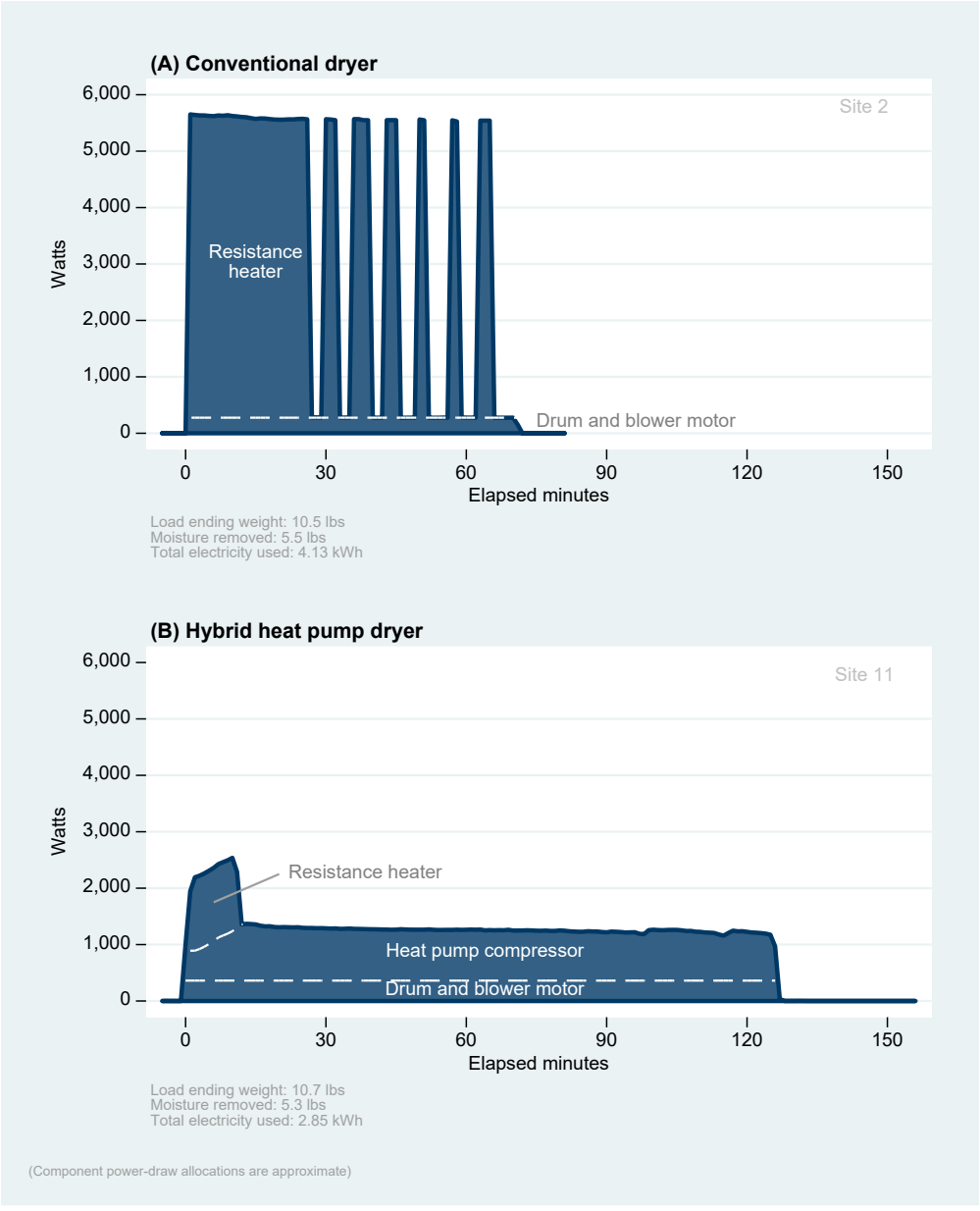
Webinar Q&A – May 6, 2021 with Slipstream
Heat Pump Clothes Dryers – MN Field and Consumer Research Findings

Questions

Question 1: Is the electrical use fairly constant over the 1 or 2 hour cycle? Just wondering how the peak load compares between conventional and HP clothes dryers.

