COMMERCE DEPARTMENT

Welcome

Conservation Applied Research & Development (CARD) Webinar

May 6, 2021

Heat Pump Clothes Dryer – Minnesota Field and Consumer Research Findings

Heat Pump Clothes Dryer Minnesota Field and Consumer Research Findings



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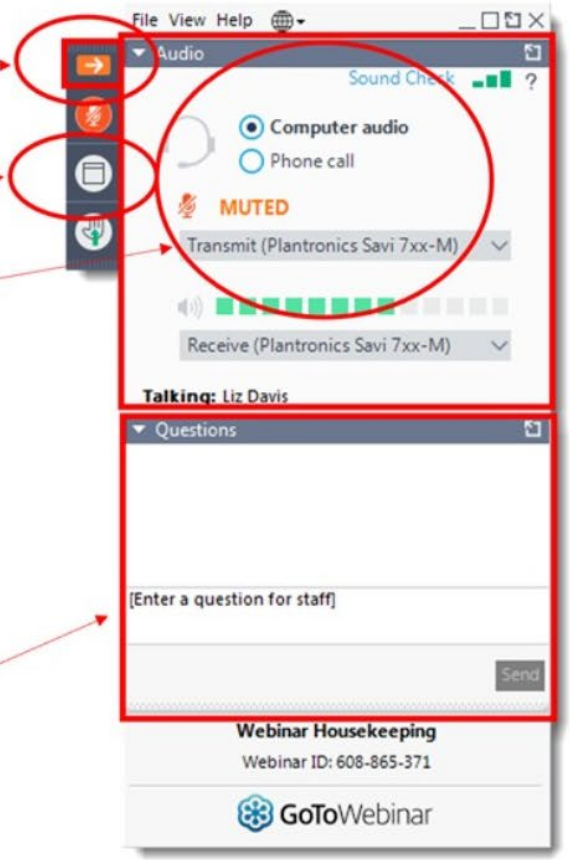
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Type in a question and hit “send” to ask a question.



Minnesota Applied Research & Development Fund

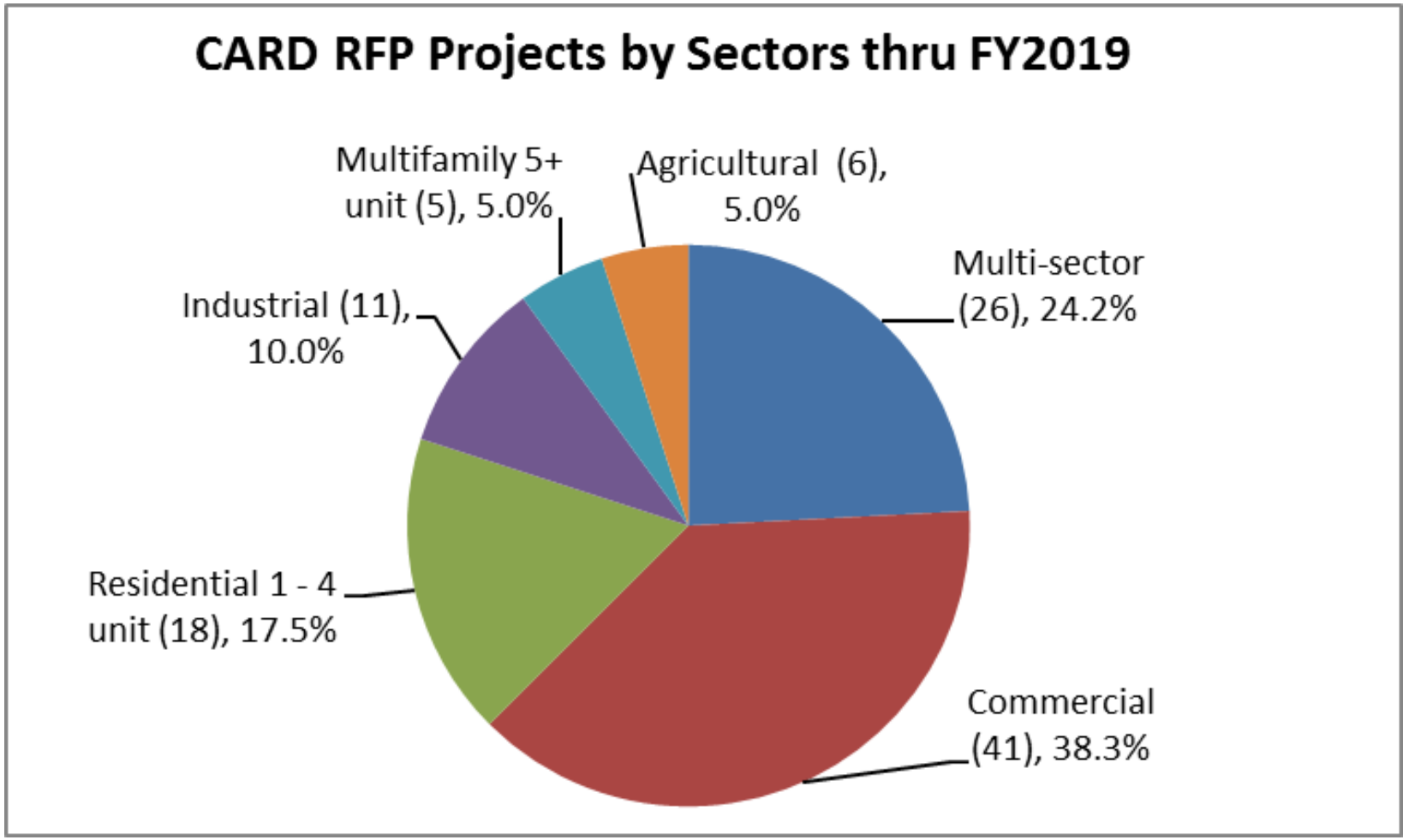
- **Purpose to help Minnesota utilities achieve 1.5% energy savings goal by:**
  - ***Identifying new technologies or strategies to maximize energy savings;***
  - ***Improving effectiveness of energy conservation programs;***
  - ***Documenting CO_2 reductions from energy conservation programs.***

