Load of Potential: Insights into National Laundry Behaviors for DOE Standards Development

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ABSTRACT

Laundry is a quintessential "co-produced" end use: the energy use changes with both the choices people make – cycle type, load size, and drying habits – and with the engineering of the machines themselves. While the Department of Energy (DOE) can inform the latter, data about customer usage, habits, and preferences are essential to ensure rulemakings take into account customers' real-world behavior. In 2021, Evergreen Economics fielded research in California that found that, counter to DOE assumptions, there was no significant correlation between washer capacity and load size. We followed up this study with national research that we present here that gives broader insight into consumer behavior, short-cycle usage, and emerging technologies.

In 2024, we fielded a nationally representative survey to 413 respondents. Findings reveal that while the vast majority of households have access to short-cycle settings, usage remains low – only one in four consumers with this feature reported using it at least monthly. Moreover, conjoint analysis revealed that, when forced to make trade-offs, consumers value purchase price and operating cost far more than cycle time. Findings suggest that other factors take priority over cycle time, especially in the absence of consumer education, and there may be limited consumer benefit from policies that isolate the short-cycle functionality as a product class.

These findings highlight the challenge of aligning DOE efficiency standards with both emerging technologies and real-world consumer priorities. Accurate, behaviorally-grounded standards are essential for achieving long-term goals for efficiency, decarbonization, and market transformation.

Introduction

Residential clothes washers and dryers account for approximately 2.7 to 10 percent of total household energy use (Dutton Institute n.d., GreenLogic 2023, RECS 2020), making them an important area of focus for appliance standards.

Emerging technologies such as heat pump dryers and combination washer-dryer units are gaining market traction, offering substantial efficiency improvements but with potentially different performance characteristics that may not align with current test procedures. Heat pump dryers can use up to 70 percent less energy compared to conventional electric dryers (EPA 2024), while combination units eliminate the need for separate appliances entirely. Understanding consumer satisfaction and behavior when using these technologies is crucial for developing standards that the market will be able to sustain.

The residential laundry research landscape has been characterized by regional studies and limited national-scale data collection, creating significant knowledge gaps for federal policymakers. Current US Department of Energy (DOE) test procedures assume laundry load weight increases with the capacity of the washer, whereas previous research suggests that this relationship is more nuanced. A 2020 Northwest Energy Efficiency Alliance (NEEA) report found that households in the Pacific Northwest with high-capacity washers do not wash larger loads compared to households with compact or standard capacity washers

(Kannah 2020). Similarly, Pacific Gas and Electric's (PG&E's) 2021 Home Energy Use Study in California found no evidence of a positive and linear relationship between washer capacity and average load weight (Evergreen 2021).

In recent years, the DOE has expressed an interest not only in national-scale studies of the relationship between capacity and load size, but also in short-cycle washers and dryers. In 2020, the DOE established new product classes for appliances that offered shorter "normal" cycle times in response to the Competitive Enterprise Institute's argument that longer cycle times diminish consumer satisfaction (DOE 2020). However, in January 2022, the DOE revoked the short-cycle product class, due to a violation of the Energy Policy and Conservation Act (EPCA) (DOE 2025).[1] Interest remains in how consumers value shorter cycle times, and empirical data on short-cycle usage patterns and consumer valuation of time savings remain limited.

Research Objectives and Survey Background

Based on this recent history and DOE research interests, Evergreen Economics, on behalf of Pacific Gas and Electric's Codes and Standards team, identified key laundry-related research questions to support rulemaking by the DOE. Specific objectives included learning about the following with a nationally representative sample:

- Use of new laundry technologies, including heat pump dryers and combination washer-dryer units
- Overall laundry appliance usage and satisfaction
- Experience with the short-cycle clothes washer option

To efficiently conduct a national survey of a representative population of adults in the US, we leveraged AmeriSpeak, which is a panel run by the National Opinion Research Center (NORC). Data from AmeriSpeak have been used by organizations such as Consumer Reports, the American Cancer Society, the Associated Press, and other reliable institutions because it ensures a representative sample of households. Amerispeak fielded a web-based survey between June and July 2024 and collected 413 responses. In order to qualify, a household needed to have a washer and dryer in their home or unit (they did not need to own their laundry appliances).