Conventional dryers have much higher peak power draw than heat pump dryers due to the presence of 5kW worth of electric resistance elements. The figure below (from the forthcoming technical report shows the typical power-draw pattern of the hybrid dryer compared to a conventional dryer. The compact heat pump dryers that we bench tested showed a very uniform power draw of 500 to 800 watts when operating.

Figure 1. Typical power-draw and drying-time profiles for a conventional dryer (A) and full-size hybrid heat pump dyer (B). The loads dried in these two examples were nearly identical in weight and moisture content.



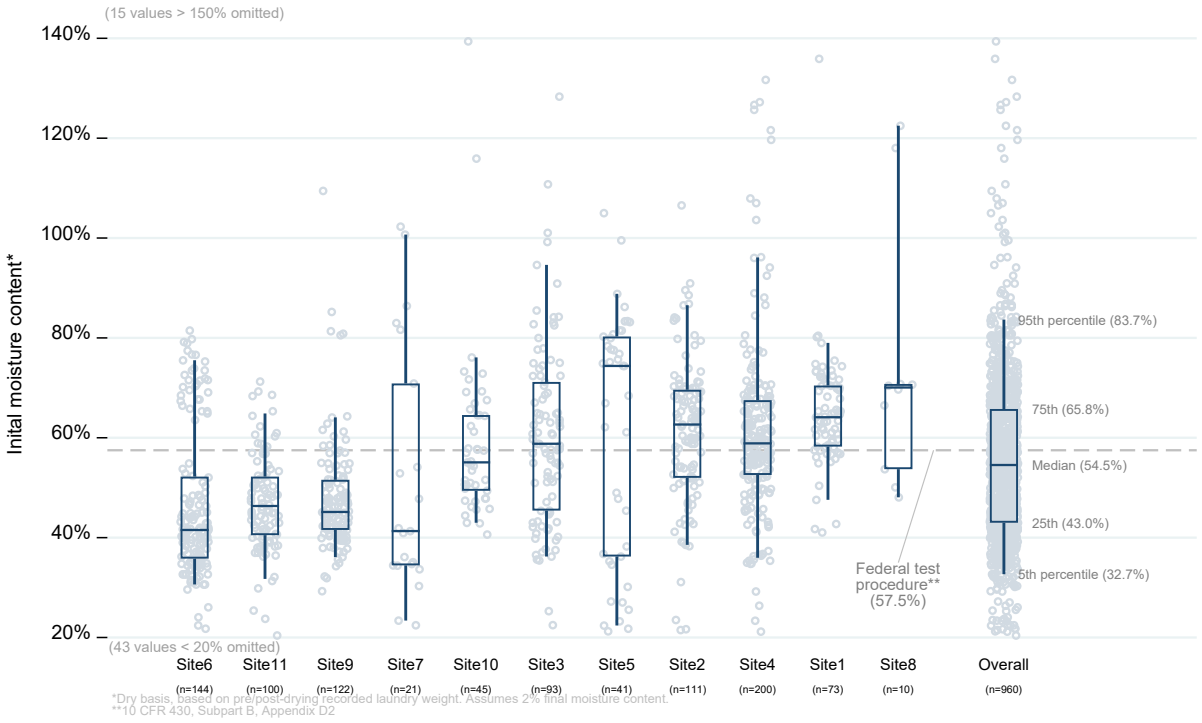
Question 2: Did any of the clothes dryers have "smart" or connected capability?

The Miele compact dryer has “smart” features as part of Miele’s WiFiConn@ct. These features were not tested as part of the bench testing process, but include remote control and monitoring, voice activation, and other networked appliance features. None of the other dryers had these features.

Question 3: Did the type of clothes washer affect the energy savings? For example, some clothes washers remove more moisture from clothes.

Probably, but it is hard to know for sure, because washer settings and load composition also affect the initial moisture content of the load when it goes into the dryer. As the figure below from the forthcoming technical report shows, there were differences across the participants in typical initial moisture content, though the average across all loads and sites is close to the moisture content specified in the federal test procedure for clothes dryers.

Figure 2. Initial moisture content for loads with pre/post-drying weights, by site and overall.



Question 4: Do you have plans to share the kw differences with each family?

Yes, we will provide a link to the webinar and a copy of the final technical report to each household, and de-anonymize their site ID.

Question 5: For the hybrid dryers, is there an automatic trigger that switches from heat pump to electric mode (not cleaning the filter)?