Minnesota Statutes §216B.241, Subd. 1e

- **Utility may reach its energy savings goal**
  - **Directly through its Conservation Improvement Program (CIP)**
  - **Indirectly through energy codes, appliance standards, behavior, and other market transformation programs**

State Capitol Image: Courtesy Minnesota Department of Administration

CARD RFP Spending by Sector thru FY2019



RFP Summary

- 10 Funding Cycles
- 472 proposals
- 121 projects funded
- $27.4 million in research

Clothes Dryers Through the Decades



Clothes Dryers in Minnesota

1.6 million single-family homes with clothes dryers



1.01 million electric dryers

540,000 gas dryers

50,000 propane dryers

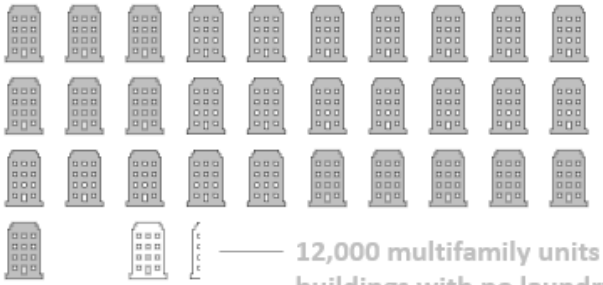
156,000 multifamily units with in-unit clothes dryers



151,000 electric dryers

5,000 gas dryers

310,000 multifamily units in buildings with central laundry facilities



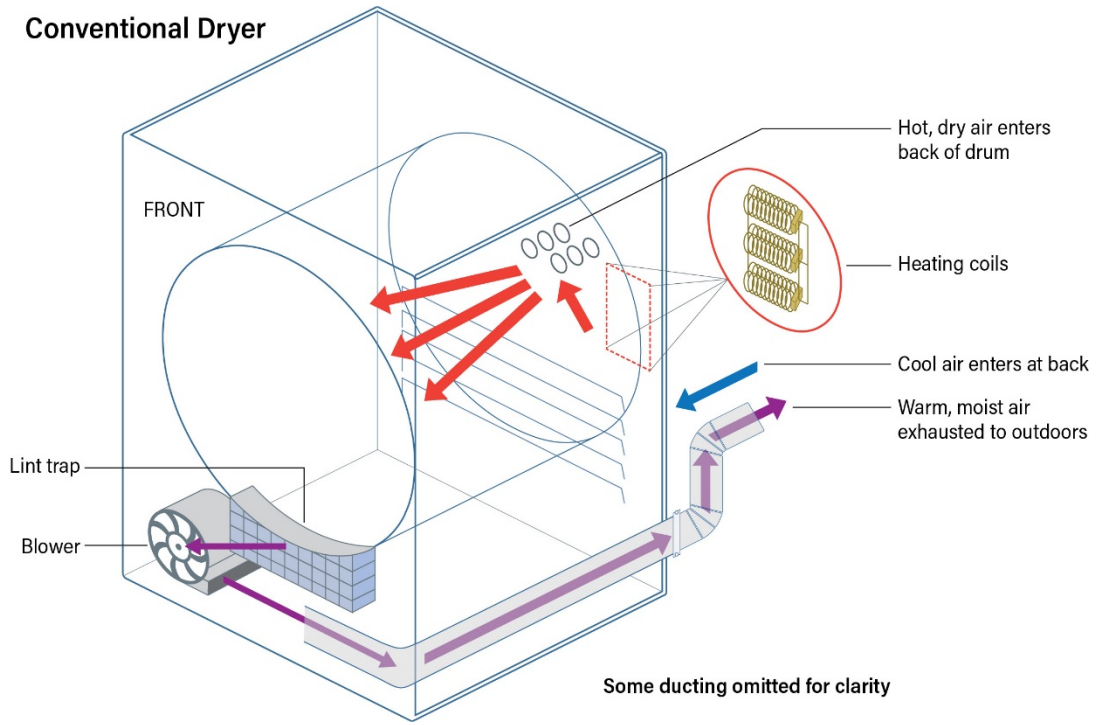
12,000 multifamily units in buildings with no laundry facilities