Survey and Conjoint Analysis Methods

All findings presented in this paper are weighted to the US population based on age, sex, education, and race/ethnicity.[2] A variety of methods were used to check for statistically significant findings, including two-proportion, one-tailed z-tests and chi-squared tests of independence.

The study team conducted a conjoint analysis designed to understand consumer preferences for washer and dryer features, focusing on the trade-offs consumers make between purchase price, operating cost, and cycle time. Conjoint analysis is a statistical technique commonly used to evaluate how individuals value various attributes that make up a product or service.

For this analysis, we used the binary logistic regression model to estimate the relative value that respondents place on different product attributes—namely, purchase price, operating cost, and cycle

[1] DOE determined that the 2020 short-cycle product classes violated EPCA because they were adopted without proper consideration of energy and water savings, technological feasibility, and economic justification. In January 2022, DOE revoked the classes and reinstated the original stricter standards. After legal challenges and RFIs, DOE proposed confirming the withdrawal in late 2024.

[2] While the proportions in figures and tables in this paper are weighted, we have included the unweighted sample sizes in captions, representing the actual number of respondents. The proportions may not exactly align with the associated sample size.

time. The dependent variable of the logistic regression model used is binary; it equals 1 for the washer or dryer chosen by the survey respondent from each respective panel of four washers or dryers and equals 0 for the washers or dryers not chosen.[3] The logistic regression model allowed us to estimate the impact that each product attribute has on the product selection decisions of consumers while holding all other attributes constant, thereby revealing which attributes consumers prioritize when choosing a washer or dryer.

Insights from the National Laundry Survey

This section details survey findings based on the three main research objectives: 1) learning about new laundry technologies, 2) collecting feedback on laundry appliance usage and satisfaction, and 3) understanding respondent experience with the short-cycle option.

Adoption and Satisfaction with New Laundry Technologies

We asked respondents about their awareness and adoption of and satisfaction with emerging laundry technologies, including heat pump dryers and combination washer-dryer units. These technologies offer potential energy and space-saving benefits but may also introduce new tradeoffs in performance and usability. This section explores how consumers are engaging with these innovations and how satisfaction varies across product types.

Heat pump dryers. Heat pump dryers are a relatively new technology that uses a more efficient non-vented heat pump-based drying technology. Of the 381 respondents to the question about whether their clothes dryer was a regular dryer, a heat pump dryer, or a hybrid heat pump dryer, 5 percent reported having a heat pump dryer, suggesting that they are not yet common.

We asked respondents who reportedly have heat pump or hybrid heat pump dryers about their purchase motivations. Of the 22 respondents who reported having a heat pump or hybrid heat pump dryer, energy efficiency was the most common reason provided.

Furthermore, respondents who had heat pump dryers reported being largely satisfied with their machines, with 51 percent reporting being "extremely satisfied." None reported being not at all satisfied. We found a statistically significant difference between the proportion of respondents "extremely satisfied" with their heat pump dryers (51%) and the proportion of respondents "extremely satisfied" with their non-heat pump dryer (33%).[4]

Combination units. We also asked respondents about combination units – a single appliance that will clean and dry clothes in the same drum without needing to take laundry out of a clothes washer and load it into a separate clothes dryer. Three percent of respondents reported having a combination unit.[5] Notably, the more recently popular combination units contain heat pump dryers, but respondents with combination units were not directly asked if they had heat pump drying technology in this study. About

[3] Each survey respondent was presented with four panels of four alternatively configured washers and asked to rank the four washers from most preferred to least. We assigned a value of 1 to the washer chosen as most preferred and a value of zero to the other three. The same process was followed for dryers.

[4] For each of the four satisfaction metrics (overall satisfaction, dryness of clothes, time it takes to dry a load of laundry, and available settings/drying features), we performed a one-tailed, two-proportion z-test with a significance level of .05. The results of these four tests were statistically significant.