The hybrid dryer does have control logic to engage the resistance heat in addition to the heat pump (which runs continuously). We are not privy to exactly how that logic is designed, but it seems to be driven by the Eco/Speed setting selection and the interior drum temperature.

Question 6: In your participant recruitment, were the existing dyers of different ages and efficiencies? In other words, not all old dryers. So, they didn't just keep the HP dryer because it was new.

We tried to mainly recruit households with newer dryers but ended up with three older ones. As the table below shows, two of those households kept the heat pump dryer and one kept their existing dryer.

Table 1. Pre-existing dryers for field-study participants

Site #	Existing Dryer	Dryer age (at start of study)	Decision about which dryer to keep
1	Inglis IED4300SQ0	3-4 years	Kept pre-existing (HP dryer malfunctioned)
2	Amana NED4655EW1	1-2 years	Kept HP dryer
3	Whirlpool WED7000DW2	<1 year	Kept HP dryer
4	Kenmore DVMX-ELE-2406026-ELDU	1-2 years	Kept pre-existing
5	GE GTD65EBPL0DG	<1 year	Kept HP dryer
6	GE GTD65EBSJ0WS	1-2 years	Kept pre-existing
7	Samsung DV40J3000EW/A2	< 1year	Kept HP dryer
8	Kenmore DWJR-ELE-2406026-FM54	5 years	Kept HP dryer
9	LG DLE2514W	15-20 years	Kept pre-existing
10	GE DDE7110VMLWH	>10 years	Kept HP dryer
11	Kenmore 86870100	>20 years	Kept HP dryer

Question 7: Did all participants in the study use washers or wash settings with similar spin speeds?

Probably not, but we had very limited information about this. See response to Question 3.

Question 8: I currently have a 5-yr old gas clothes dryer that just plugs into a standard electric receptacle. Would a heat pump dryer require any electrical changes for that circuit?

In most cases yes, you would need to install a 240-volt electrical outlet to operate a heat pump dryer. There are some compact heat pump dryers that can simply be plugged into a standard electric receptacle, however.

Question 9: So, there was no comparison between gas and heat pump electric dryers if I read this correctly.

That is correct, our study only compared heat pump and conventional electric dryers.

Question 10: Do you have a similar study on Cold Climate Air Source Heat Pumps?

The Center for Energy and Environment (CEE) has on-going research related to cold-climate air-source heat pumps in Minnesota, including a prior CARD-funded effort. See the Air Source Heat Pump research page on CEE's webpage.

Question 11: What are typical amperage/wattage ranges for compact heat pump dryers?

Operating wattage for the four compact heat pump dryers that we tested were in the range of 500 to 800 watts.

Question 12: Do you need to have a certain size space for a heat pump dryer?

The full-size hybrid dryer that we tested is the same size as a conventional dryer. Compact heat pump dryers are several inches narrow and not as tall as a conventional dryer, and so take up *less* space.

Question 13: How much does it save to avoid installing the dryer venting?

That is a very good question, especially for multifamily new construction—but we don't have a good answer to it at this time.

Question 14: Do you need to run a drain line for condensate? On avg how much additional cost to homeowner does this represent? Would that be gravity drain, or is there a pump inside dryer to tie in with washer drain?

Compact heat pump dryers generally offer a choice of how to deal with the condensate that the dryer produces. If a nearby drain is available, the dryer will use a built-in pump to send the condensate down the drain (subject to some height and distance restrictions). If there is no nearby drain, the dryer can be configured to store condensate in a built-in receptacle that must be emptied manually after each load. The full-size Whirlpool dryer that we tested does not have a built-in receptacle and must either be located near a drain or the user must provide their own receptacle for temporarily storing condensate.

The only time a homeowner would incur an additional cost would be if they do not wish to manually dispose of condensate and the dryer is located too far from a drain for the unit's built-in pump to work. In that case, a third-party condensate pump could potentially be purchased for $40 to $50 to collect condensate from the dryer and pump it to a drain line that is at a distance.

Question 15: How does [the] noise of [a heat pump dryer] compare to [a] conventional [dryer]?

In our experience heat pump dryers are somewhat noisier than a conventional dryer but not disturbingly so. The noise from a conventional dryer mainly results from a combination of the internal blower and the sound of the drum rotating with laundry in it. A heat pump dryer shares these noise sources, but adds the sound of the heat pump compressor, which is somewhat louder than the sound of an operating refrigerator in our experience. We did not conduct noise-level testing, but the published specifications for many dryers, including heat pump dryers, provide decibel ratings.