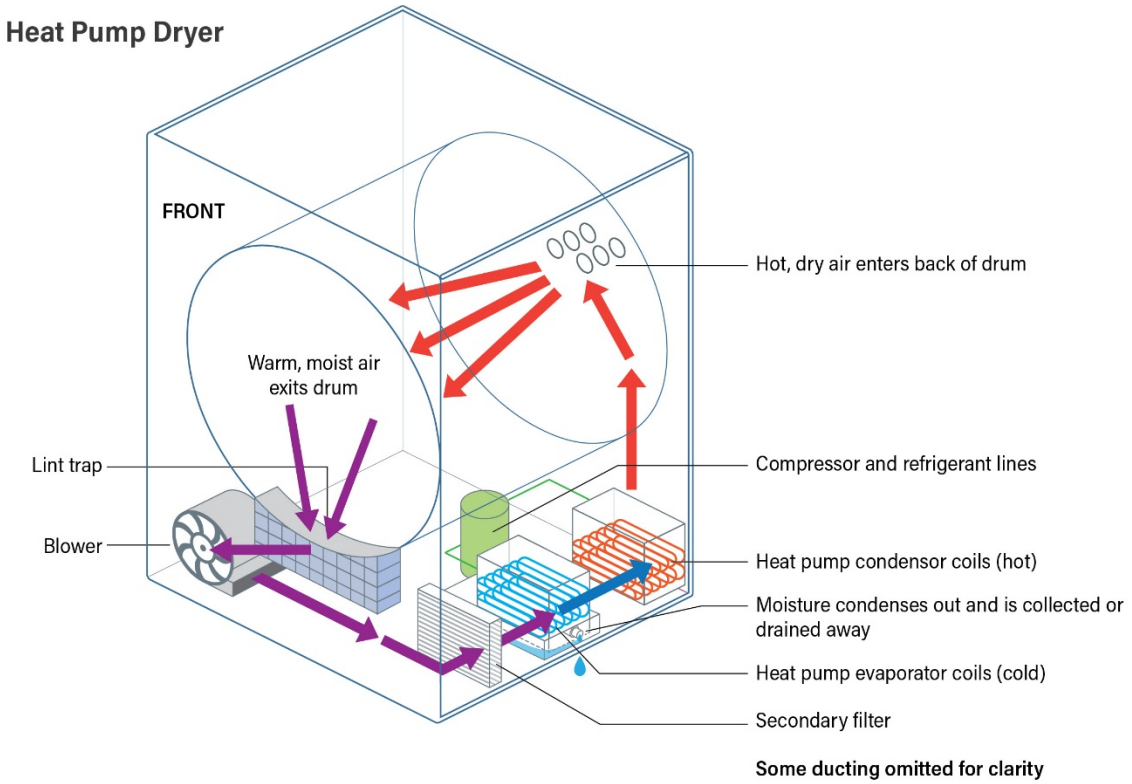
Source: 2018 Minnesota Energy Efficiency Potential Study

