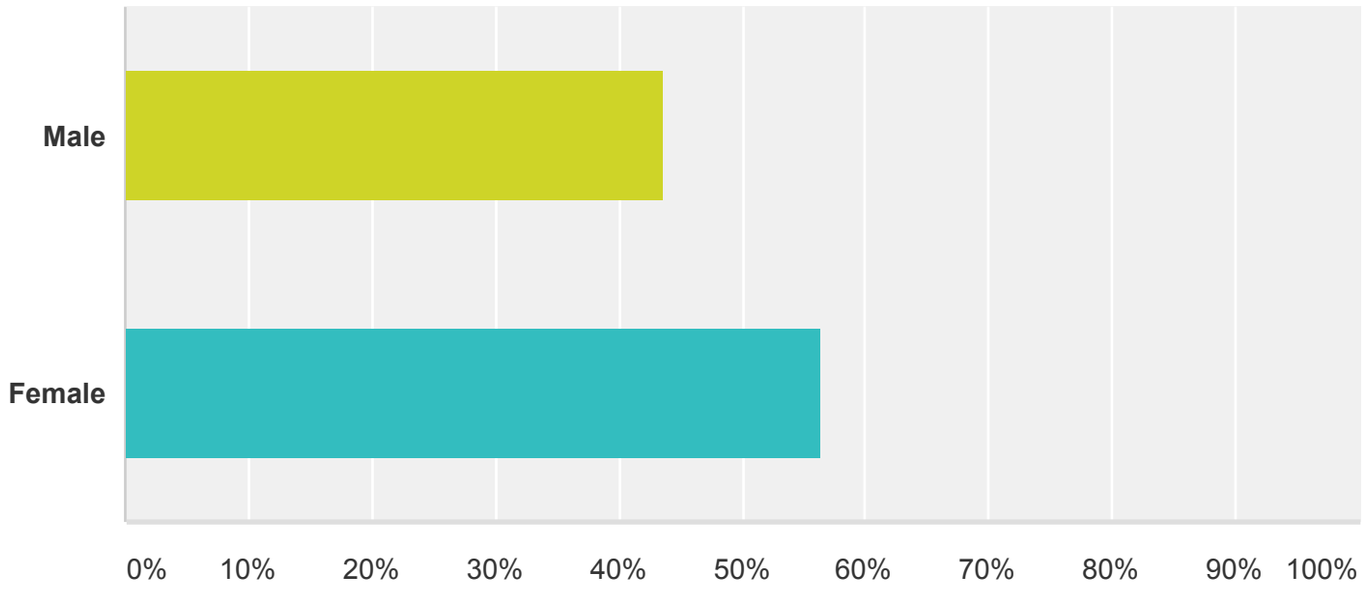
Answer Choices	Responses	
Yes	**45.36%**	181
No	**54.64%**	218
Total		399

PAGE 8: SurveyMonkey Audience

Q12 — Customize — Export

Gender

Answered: 636 Skipped: 12

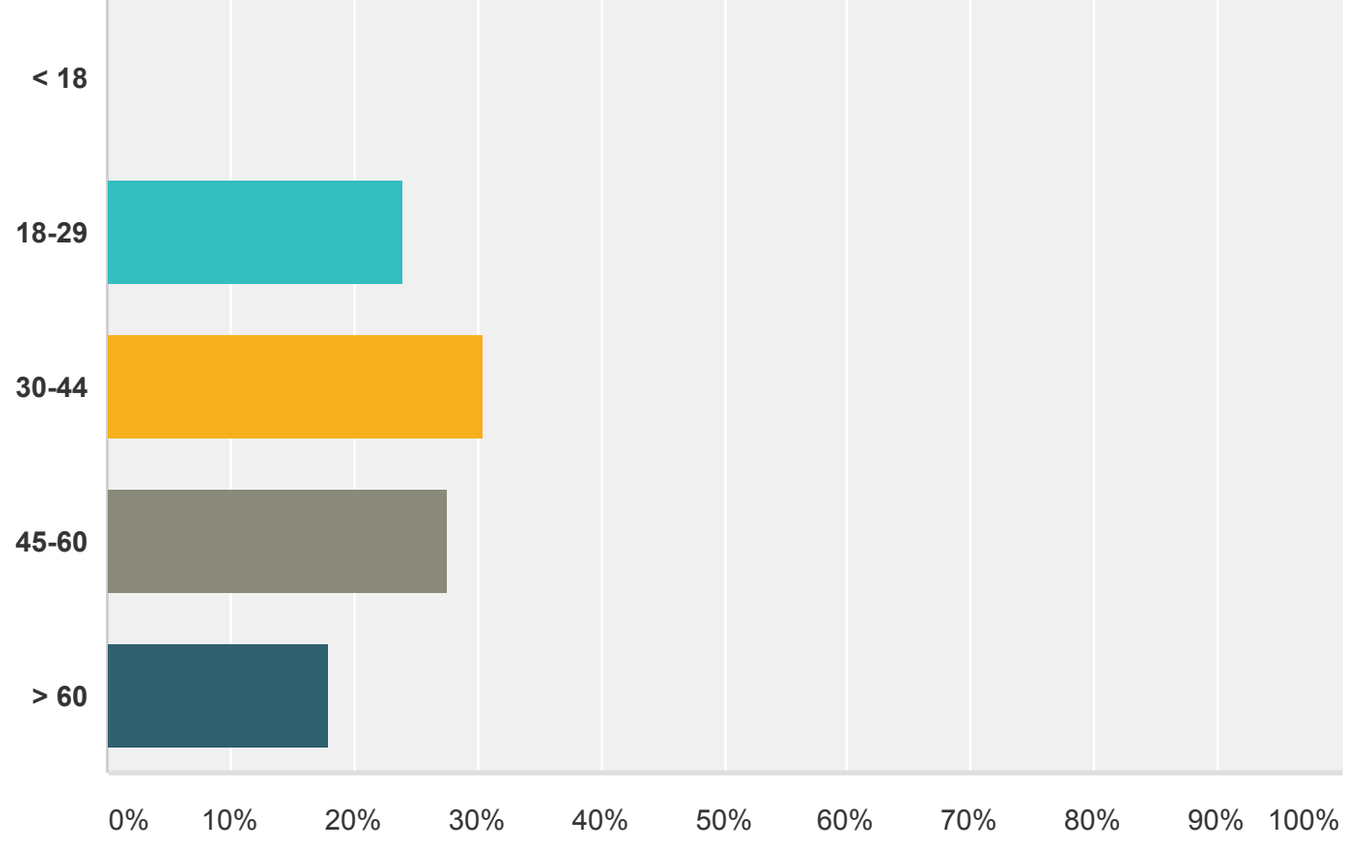


Answer Choices	Responses	
Male	**43.71%**	278
Female	**56.29%**	358
Total		636

Q13 — Customize — Export

Age

Answered: 636 Skipped: 12



Answer Choices	Responses	
< 18	**0.00%**	0
18-29	**24.06%**	153
30-44	**30.50%**	194
45-60	**27.52%**	175
> 60	**17.92%**	114
Total		636