Question 16: What was the average age of the existing dryers?

See Question 6.

Question 17: With regards to load size, did you check if the washer load was comparable to the dryer load? That is, can the washer hold more laundry than the dryer or vice-versa?

We did not track this, but the full-size dryers that we tested in the field study have a capacity of 7.4 cubic feet and can generally handle a full load of laundry from a residential clothes washer. It is certainly possible to wash more laundry in a standard washer than can be handled by the compact heat pump dryers that we tested, but, as we noted in the webinar, 95 percent of the loads dried by our field-study participants would readily fit in a compact dryer as well.

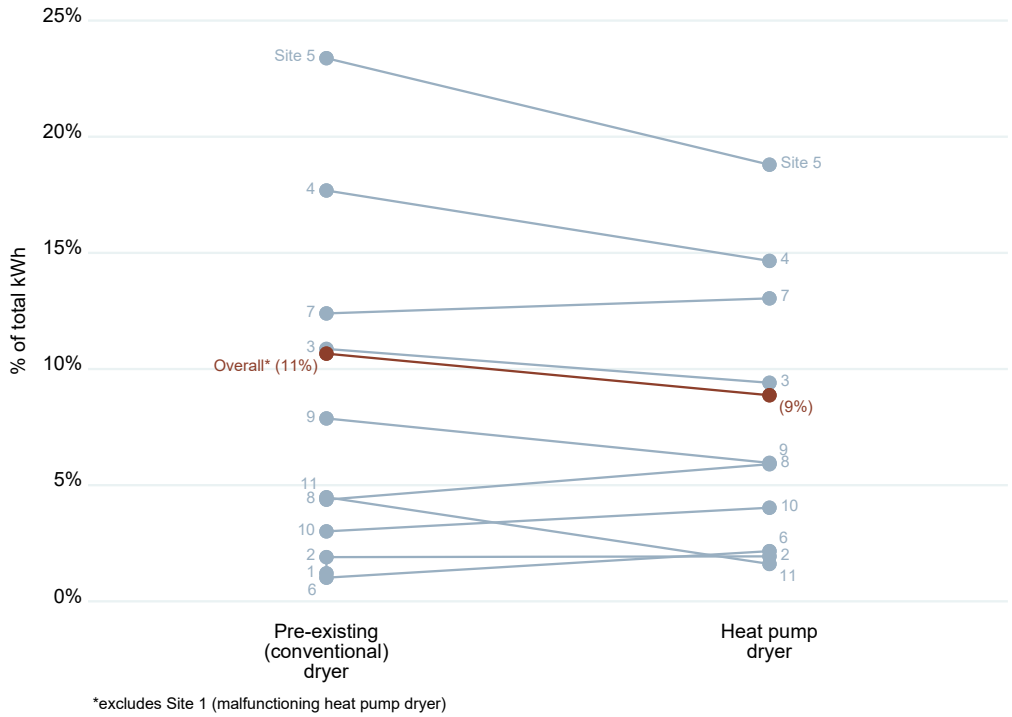
Question 18: Has Whirlpool addressed lint bypass? My 2018 hp dryer needs to be "cleaned & tuned" about every 6 months to de-lint the cold coil.

We can't speak for Whirlpool but can say that the current version of the full-size hybrid dryer that we purchased for our field-study participants appears to have the same primary and secondary lint-trap design as the original model that we purchased for our first participant in 2018.

Question 19: Did the heat pump dryers experience more [or] less touch-up drying than pre-existing dryers?

On average, the percent of dryer electricity that went into touch-up cycles decreased slightly with the heat pump dryers compared to the conventional dryers (9% for the heat pump dryers vs. 11% for the conventional dryers). Touch-up cycle use increased slightly for four participants and decreased for six:

Figure 3. Aggregate percent of dryer electricity devoted to subsequent cycles beyond the first for a given load.



Question 20: What does "ease of use" mean? how can a dryer be more/less easier to use?

Ultimately, ease of use is interpreted by the participant. We intended the question to provide indications of whether the user interface, controls, instructions, and processes involved in drying clothes were easy to navigate. This could also include such factors as feedback to the user on how long a load will take, the audible signal that a load is done, and cleaning lint filters or exhaust vents.