[5] Thirty-one out of 314 respondents (~10%, weighted) reported owning a combination unit, but only 12 provided verifiable model numbers. Just four of the 12 were confirmed to be combination units and the rest were misclassified. Applying this 1-in-3 ratio to the original 31 yields an estimated 10 true combination units, or approximately 3 percent.

half of the respondents who reported having a combination unit (51%) said they would be extremely or very likely to buy another one.

We then asked respondents who reported having combination units about their satisfaction with them. Overall, most respondents were satisfied with their units, with no one reporting that they were not very or not at all satisfied. About half of respondents reported being extremely or very satisfied with the time to wash a load of laundry and the dryness of their clothes. Conversely, respondents were least satisfied with the time it takes to dry a load of laundry, with 26 percent reporting to be not very or not at all satisfied. Overall satisfaction was lower for combination units than the satisfaction ratings for individual units.

Respondent satisfaction among heat pump, combination, and traditional dryers. Our survey results reveal notable differences in respondent satisfaction across the three dryer technologies examined: heat pump dryers, traditional dryers, and (reported) combination units. Figure 1 shows the overall satisfaction ratings for all three technologies. Respondents had the highest levels of satisfaction for heat pump dryers, with 51 percent being extremely satisfied, compared to 33 percent being extremely satisfied with traditional dryers and 25 percent being extremely satisfied with combination units.

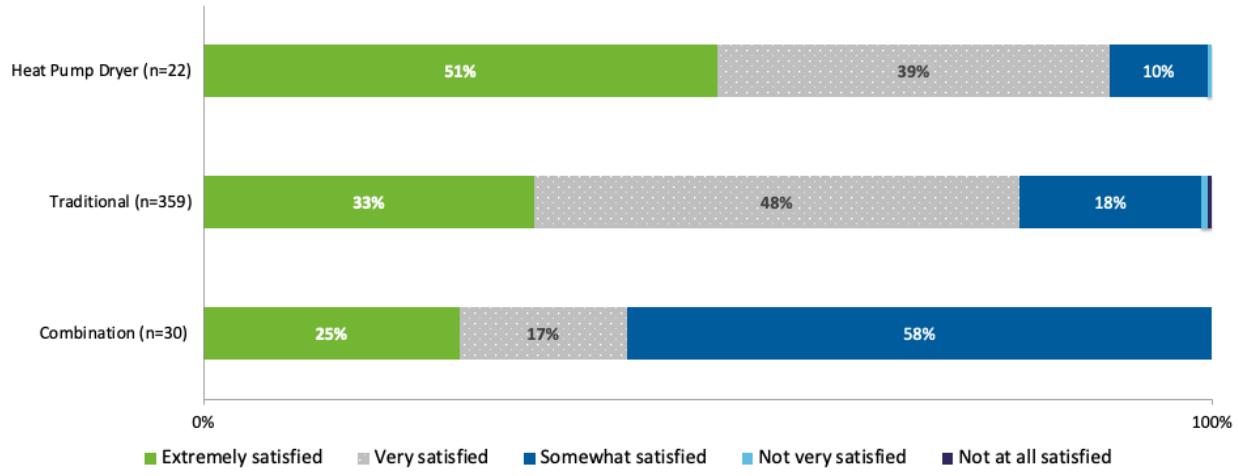


Figure 1. Overall satisfaction with heat pump, traditional, and combination dryers (n varies)

These findings suggest that while heat pump dryers represent a relatively new technology with limited market penetration (5% of our sample), they deliver superior user satisfaction compared to both traditional dryers and combination units. This higher satisfaction persists despite heat pump dryers typically having longer cycle times than traditional vented dryers, suggesting that other factors such as energy efficiency, gentler drying, or quieter operation may outweigh cycle time considerations for these users. Combination units, despite offering the convenience of a single appliance for washing and drying, show the lowest satisfaction levels (though the sample size is limited).

Overall Usage and Satisfaction with Washers and Dryers

We asked respondents for details about how they use their washers and dryers in addition to asking about satisfaction with their clothes washers and dryers. We surveyed respondent satisfaction in terms of their overall satisfaction and how they react when their laundry is not clean or dry enough after a cycle completes.