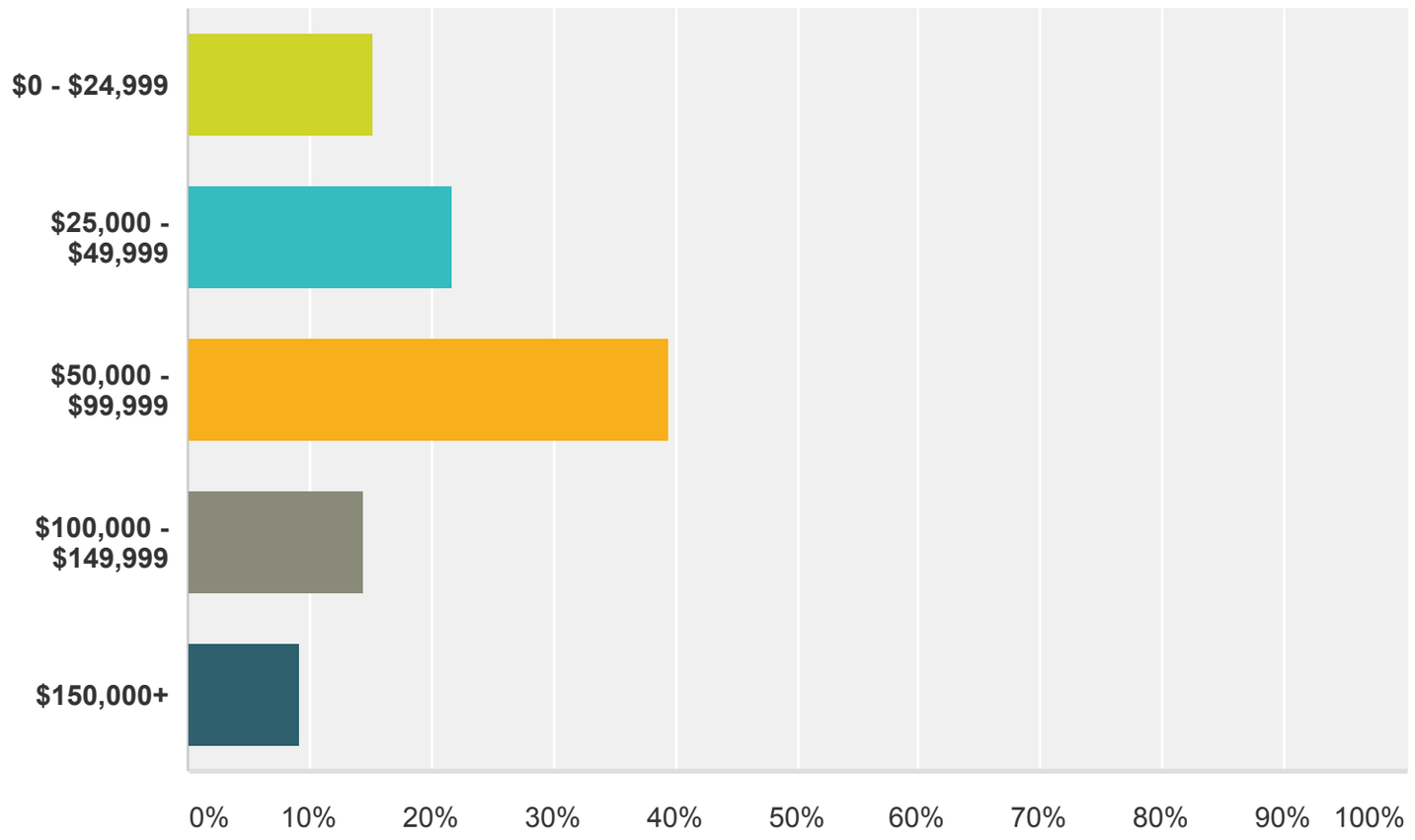
Q14

Customize

Export

Household Income

Answered: 522 Skipped: 126



Answer Choices	Responses	
$0 - $24,999	**15.33%**	80
$25,000 - $49,999	**21.65%**	113
$50,000 - $99,999	**39.46%**	206
$100,000 - $149,999	**14.37%**	75
$150,000+	**9.20%**	48

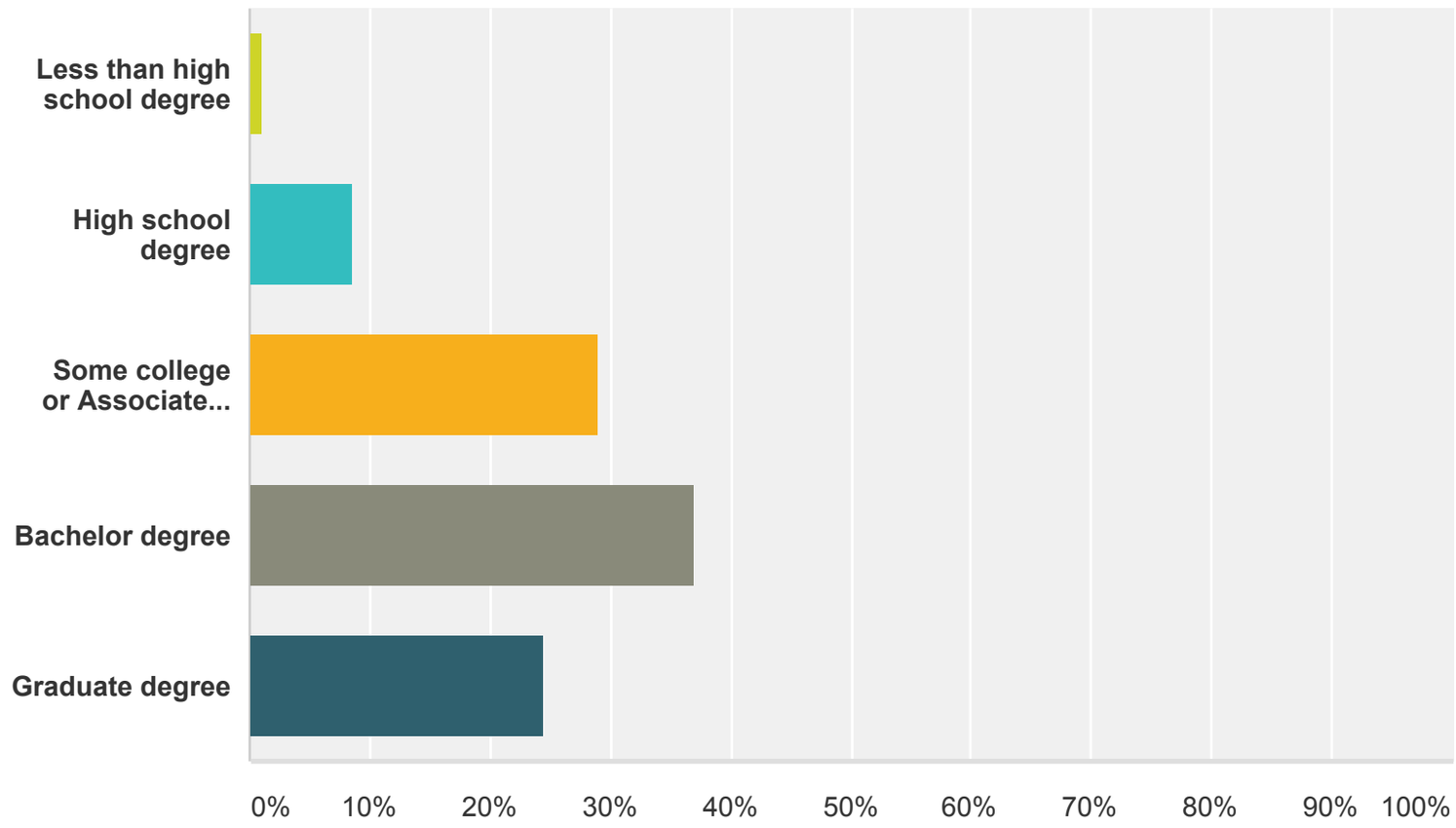
Total	522

Q15

Customize Export

Education

Answered: 634 Skipped: 14



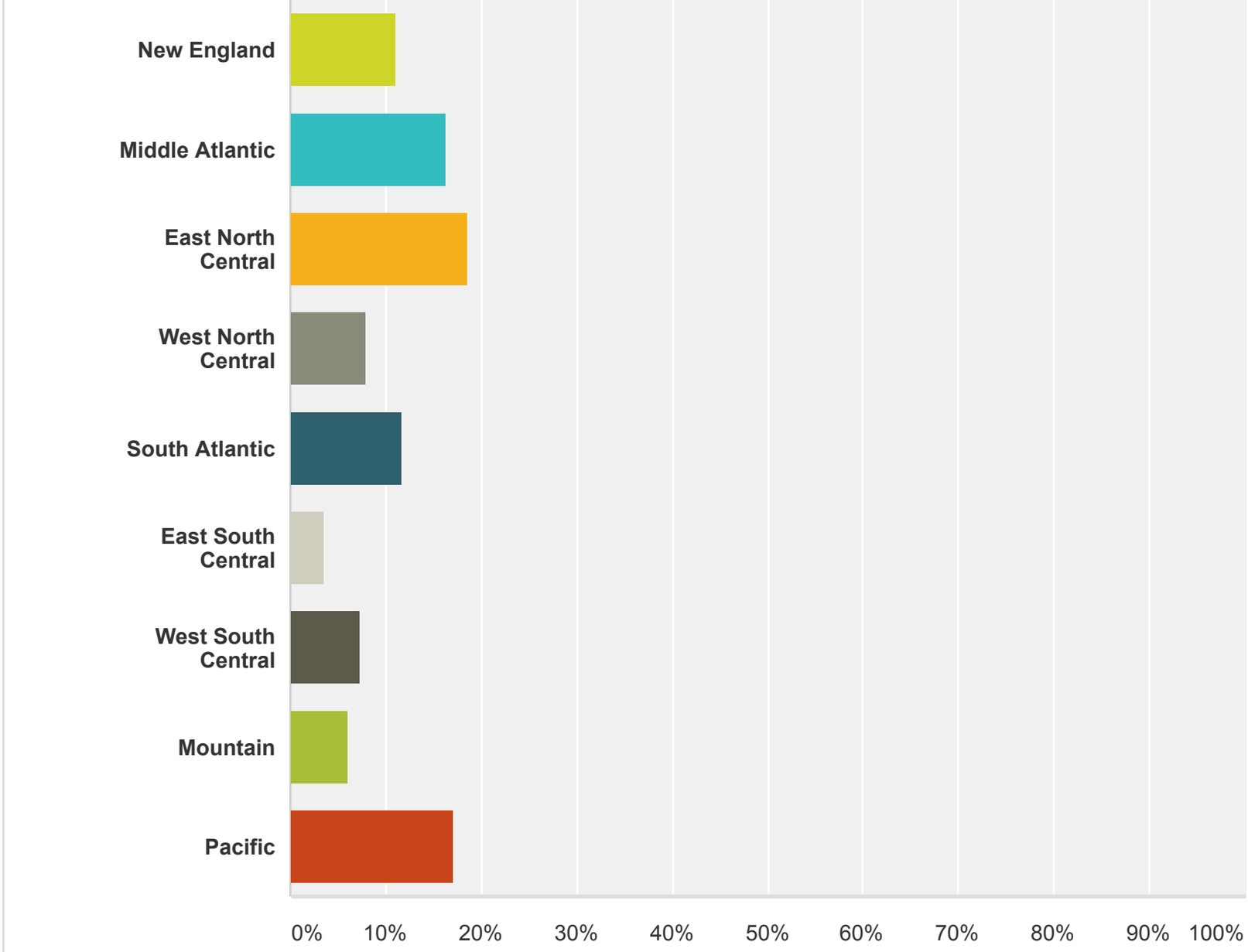
Answer Choices	Responses	
Less than high school degree	**1.10%**	7
High school degree	**8.52%**	54
Some college or Associate degree	**29.02%**	184
Bachelor degree	**36.91%**	234
Graduate degree	**24.45%**	155
Total		634