Question 21: Because the heat from the dryer stays in the house, might it make sense to pair the dryer with a heat pump water heater that could use the added heat in the space?

That is an interesting idea.

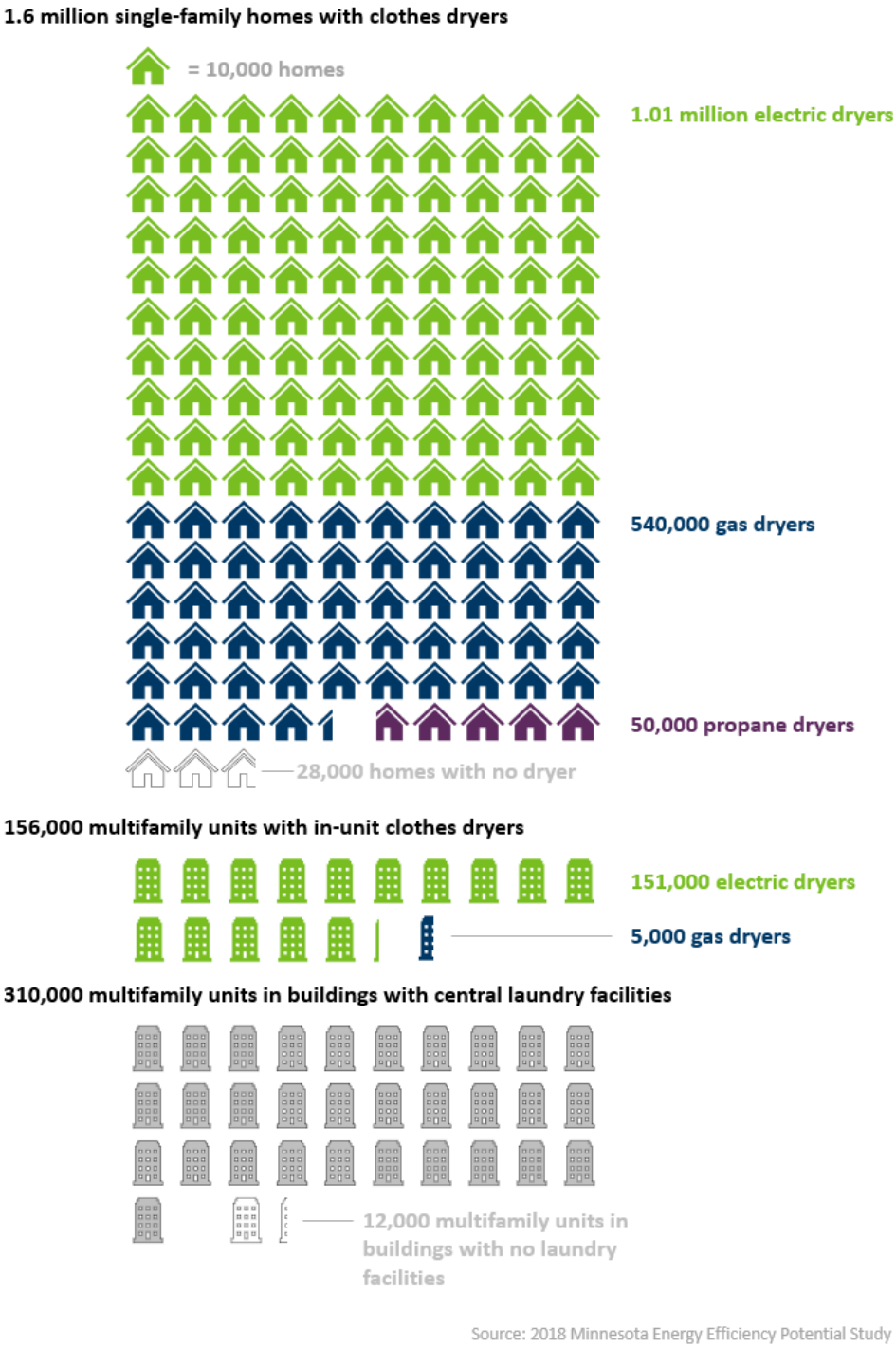
Question 22: Can you compare condensing dryers to HP dryers in terms of performance, efficiency, and reliability?