Dryer Types

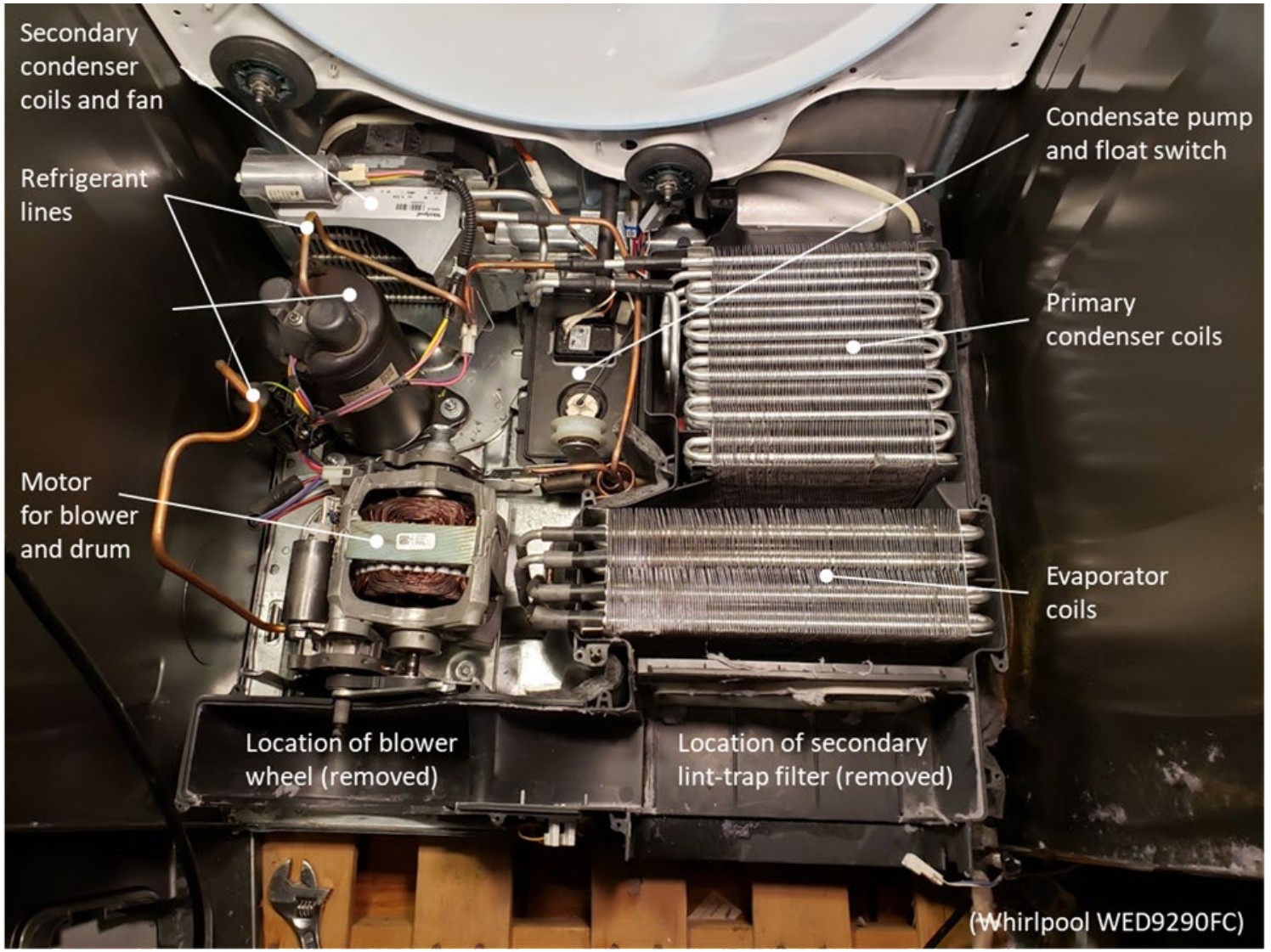


Conventional vs Heat Pump Dryer





The Guts of a Heat Pump Dryer



Heat Pump Dryers in North America

Compact

Miele
Bosch
Blomberg
LG
Samsung
Whirlpool
Beko
Asko



Full-Size

Whirlpool (hybrid)

All are Ventless

Study Overview – What We Did

- Gave full-size Whirlpool hybrid heat pump clothes dryers to 11 households
  - Collected dryer journals and interviewed participants
  - Monitored before/after dryer energy and laundry weights for a year, split between:
    - Pre-existing dryer
    - Heat pump dryer
- Bench-tested 5 different make/model heat pump dryers
- Modeled indirect effects of dryers on space heating and cooling
  - Single-family homes
  - Multifamily new construction





What did participants know about the dryers?

- What is a heat pump dryer, anyway?
  - Only one participant recruited via social media advertisements had heard of heat pump technology
  - Most would not have considered a heat pump dryer without more information (and expected a price premium of $100 to $200)
  - They would be unlikely to run into one during the shopping process

What did participants say about dryer characteristics?

Metric	Conventional dryer average score	Heat pump dryer average score	Difference
Ease of use	3.83	4.33	+0.50
Effectiveness	2.67	3.00	+0.33
Features	2.83	4.50	+1.67
Feel of clothes	3.33	3.50	+0.17
Gentleness on clothes	3.33	3.67	+0.34
Time to dry	3.00	2.67	-0.33



What did participants say about the drying times?