Clothes washers. Eighty-one percent of respondents reported that they were extremely or very satisfied with their clothes washer overall (Figure 2). Respondents reported high satisfaction with loading style and washer performance. Respondents gave the lowest satisfaction rating to the time it takes to wash a load of laundry. However, no one reported that they were not satisfied at all with the time of the cycle, the cleanliness of clothes, or available settings.

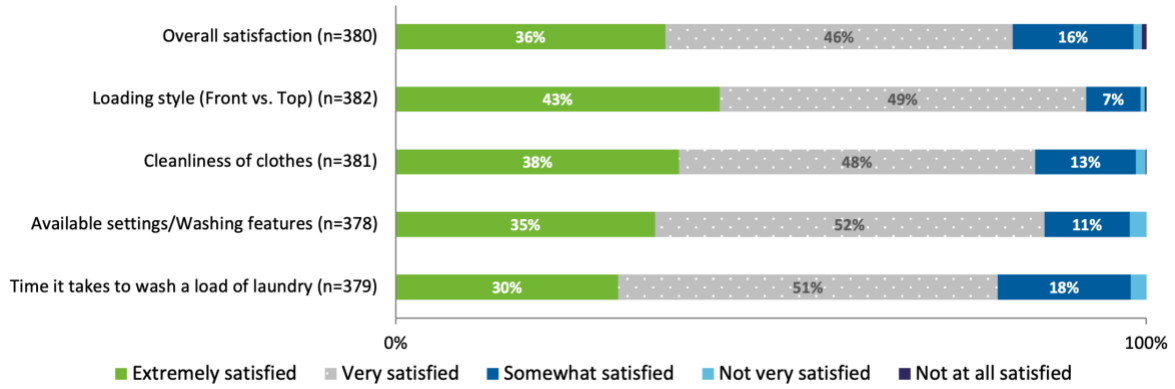


Figure 2. Respondent satisfaction with clothes washer (n varies)

We also asked respondents how often their wash cycle did not sufficiently clean their laundry. Seventy-six percent of respondents reported that they did not run into this issue. While this suggests that a washer's ability to clean is a non-issue, the behavior of respondents who did find their laundry to be insufficiently clean has important implications for energy use and water conservation.

Table 1 shows how respondents reacted when their laundry was insufficiently clean after completing a wash cycle. Among those who occasionally found their laundry to be insufficiently clean after the first cycle, about half of them reported re-running their full clothing load or only the clothing that was not clean enough. Among those who frequently found their laundry to be insufficiently clean after the first cycle, the most common response was to re-run the full clothing load using the same wash settings. Among both groups, those who selected "something else" stated that they would do another rinse/spin cycle, remove lint or particles stuck to the clothing, or let the clothing soak in water before rewashing the load.

Table 1. Respondent reaction to insufficiently clean laundry (n* varies, multiple responses allowed)

	Occasionally unclean		Frequently unclean	
Respondent action	n	Percent	n	Percent
Re-run the full clothing load using the same wash settings	92	49%	13	70%
Re-run the full clothing load using different wash settings	91	47%	13	41%
Re-run only clothing that is not sufficiently clean using the same wash settings	92	50%	13	47%
Re-run only clothing that is not sufficiently clean using different wash settings	90	39%	13	39%

Respondent action	Occasionally unclean		Frequently unclean	
	n	Percent	n	Percent
Remove the clothing that is not sufficiently clean, spot clean, and dry as normal	88	22%	13	27%
Remove the clothing that is not sufficiently clean, spot clean, and wait to wash it again	90	45%	13	43%
Something else	32	7%	2	30%

*n represents the denominator for each respondent action asked about, and thus the differences reflect varying levels of nonresponse.

Clothes dryers. We also asked respondents to rate their satisfaction with their clothes dryer. Eighty-two percent of respondents reported that they were extremely satisfied or very satisfied with their clothes dryer. Similar to clothes washers, the time it takes to dry a load of laundry informs their satisfaction rating, with only 30 percent of respondents having reported that they were extremely satisfied with the time it takes to dry their clothing (Figure 3).