We bench-tested one compact condensing dryer in our study (a Bosch unit). Per pound of removed moisture, the condensing dryer required about the same amount of drying time as the compact heat pump dryers that we bench tested and used about three times as much electricity (on par with the conventional dryers in the field study). We did conduct any formal reliability assessments, but a heat pump dryer does have a refrigeration system and is thus a more complex device than a conventional condensing dryer.

Question 23: [I'm] really surprised by graphic that shows 63% of MN SF dryers are electric (by my math, 34% gas). And certainly, this isn't a MN population figure (too few). What are the trends … toward electric or gas now?

The figure from the webinar (reproduced below) is meant to depict the Minnesota population of housing units. We did not assess recent trends in dryer fuel as part of this study, but we can say that in a sample of 87 new single-family homes for a recent CARD-funded study of Minnesota new construction practices, 81±6 percent of homes had an electric dryer.

Figure 4. Residential clothes dryers in Minnesota.



Question 24: [Were these] all electric to electric replacements or some gas to electric? if both, any differences in those who went gas to electric and electric to electric in terms of customer satisfaction?

All of the field-study participants had existing electric dryers.

Question 25: Were all of the dryers in the study Whirlpool, full-sized dryers, or were some of them compact dryers?

There were two distinct parts of the project: (a) a field study in which we supplied 11 households with a full-size Whirlpool hybrid dryer for monitoring and consumer research; and (b) bench-testing for which we purchased some compact heat pump dryers for testing, in addition to doing bench-testing of several of the full-size Whirlpools from the field study that were returned by participants.

Question 26: Was there any research done on switch gas to electric in terms of additional required investments - I considered an electric dryer recently but needed to upgrade my panel (cost of ~$3,000), which made it cost prohibitive. Guessing this is a common issue.

We did not investigate switching from gas to electric clothes dryers.

Question 27: Interesting observation about length of time to dry the clothes. Definition of "energy efficiency" is essentially getting the same "work"(utils) from the technology for lower energy use. But, in this case, seems like the "work" is not equivalent between the default electric dryers and the heat pump dryers. How would this be reconciled in terms calculating heat pump dryer savings?

We did try to put the two dryer technologies on the same footing for each field site by calculating average electricity use per laundry load as well as per pound of removed moisture. Both of these measures take time out of the equation by focusing on the total amount of electricity required to dry a normalized load of laundry.

Question 28: Are HP dryers quieter or same sound as electric dryers?

See Question 15.

Question 29: What were the washing machines used? What was the starting moisture content before clothing went into dryer?

See the table below for field-study participant washers. See Question 3 regarding initial moisture content.

Table 2. Clothes washers for field-study participants.

Site #	Washer Model	Washer age (at start of study)
1	Inglis ITW4300SQ	
2	Amana NTW4516FW0	2 years
3	Whirlpool WTW7000DW3	
4	Kenmore 110.28132411	1-2 years
5	GE GTW685BPL0DG	
6	GE GTW680BSJ1WS	5 years
7	LG WT7200CW	<1 year
8	Kenmore 110.20022014	5 years
9	LG WM1814LW	15-20 years
10	Whirlpool LSB6200KQ0	10-15 years
11	Whirlpool WTW8000NW0	7 years

Question 30: Apologies if you already said this, [but] why did you not field test the compact dryers?

We were unsuccessful in our attempts to recruit households in multifamily buildings where compact dryers are typically deployed.

Question 31: Why to HP dryers have a 2nd lint filter?

They main reason is that the air used to dry the clothes must pass over two sets of heat pump coils with closely spaced heat-exchanger coils. This makes it important to remove as much lint as possible to avoid fouling those coils over time. In addition, heat pump dryers recirculate the air used for drying, so filtering is the only mechanism for removing lint.

Question 32/33: Other than features, are any of these differences actually statistically significant? Sorry that question was with regards to what participants say about dryer characteristics.

No, the number of households in the study was too low to expect any statistical significance, so consumer response information should be taken as qualitative indicators. With 11 sample points, margins of error are as high as 25 percentage points (for proportional metrics) at 90 percent confidence levels. That is a high bar for any statistical tests.

Participant Comments

Comment 1

There are maintenance costs for conventional clothes dryers as well. Some condo HOAs require annual dryer vent cleaning that can cost app. $150 annually.