Q16

Customize Export

Location (Census Region)

Answered: 636 Skipped: 12



Answer Choices	Responses	
New England	**11.01%**	70
Middle Atlantic	**16.35%**	104
East North Central	**18.55%**	118
West North Central	**8.02%**	51
South Atlantic	**11.79%**	75
East South Central	**3.62%**	23
West South Central	**7.39%**	47
Mountain	**6.13%**	39
Pacific	**17.14%**	109
Total		636

Warming Your Shower Survey

Design Survey | Collect Responses | Analyze Results

CURRENT VIEW

+ FILTER | + COMPARE | + SHOW

- FILTER: Q6: Tub/Shower Combo
- ✓ FILTER: Q8: Tub Spout Warm Up
- FILTER: Midwest Census Region
- FILTER: South Census Region
- FILTER: West Census Region
- FILTER: Northeast Census Region
- FILTER: Q8: Showerhead Warm Up
- FILTER: Q8: Tub Spout Warm Up

SAVED VIEWS (2)

Original View (No rules applied) Revert

View complete responses only

+ Save as...

EXPORTS

SHARED DATA (1)

Shared Data 1

FILTERED: 258 of 1,057 respondents — Export All | Share All

Question Summaries | Data Trends | Individual Responses

All Pages

PAGE 2: Tell Us A Little About Yourself

Q1 — Export

Demographic Info

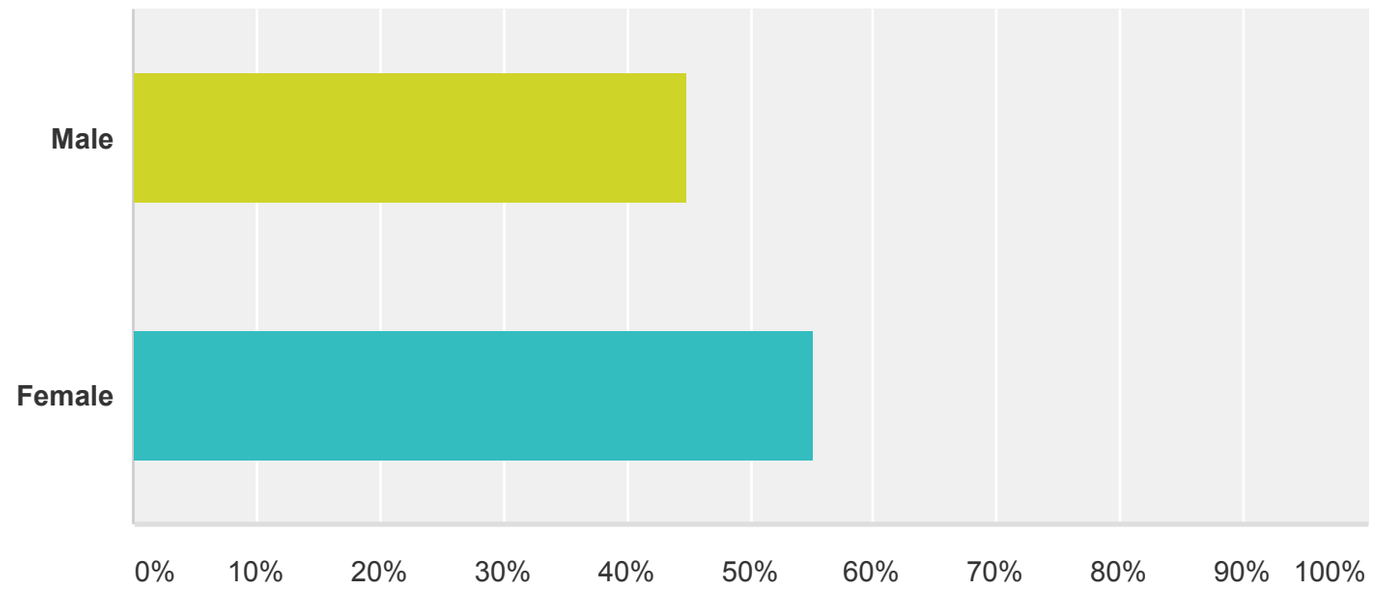
Answered: 258 Skipped: 0

Answer Choices		Responses	
Name	Responses	100.00%	258
Company	Responses	0.00%	0
Address	Responses	0.00%	0
Address 2	Responses	0.00%	0
City/Town	Responses	0.00%	0
State/Province	Responses	100.00%	258
ZIP/Postal Code	Responses	0.00%	0
Country	Responses	0.00%	0
Email Address	Responses	0.00%	0
Phone Number	Responses	0.00%	0

Q2 — Customize | Export

What is your gender?

Answered: 258 Skipped: 0



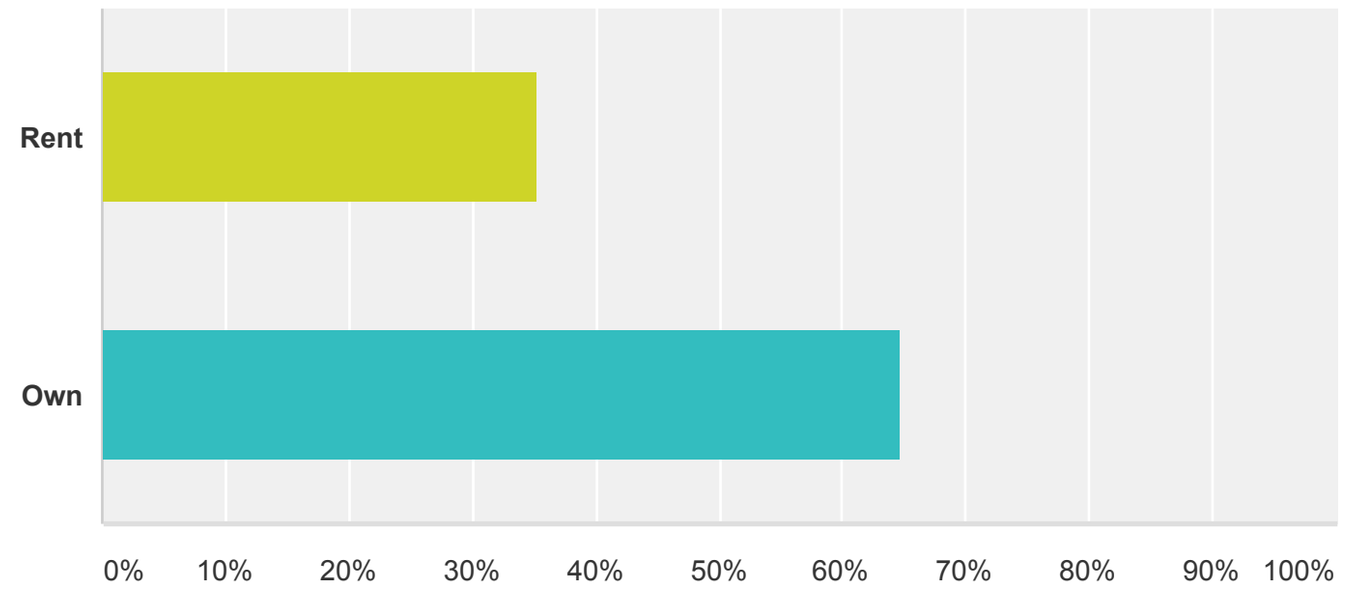
Answer Choices	Responses

Male	44.96%	116
Female	55.04%	142
Total		258

Q3 Customize Export

Do you rent or own?