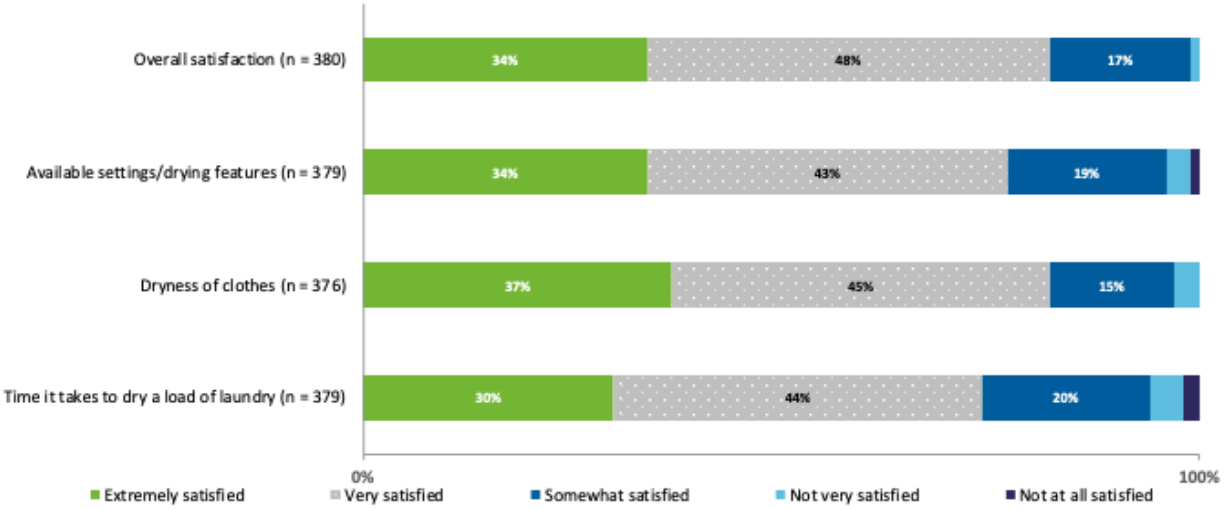


Figure 3. Respondent satisfaction with clothes dryer (n varies)

We asked the 21 respondents who said they were not satisfied with the time it takes to dry their clothes to explain their dissatisfaction. Thirty-eight percent mentioned that they must run their dryer two or three times to get their clothing fully dry. A minority of respondents said that they hang-dry their laundry outside to allow it to finish drying.

We asked all respondents (n=380) how often their dryer did not sufficiently dry their laundry. Sixty-six percent of respondents reported that their laundry is occasionally or frequently not sufficiently dry after a dry cycle. Compared to the 24 percent of respondents who reported that their laundry is occasionally or frequently not sufficiently clean after a wash load, this suggest that respondents' dryer performance is a bigger issue than washer performance. This may be due to the fact that assessing the

cleanliness of wet clothing after a wash cycle is more difficult than assessing the dryness of clothes after a dry cycle. We found that there was a statistically significant difference between the proportion of respondents who always found their clothes clean enough (76%) after a single washer cycle and the proportion of those who always found their clothes dry enough (34%) after a single dryer cycle.[6]

We then asked what they did if their laundry was not dry enough. We provided a list of options of actions in response to insufficiently dry laundry; Table 2 shows that respondents use multiple methods to address this, with over half choosing to run the dryer a second time.

Table 2. Respondent reaction to insufficiently dry laundry (n varies, multiple responses allowed)

Respondent action	Percent
Re-run the full clothing load using different dryer settings (n=240)	60%
Re-run only clothing that is still damp using the same dryer settings (n=241)	58%
Re-run only clothing that is still damp using different dryer settings (n=239)	58%
Re-run the full clothing load using the same dryer settings (n=242)	54%
Remove the laundry and hang dry (n=237)	38%
Something else (n=62)[7]	8%

Using the data from Table 2, we can see that among the respondents whose dryers do not dry their clothing enough after the first cycle, a sizeable proportion re-run the cycle a second time. Among the 380 complete dryer responses, 36 percent of respondents run the dry cycle a second time when their clothes are not dry enough after the first cycle.