- Half of participants did not care about drying time at all
  - Zero loads over 8-week span
- Half cared ... some of the time
  - Range: 14 to 44 percent of loads dried
  - Either needed the items or the dryer

What did participants reveal about their preferences?

7 of 10* kept the heat pump dryer

- Higher end appliance (3)
- Energy savings / reduced costs (3)
- Ventless provides more options (2)
- Better performance (than their pre-existing dryer)

3 kept their pre-existing dryer

- Matched the washer (2)
- Shorter drying times (2)
- Disliked the second lint filter (1)

**excludes the dryer that malfunctioned, which was also returned*

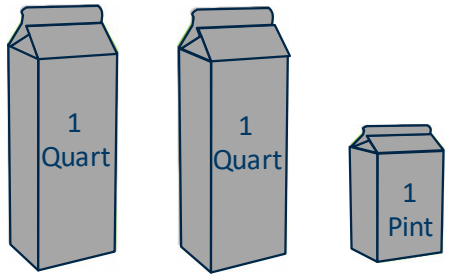
Real-World Laundry Habits

- Complicated!
  - Some people did lots of separating and touch-up cycles
  - up to 770 **dryer cycles** per year
  - up to 430 **laundry loads** per year
- 2 ways of assessing savings
  - kWh per load
  - kWh per pound removed moisture

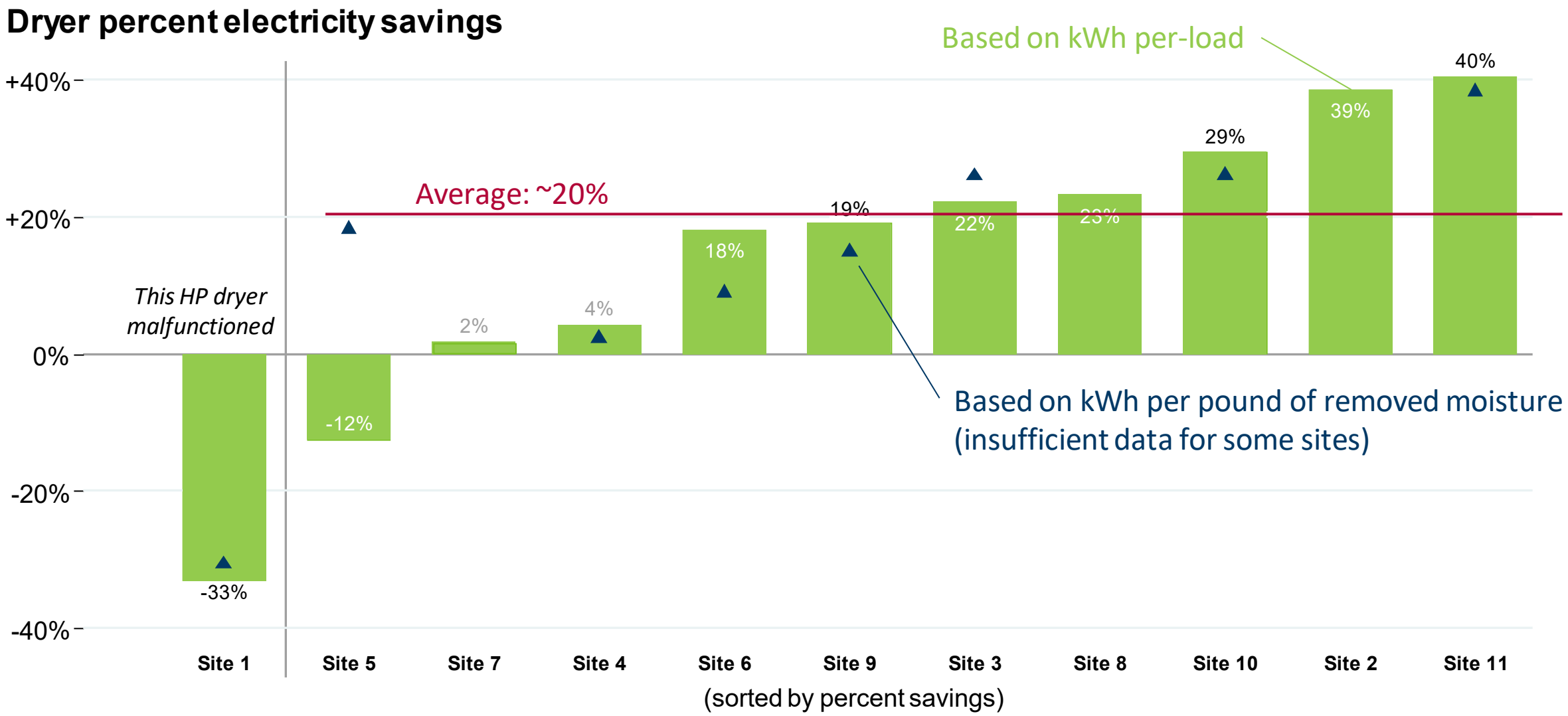
Average dryer load



8-10 lbs laundry
+
2.5 quarts of water



Electricity Savings for Full-Size Hybrid (Whirlpool)