Answered: 258 Skipped: 0

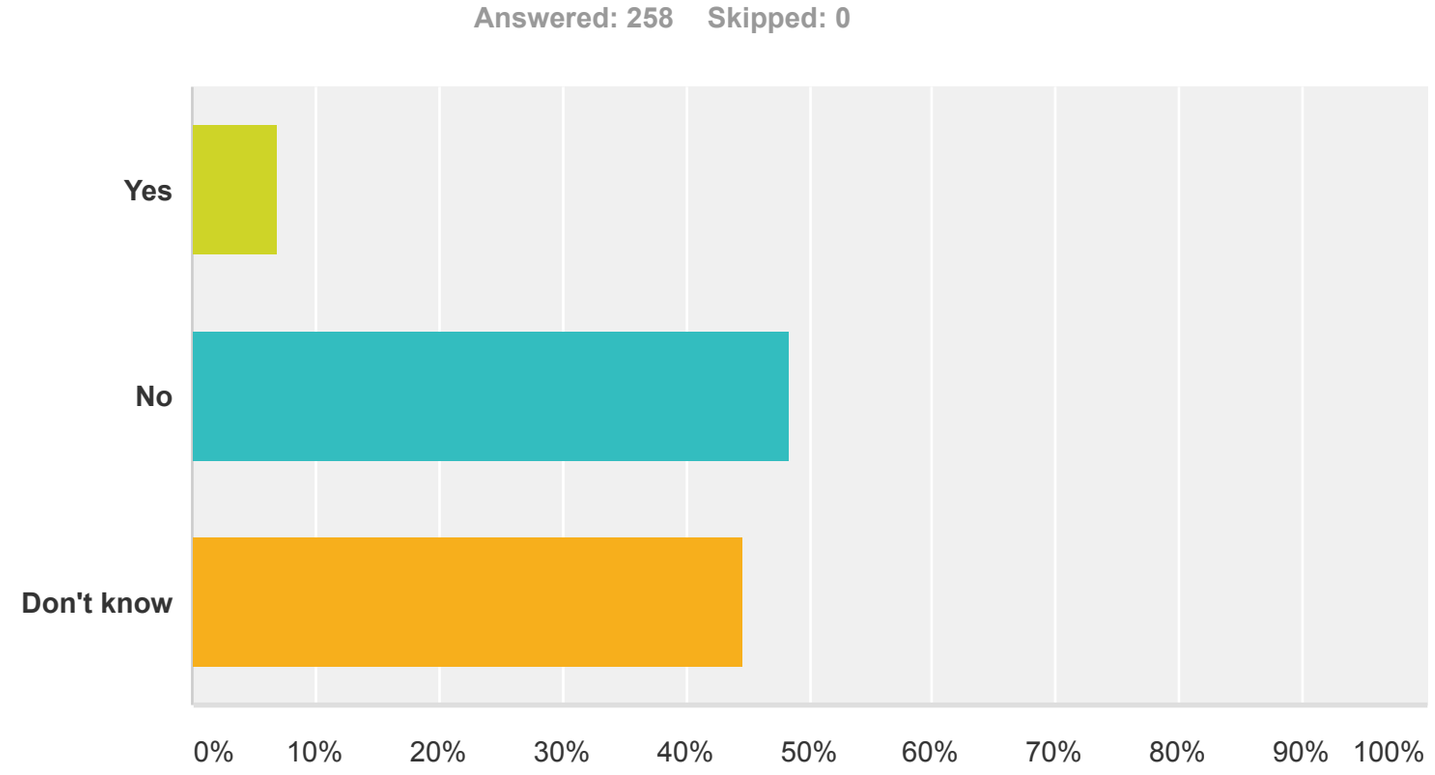


Answer Choices	Responses	
Rent	35.27%	91
Own	64.73%	167
Total		258

Q4 Customize Export

Do you have a hot water recirculation loop or hot water recirculation system in your residence?

Answered: 258 Skipped: 0



Answer Choices	Responses	
Yes	6.98%	18
No	48.45%	125
Don't know	44.57%	115

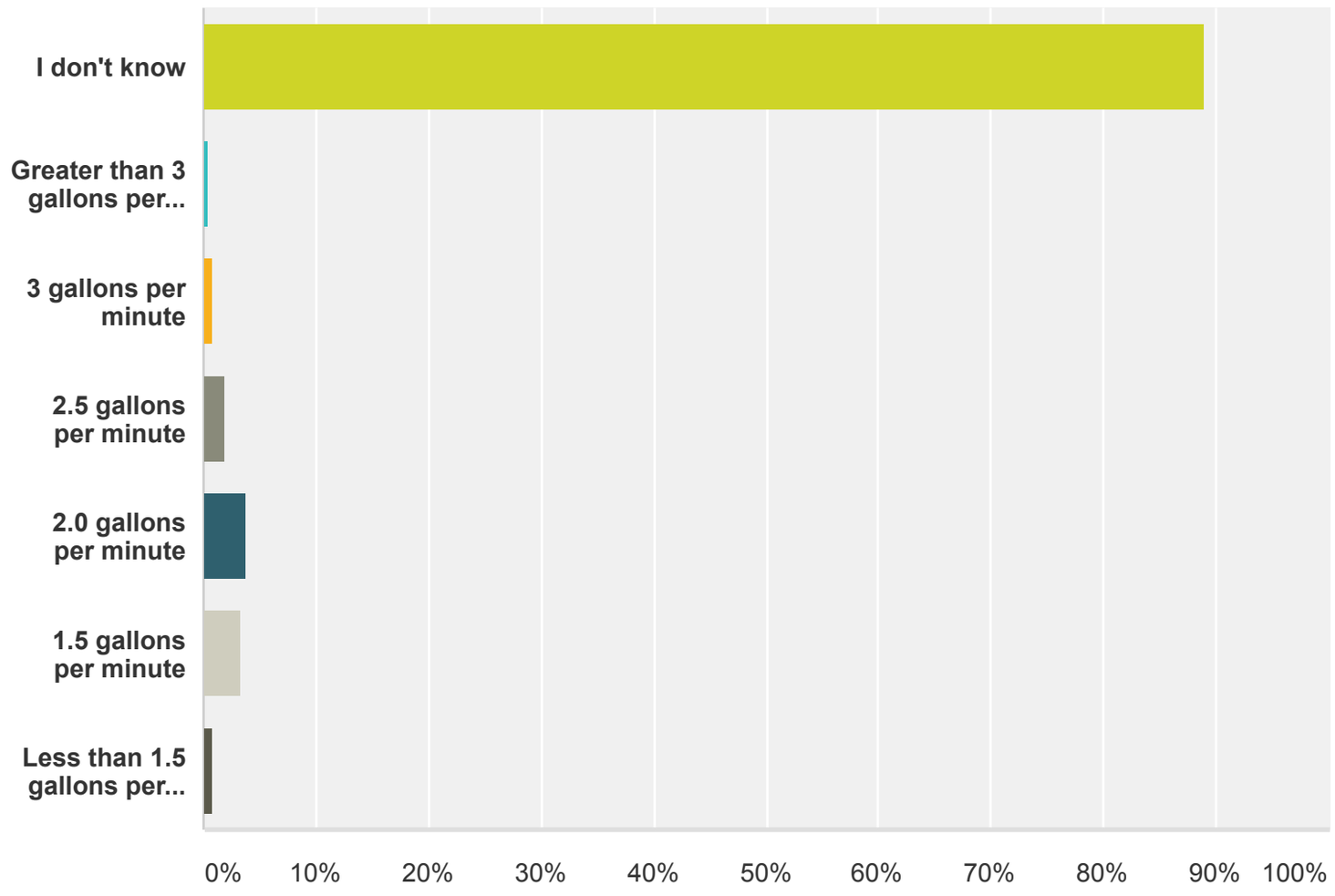
Total	258

Q5

Customize | Export

What is the rated flow rate of the showerhead that you typically shower with? Please DO NOT guess. If you don't know, please select "I don't know".

Answered: 215 Skipped: 43



Answer Choices	Responses	
I don't know	88.84%	191
Greater than 3 gallons per minute	0.47%	1
3 gallons per minute	0.93%	2
2.5 gallons per minute	1.86%	4
2.0 gallons per minute	3.72%	8
1.5 gallons per minute	3.26%	7
Less than 1.5 gallons per minute	0.93%	2
Total		215

PAGE 3: Type Of Shower

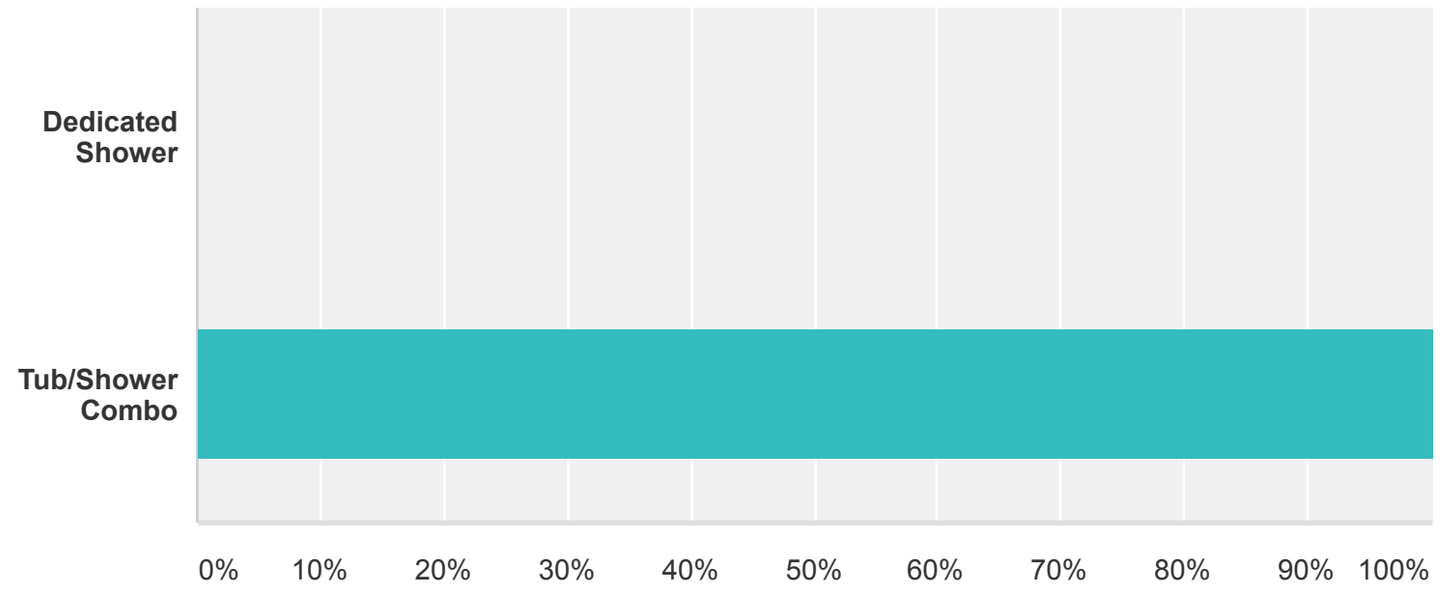
Q6

Customize | Export

In general, there are two types of showers. One type is a "Dedicated Shower". The other is a "Tub/Shower Combo". Dedicated Showers consist of a shower enclosure that only contains a showerhead. Tub/Shower combos consist of a tub and shower combined into a single unit. Do you typically take your shower in a Dedicated

Shower or a "Tub/Shower Combo"?