Short-Cycle Settings: Availability and Usage Patterns

Given the DOE's recent creation and subsequent rescission of a short-cycle product class, the short-cycle/quick wash setting was of specific interest to the study team. We asked respondents a series of questions regarding the availability and their usage of the short-cycle/quick wash setting to understand how respondents engage with the feature.

We began by asking respondents to report all the settings available on their clothes washer, as well as which features they use at least once per month. Notably, most respondents (76%) said they had the short-cycle/quick wash option on their washer.

We then asked respondents to report which of the available settings they use at least once per month. Seventy-six percent of respondents' clothes washers have a short-cycle setting, yet only 25 percent of respondents (n=71) with that setting reported that they use it at least once per month (Figure 4). Of those 71 respondents, nearly one-third of them (30%) said that they used the short-cycle/quick wash setting almost always or most of the time, suggesting that many consumers find value in this efficient setting, when they are willing to give it a try.

[6] We performed a two-proportion, one-tailed z-test with a significance level of .05 to test if the reported occurrence of always sufficient laundry cycles was greater for washers than for dryers.

[7] Of the 62 respondents that selected "something else," 6 indicated (unprompted/open ended) that they would set a shorter cycle and re-run the dryer, clean out the lint filter, or untangle the load and re-run the dryer. These respondents also selected one of the four actions involving re-running the dryer.

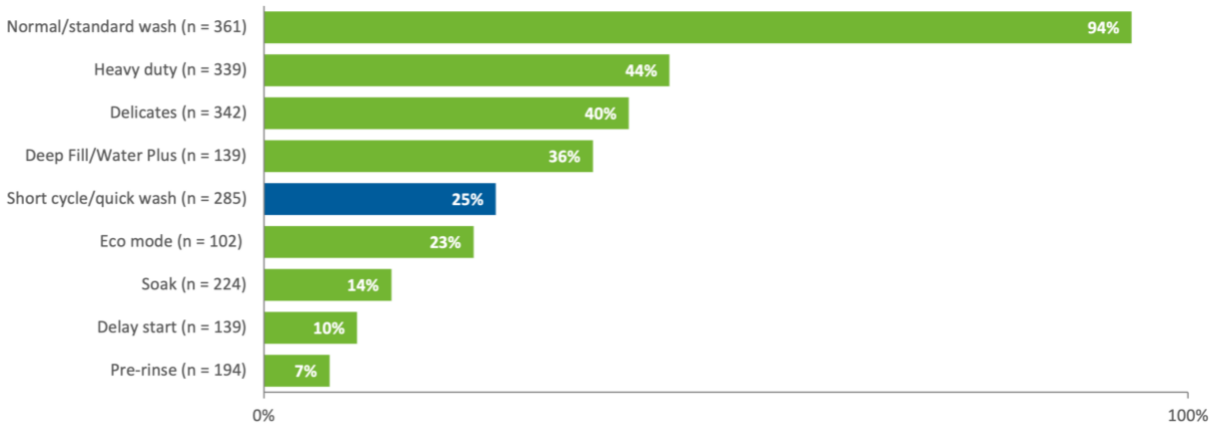


Figure 4. Washer settings used at least once per month (of respondents with a given feature)

We explored whether there were factors relating to the respondents' households, incomes, or other demographic information that influenced their usage of this setting. Among the three demographic characteristics (household size, income, and region), we found a statistically significant relationship between household income and respondents' usage of the short-cycle setting.[8] Respondents with household incomes below $30,000 a year reported more short-cycle usage (50% of households) compared to respondents with household incomes of $30K – $60K (17%), $60K - $100K (31%), and over $100K (21%).

Conjoint Analysis: Tradeoffs in Washer and Dryer Purchase Decisions

The study team conducted a conjoint analysis designed to understand consumer preferences for washer and dryer features, focusing on the tradeoffs consumers make between purchase price, operating cost, and cycle time. The binary logistic regression model estimated the impact of purchase price, operating cost, cycle time, and style on consumers' washer and dryer choices. The coefficients indicate the relative importance of each attribute, revealing the tradeoffs respondents are willing to make when selecting appliances.