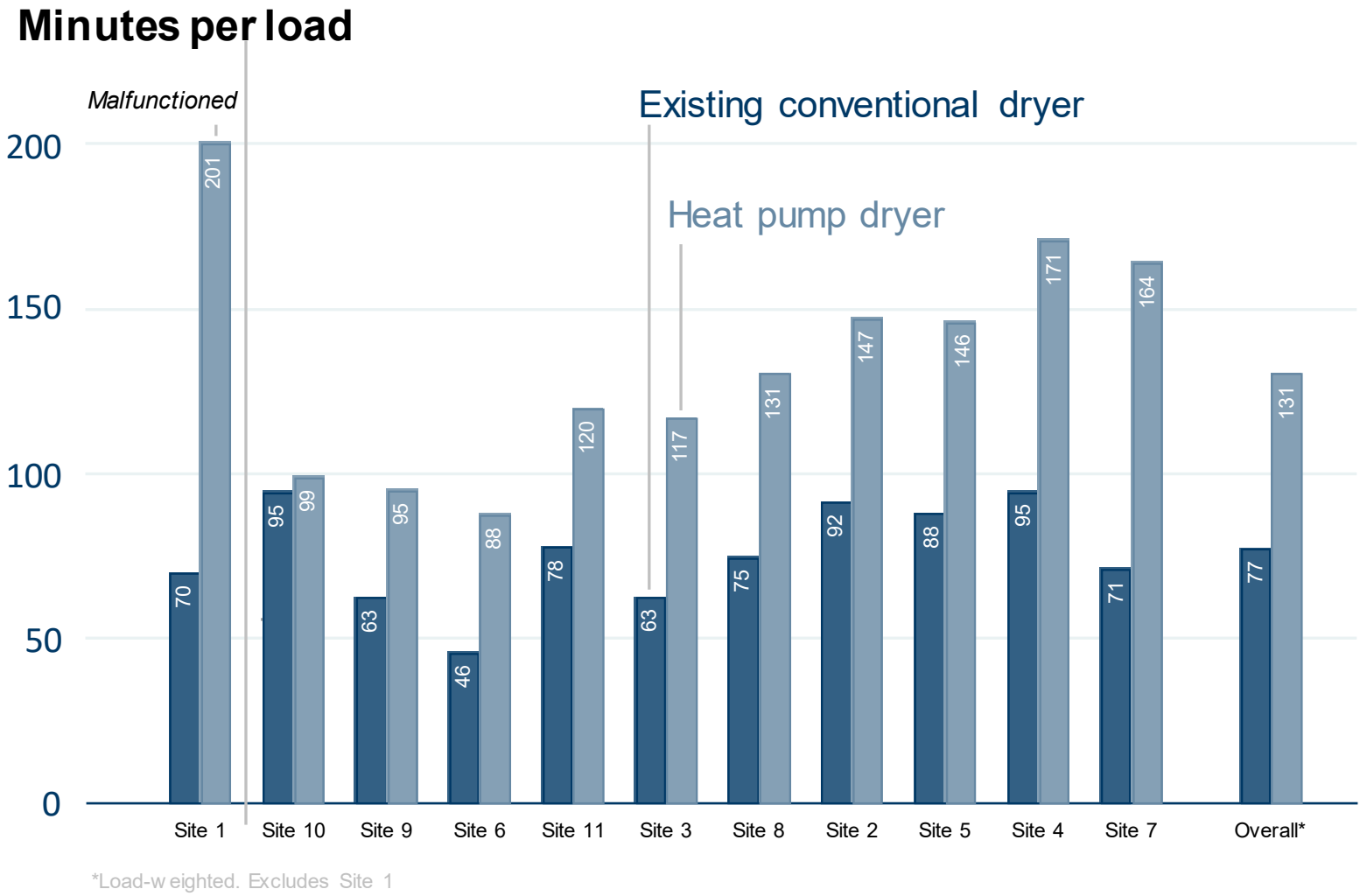


For Typical Hybrid Dryer Electricity Savings of 20%

Number of people in household	Annual dryer loads*	Annual dryer kWh savings	Annual $ savings**
1	110	75	$8
2	220	150	$17
Average household* (2.6)**	**285**	**195**	**$22**
3	330	225	$25
4	440	300	$33
5	550	375	$41
6	655	450	$50