Answered: 258 Skipped: 0



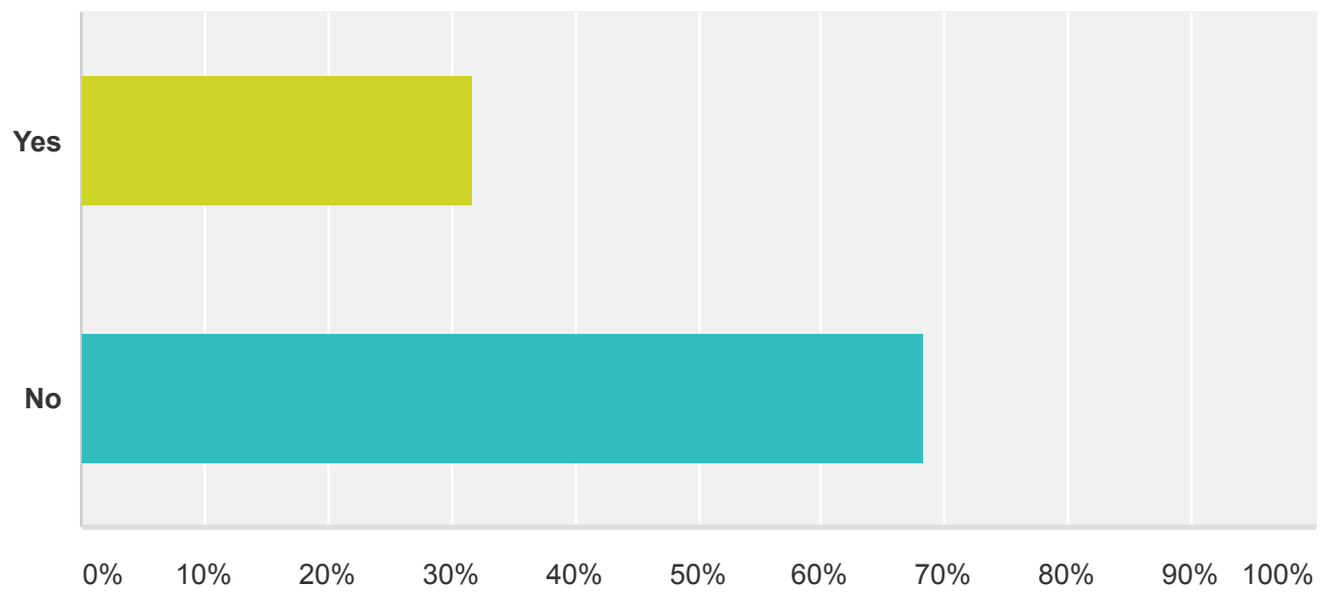
Answer Choices	Responses	
Dedicated Shower	**0.00%**	0
Tub/Shower Combo	**100.00%**	258
Total		258

PAGE 4: Tub Shower Combo

Q7 Customize Export

Some tub spouts leak during a shower. To see this kind of leak all you have to do is look down at the tub spout during your shower. If water is coming out of it while you are showering, the tub spout is leaking. Does your tub spout leak while you are showering?

Answered: 258 Skipped: 0

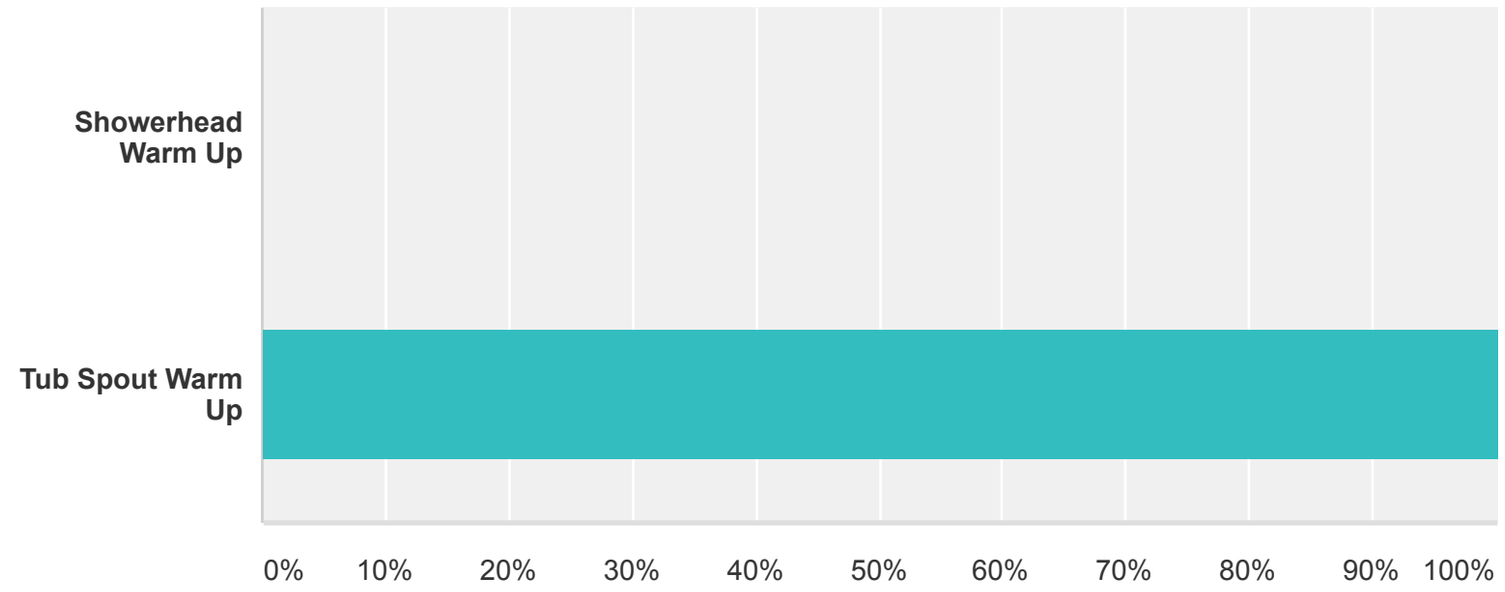


Answer Choices	Responses	
Yes	**31.78%**	82
No	**68.22%**	176
Total		258

Q8 Customize Export

Assuming you are going to take a shower, there are generally two different ways of warming your shower in a Tub/Shower Combo. One way is to turn on the tub and immediately pull up the diverter on the tub spout so the water warms up while running through the showerhead. We call this a “Showerhead Warm Up”. The other method is to turn on the tub and to let the water warm up while running through the tub spout. We call this a “Tub Spout Warm Up.” How do you warm your shower in your Tub/Shower Combo?

Answered: 258 Skipped: 0



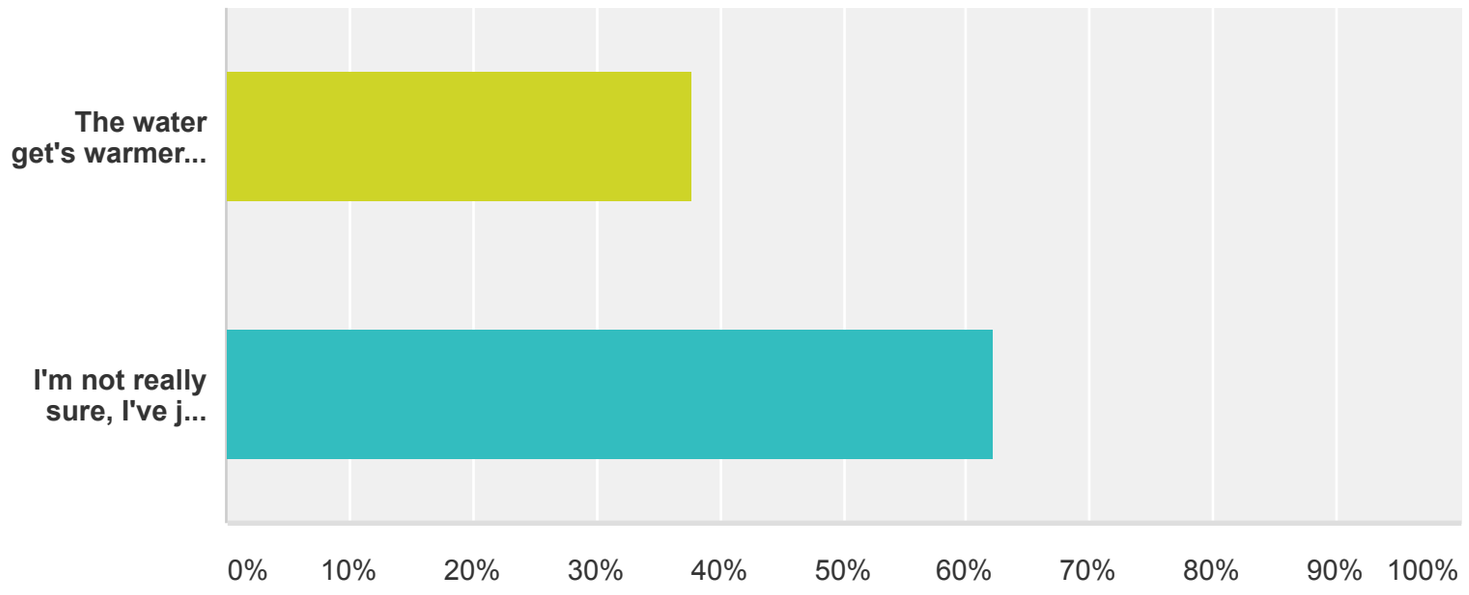
Answer Choices	Responses	
Showerhead Warm Up	**0.00%**	0
Tub Spout Warm Up	**100.00%**	258
Total		258

PAGE 5: Tub Spout Warm Up Reason

Q9 Customize Export

Why do you get the water warm by running it through the tub spout? Pick the best answer from the choices below.