For washers, purchase price, operating cost, cycle time, and style all have statistically significant effects, with negative coefficients indicating that higher costs or longer cycle times decrease the likelihood of selection. Washer style (top-load vs. front-load) has a significant positive effect, with consumers favoring top-load washers.

For dryers, the results were consistent; purchase price, operating cost, cycle time, and style all significantly influence preferences, with ventless dryers being significantly less favored compared to vented models. Table 3 summarizes the statistical results for both models.

Table 3. Binary logistic regression models output, washers and dryers

Attribute	Washer coefficient (std. error)	Dryer coefficient (std. error)	Significance
Intercept	1.94 (0.15)	2.93 (0.16)	***
Purchase price	-0.0019 (0.0001)	-0.0025 (0.0001)	***

[8] We performed a chi-squared test of independence with a significance level of .05 for short-cycle usage by the three demographic variables.

Attribute	Washer coefficient (std. error)	Dryer coefficient (std. error)	Significance
Operating cost	-0.0144 (0.0010)	-0.0176 (0.0015)	***
Cycle time	-0.0223 (0.0023)	-0.0222 (0.0023)	***
Style	Top Load: 0.19 (0.06)	Ventless: -0.63 (0.07)	***, ***

*** indicates that the corresponding coefficient is statistically significant at the 0.1% level, $p < 0.001$

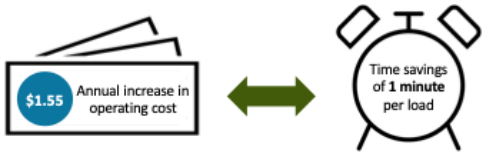
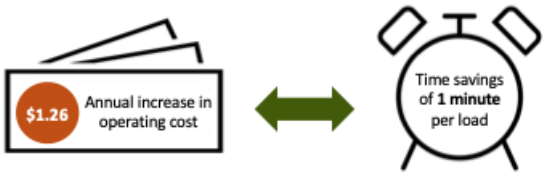
The coefficients on purchase price, operating cost, and cycle time are negative and statistically significant for both the washer and dryer model, indicating that increases in these attributes decrease the likelihood of a product being chosen. The estimated coefficients provide information about the direction of the effect (negative) and confirm the statistical significance of these attributes in influencing consumer decisions.

To estimate the practical impact that each attribute has on washer and dryer purchasing decisions, we estimated the rate at which consumers "trade off" levels of one attribute for levels of another attribute.[9] By analyzing the tradeoff between purchase price, operating cost, and cycle time, we were able to estimate the value consumers place on these attributes, thereby allowing us to determine whether these attributes hold practical importance in the real-world decision-making of consumers.

The relationships summarized in Table 4 quantify the value respondents place on the tradeoffs between purchase price, annual operating cost, and cycle time, highlighting consumer priorities in washer and dryer selection. This conjoint analysis highlights how consumers prioritize purchase price and annual operating cost over cycle time when selecting washers and dryers. While consumers demonstrate a willingness to trade higher purchase prices for lower operating costs, they place minimal value on reducing cycle time, as evidenced by the low tradeoff values associated with this attribute. The findings provide valuable insights into consumer preferences, emphasizing cost considerations as the dominant factor in decision-making for both washers and dryers.