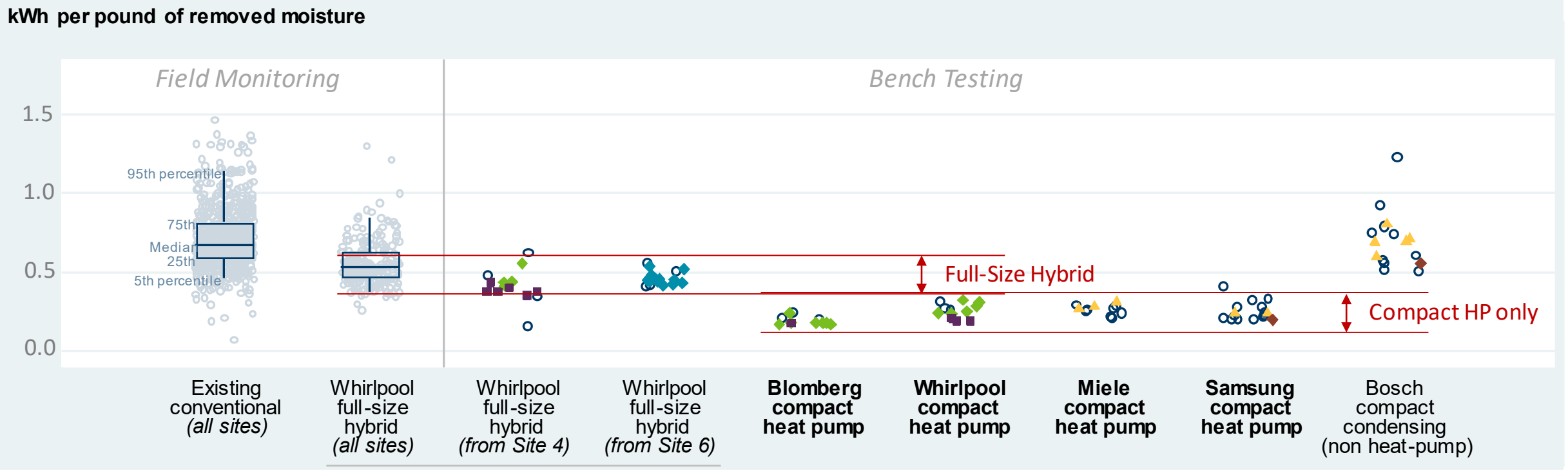
*2.1 loads per person per week
**11 cents per kWh
***for Minnesota single-family and small multifamily

Drying Time Almost Doubled



*Load-weighted. Excludes Site 1

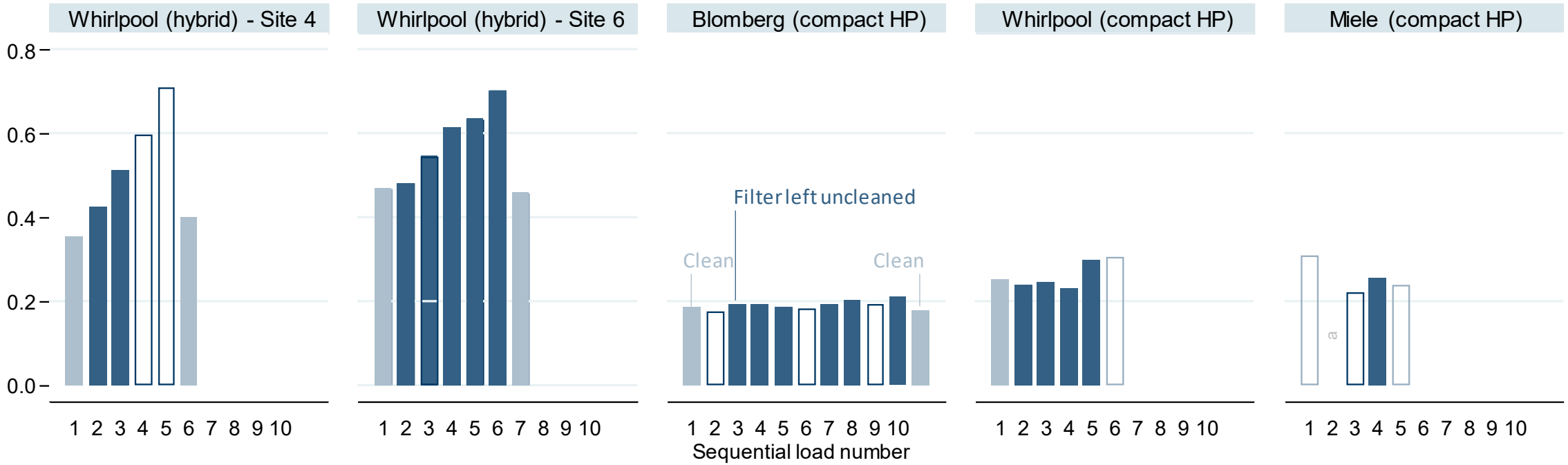
Bench Testing – Compact HP dryers about 2X more efficient