Answered: 256 Skipped: 2



Answer Choices	Responses

The water get's warmer faster.	37.89%	97
I'm not really sure, I've just always done it this way.	62.11%	159
Total		256

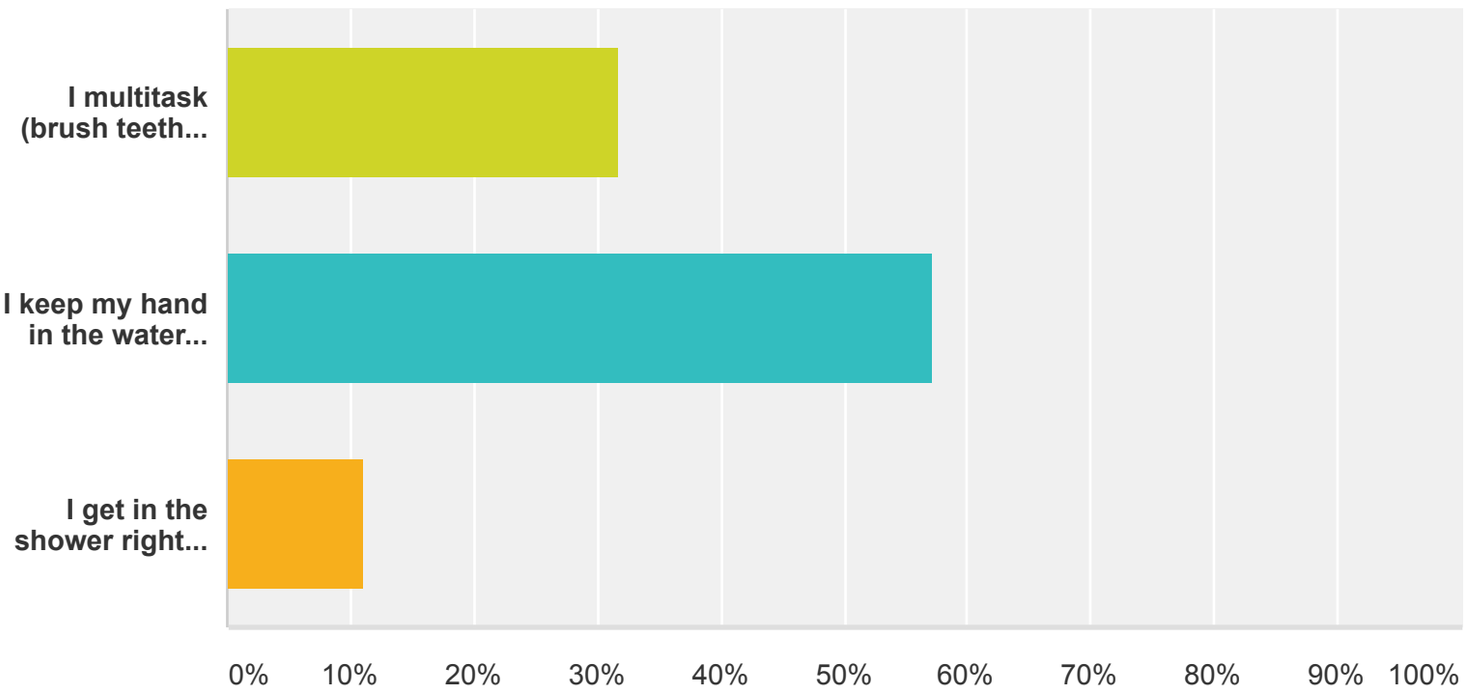
Comments (62)

PAGE 6: Waiting For The Water To Become Warm

Q10 Customize Export

Which answer best describes what you typically do during your warming routine?

Answered: 255 Skipped: 3



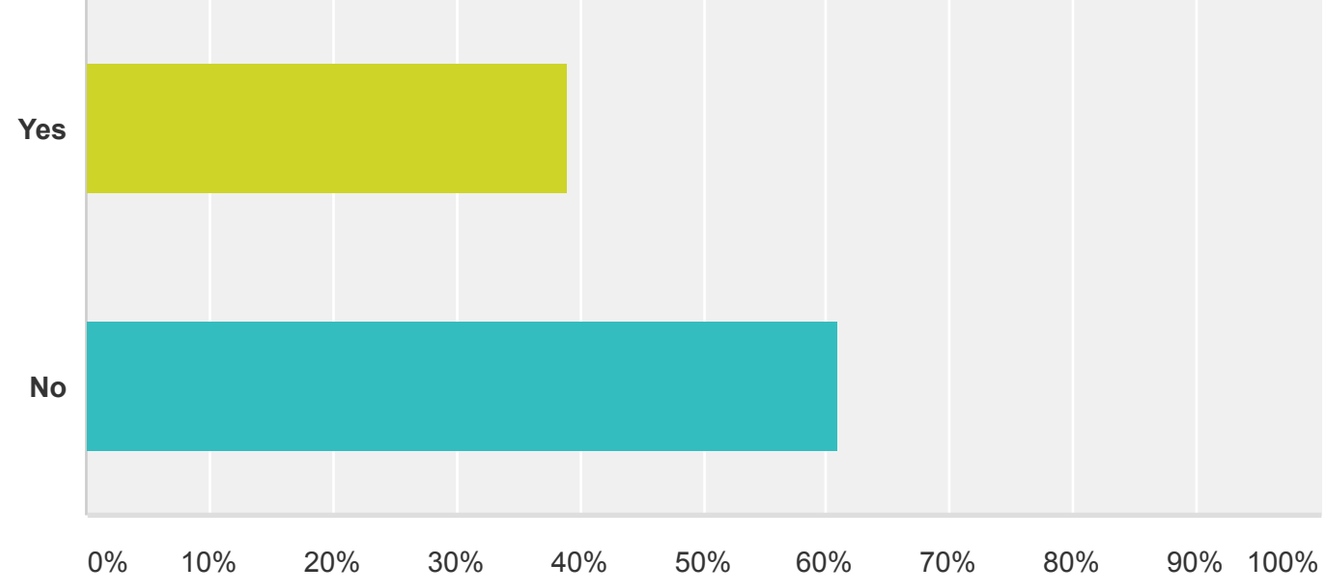
Answer Choices	Responses
I multitask (brush teeth, get a towel, use the washroom, pick out clothes ...) and then return once I know the water is warm.	31.76% 81
I keep my hand in the water to constantly monitor the temperature and get in as soon as it is warm.	57.25% 146
I get in the shower right way regardless of the water temperature.	10.98% 28
Total	255

PAGE 7: Further Inquiry

Q11 Customize Export

Even though you typically wait by the shower with your hand in the water or get in right away, are there times when you have multitasked (brush teeth, get a towel, use the washroom, pick out clothes ...) while warming your shower?