[9] Trade-offs between purchase price, operating cost, and cycle time were estimated using the marginal rate of substitution (MRS) between each pair of attributes. The MRS measures how much of one attribute a consumer is willing to forego for another attribute, while maintaining the same level of satisfaction. The MRS is calculated using the formula: $MRS_{(X,Y)} = \frac{\beta_X}{\beta_Y}$

Table 4. Tradeoffs between purchase price, operating cost, and cycle time for washers and dryers

	Washer tradeoffs	Dryer tradeoffs
Operating cost and purchase price	 **Operating Cost $1 Saved ~ Purchase Price $7.58 Increase:** Respondents are willing to trade $7.58 in additional purchase price for a washing machine to save just $1 total per year in annual operating costs. This shows that consumers place a higher value on reducing long-term operating costs relative to initial price.	 **Operating Cost $1 Saved ~ Purchase Price $7.01 Increase:** Respondents are willing to pay $7.01 more in purchase price for a dryer to save just $1 total per year in annual operating costs. This demonstrates a preference for reducing ongoing operating costs over minimizing the initial purchase price.
Cycle time and purchase price	 **Cycle Time 1 Minute Saved ~ Purchase Price $11.78 Increase:** Consumers are willing to pay an additional $11.78 more in purchase price to reduce cycle time by one minute for each load over the washer's lifetime; according to the DOE, the estimated useful life [EUL] of a washer is 13.37 years (DOE 2024). The DOE also found that the typical American household does 210 loads of laundry each year. This translates to valuing one minute saved per load over the lifetime of a washing machine at just $0.004 per load.[10] This suggests that consumers place very little value on reducing cycle time.	 **Cycle Time 1 Minute Saved ~ Purchase Price $8.83 Increase:** Consumers are willing to pay an additional $8.83 more in purchase price to reduce drying cycle time by one minute for each load over the dryer's lifetime, which according to the DOE is 14.4 years (DOE 2024). This translates to valuing one minute saved per load over the lifetime of a dryer at just $0.003 per load,[11] underscoring the very low importance placed on cycle time reduction. This mirrors our finding for washing machines.
Cycle time and operating cost	 **Cycle Time 1 Minute Saved ~ Operating Cost $1.55 Increase:** To save one minute of cycle time per load over the washer's lifetime, respondents are willing to accept an increase of $1.55 in annual operating costs. This translates to valuing one minute saved per load over one year at just $0.007 per load.[12] This reinforces the low importance consumers assign to cycle time relative to financial costs.	 **Cycle Time 1 Minute Saved ~ Operating Cost $1.26 Increase:** To save one minute of drying time per load over the dryer's lifetime, respondents are willing to accept an increase of $1.26 in annual operating costs. This translates to valuing one minute saved per load over the course of one year at just $0.006 per load.[13] This further highlights the minimal value consumers associate with shorter cycle times.

[10] Calculated using the formula: $11.78 / (210 loads per year x 13.37-year life of washer) = $0.004
[11] Calculated using the formula: $8.83 / (213 loads per year x 14.4-year life of dryer) = $0.003
[12] Calculated using the formula: $1.55 / 210 loads per year = $0.007
[13] Calculated using the formula: $1.26 / 213 loads per year = $0.006

Conclusions

This study provides nationally representative insights into consumer laundry behaviors, technology adoption, and short-cycle use, offering valuable evidence for refining DOE efficiency standards. While the vast majority of households have access to short-cycle settings, usage remains low – only one in four consumers with this feature reported using it at least monthly. Moreover, conjoint analysis revealed that when forced to make tradeoffs, consumers place far greater weight on purchase price and operating cost than on cycle time. While shorter cycles may still be valued, these findings suggest that other factors take priority, especially in the absence of consumer education about the benefits of shorter cycles, and there may be limited consumer benefit from policies that isolate the short-cycle functionality as a product class.

The data also highlight that household demographics influence behavior: lower-income households are more likely to use short-cycle washer settings, suggesting that time savings may hold different value for different groups. However, across the broader sample, cycle time consistently ranked as the relatively least influential factor in purchasing decisions for both washers and dryers.

The results further underscore emerging distinctions in consumer satisfaction with new laundry technologies. Heat pump dryers, though representing only 5 percent of the sample, were associated with significantly higher satisfaction levels than both traditional dryers and combination units – pointing to the potential to increase market acceptance of higher-efficiency laundry appliances.[14] In contrast, combination units showed relatively low satisfaction across several dimensions, especially drying time, indicating possible barriers to broader adoption.

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[14] The more recently popular combination units contain heat pump dryers, but respondents with combination units were not directly asked if they had heat pump drying technology in this study.

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