Answered: 174 Skipped: 84

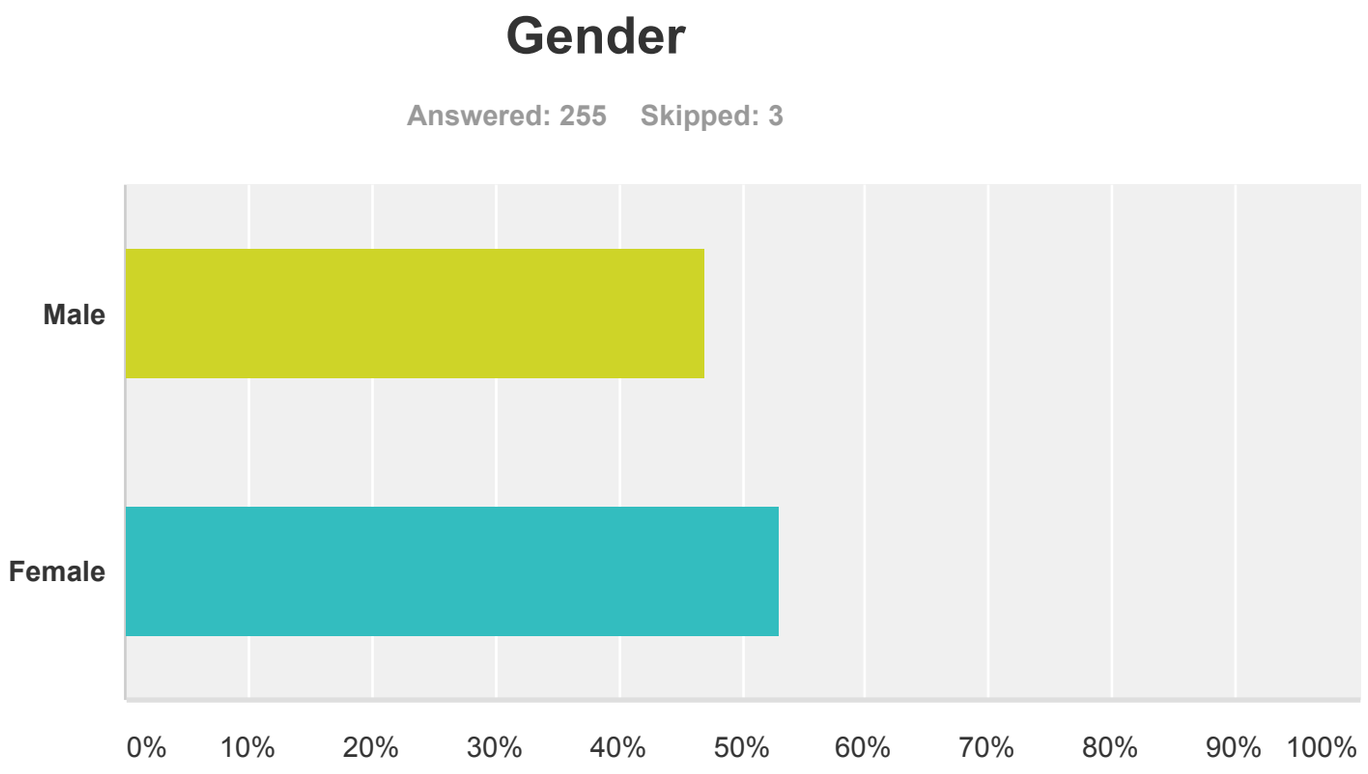


Answer Choices	Responses	
Yes	**39.08%**	68
No	**60.92%**	106
Total		174

PAGE 8: SurveyMonkey Audience

Q12

Customize | Export



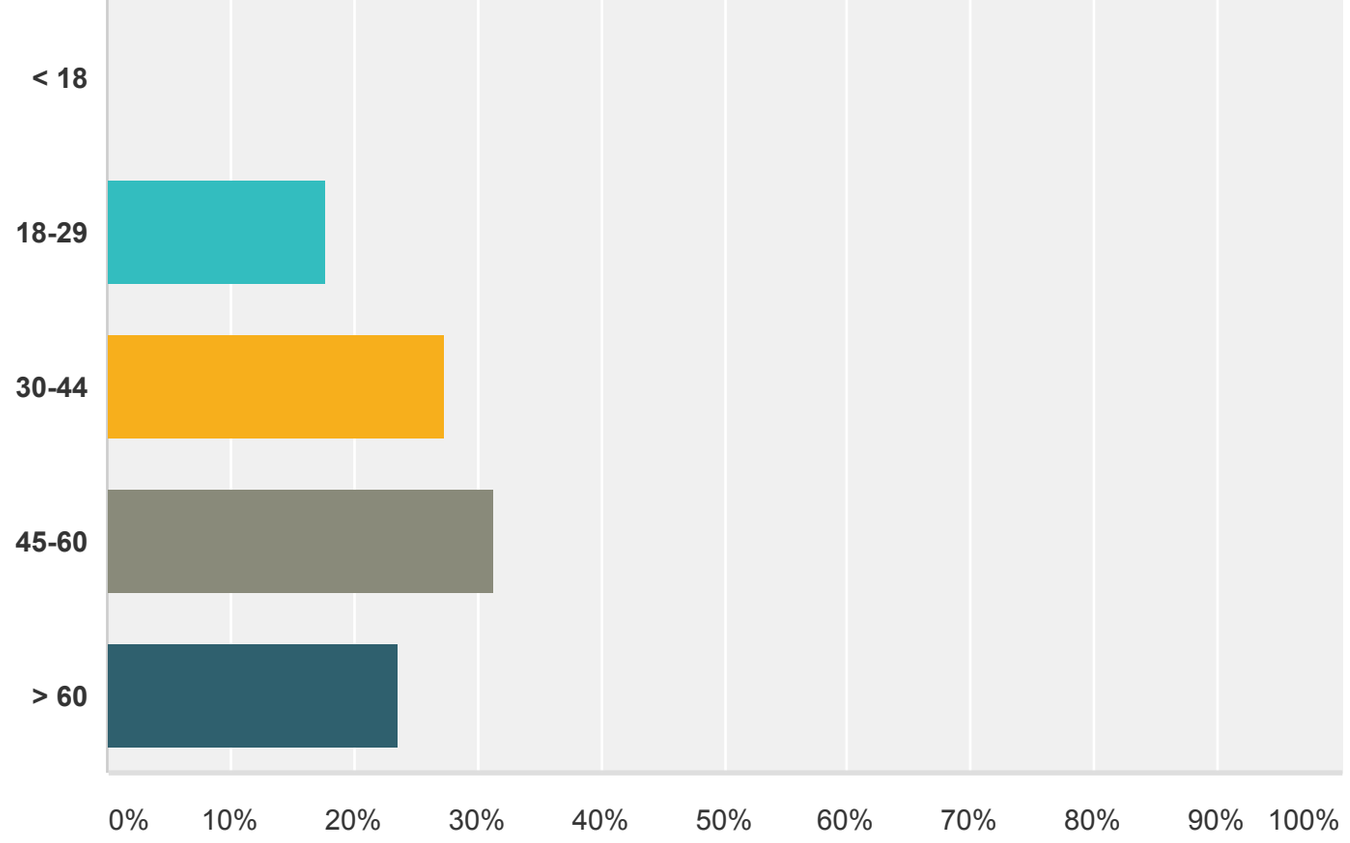
Answer Choices	Responses	
Male	**47.06%**	120
Female	**52.94%**	135
Total		255

Q13

Customize | Export

Age

Answered: 255 Skipped: 3



Answer Choices	Responses	
< 18	**0.00%**	0
18-29	**17.65%**	45
30-44	**27.45%**	70
45-60	**31.37%**	80
> 60	**23.53%**	60
Total		255

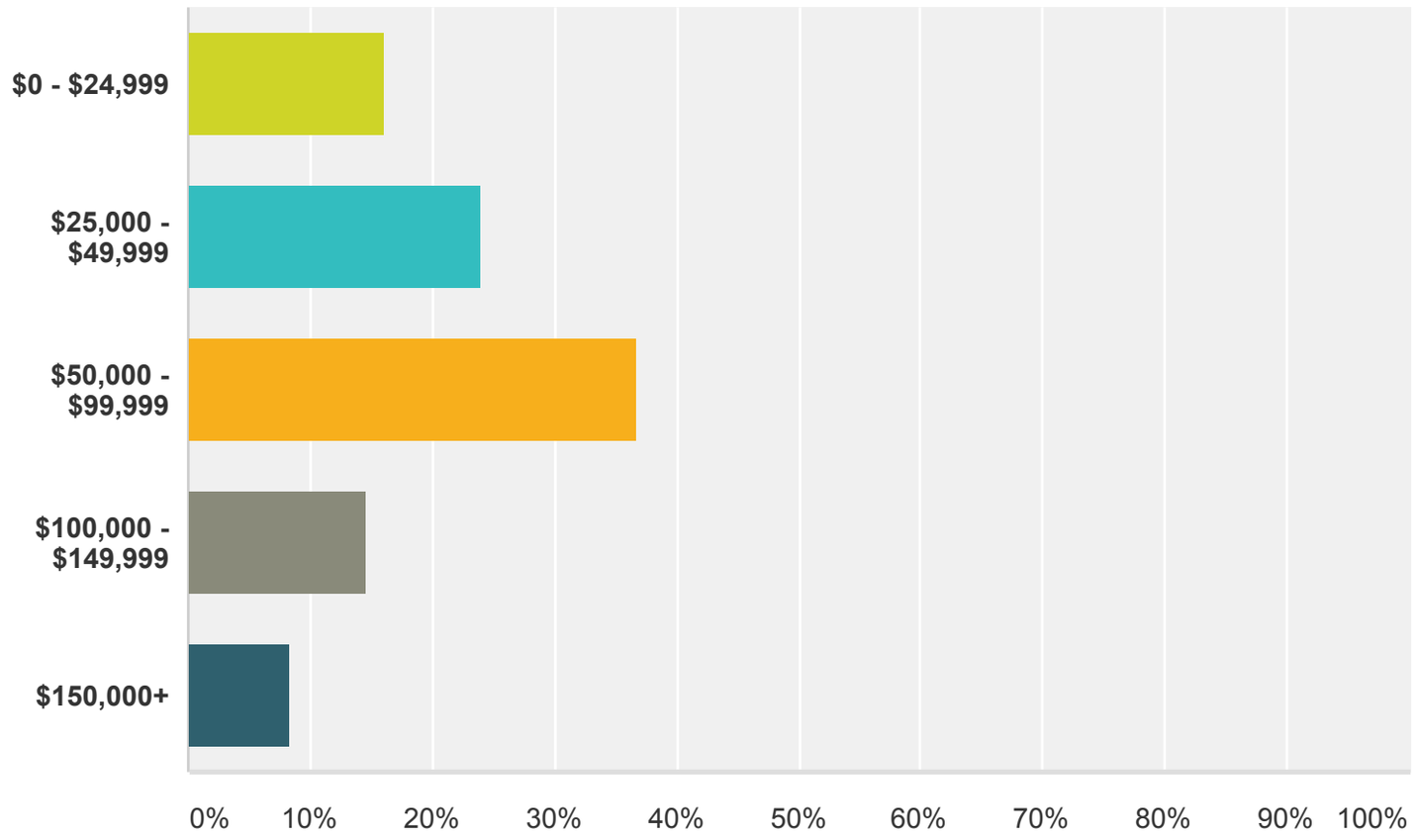
Q14

Customize

Export

Household Income

Answered: 204 Skipped: 54



Answer Choices	Responses	
$0 - $24,999	**16.18%**	33
$25,000 - $49,999	**24.02%**	49
$50,000 - $99,999	**36.76%**	75
$100,000 - $149,999	**14.71%**	30
$150,000+	**8.33%**	17

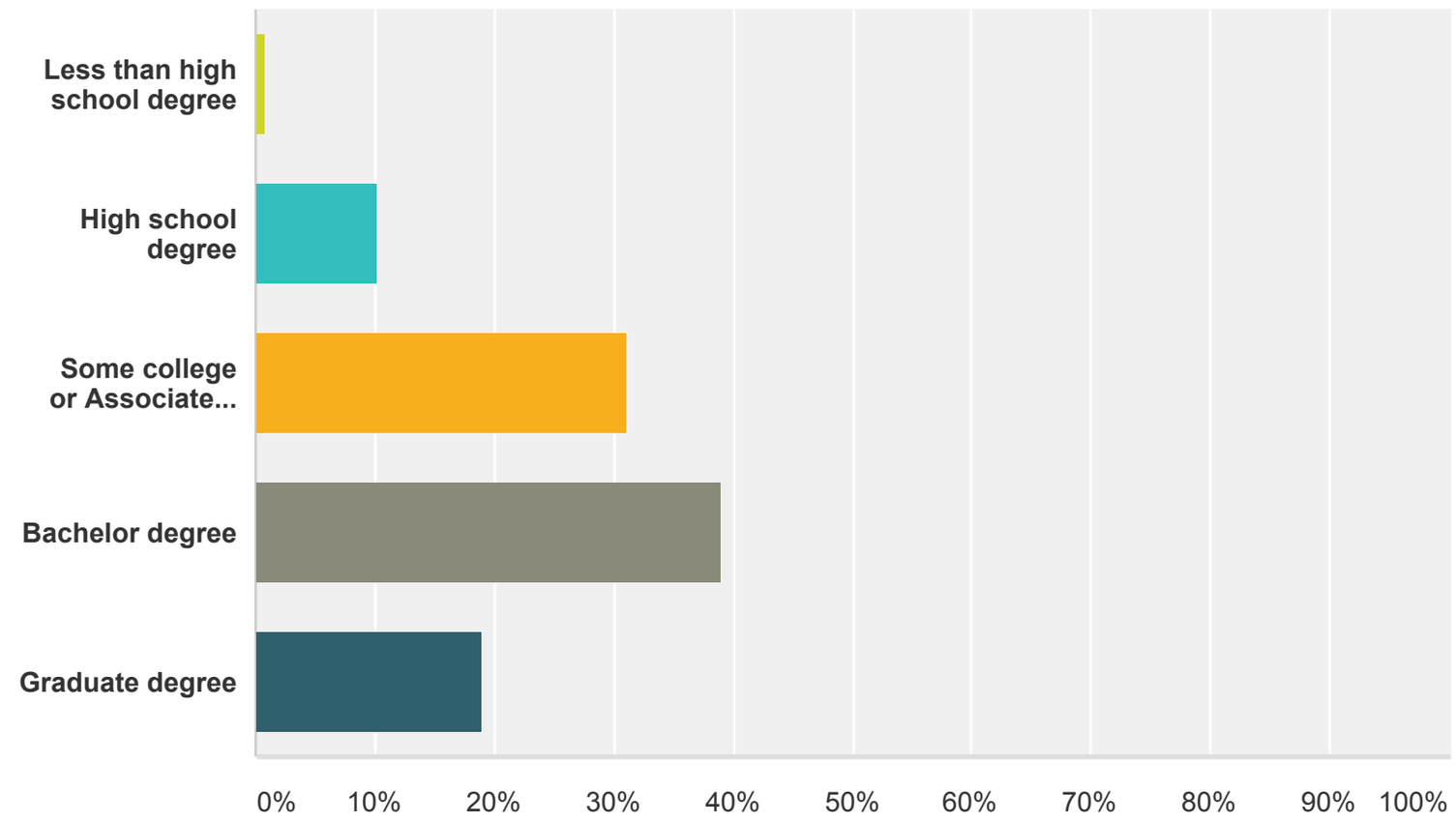
Total	204

Q15

Customize Export

Education

Answered: 254 Skipped: 4



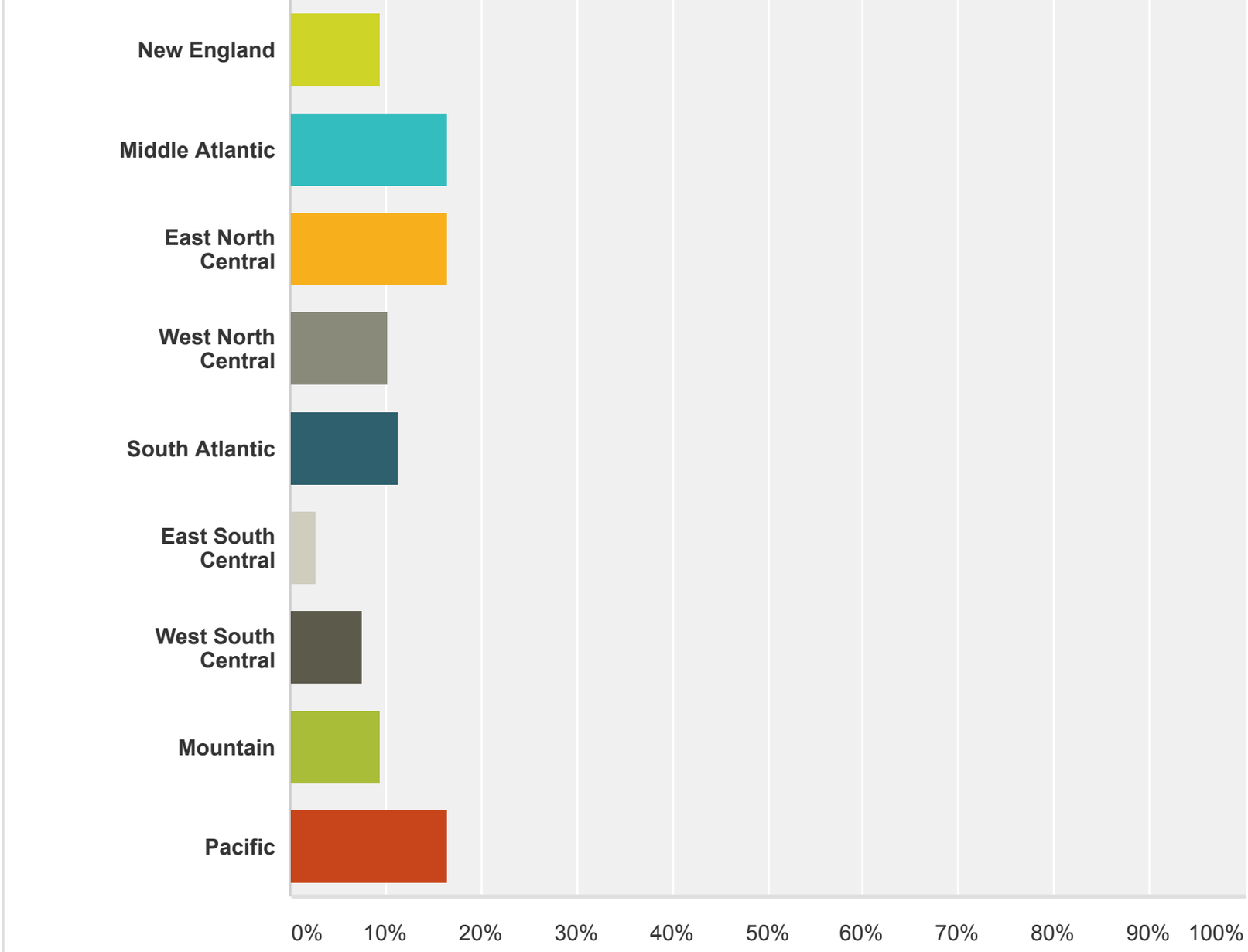
Answer Choices	Responses	
Less than high school degree	**0.79%**	2
High school degree	**10.24%**	26
Some college or Associate degree	**31.10%**	79
Bachelor degree	**38.98%**	99
Graduate degree	**18.90%**	48
Total		254

Q16

Customize Export

Location (Census Region)

Answered: 255 Skipped: 3



Answer Choices	Responses	
New England	**9.41%**	24
Middle Atlantic	**16.47%**	42
East North Central	**16.47%**	42
West North Central	**10.20%**	26
South Atlantic	**11.37%**	29
East South Central	**2.75%**	7
West South Central	**7.45%**	19
Mountain	**9.41%**	24
Pacific	**16.47%**	42
Total		255