Settings and load composition didn't seem to matter much…

Whirlpool hybrid affected by filter maintenance

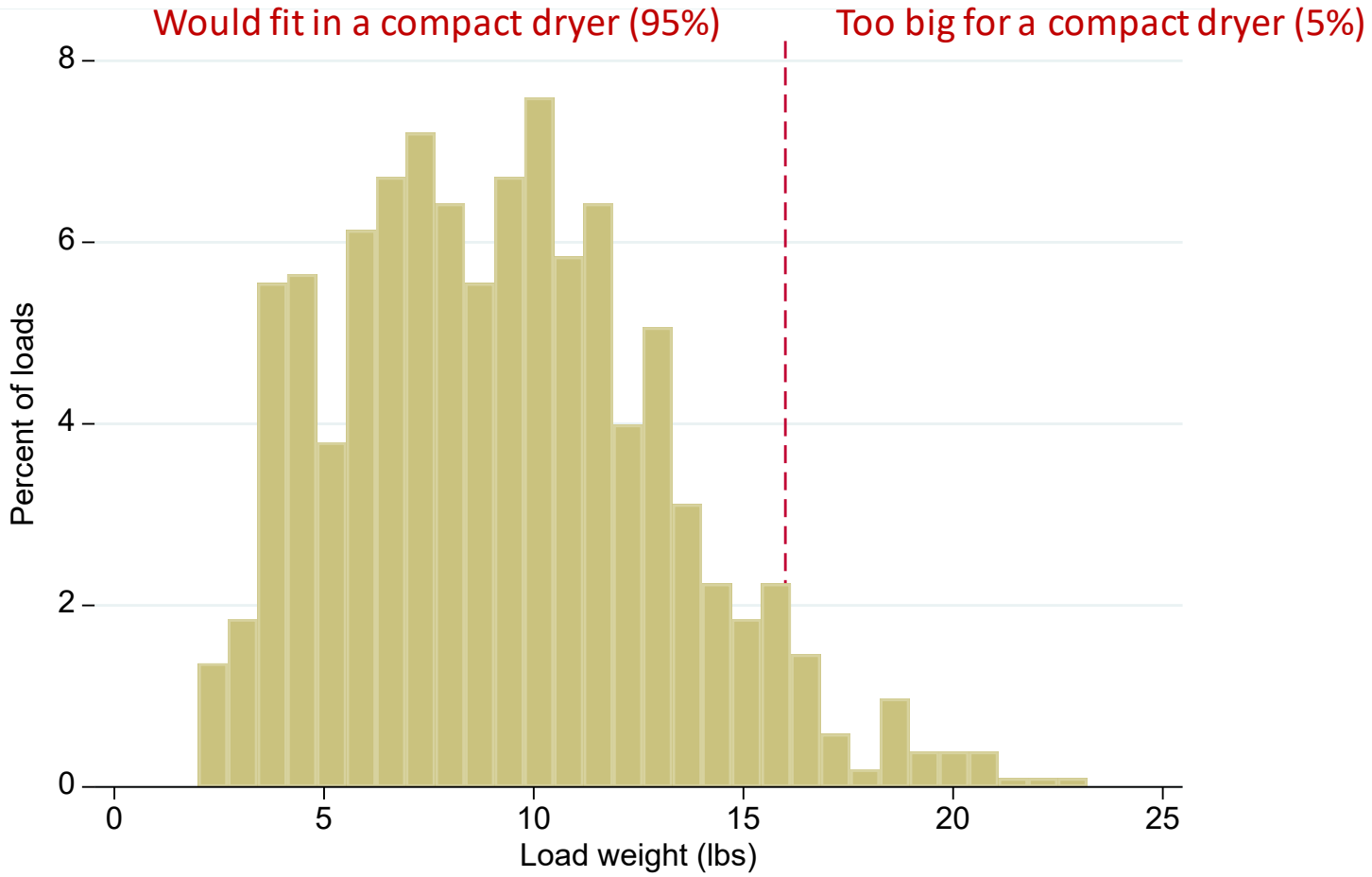
kWh per pound of removed moisture







95% of loads dried in a full-size dryer would fit in a compact dryer



(n=1,027 loads dried in pre-existing or full-size HP dryer by field-study participants)







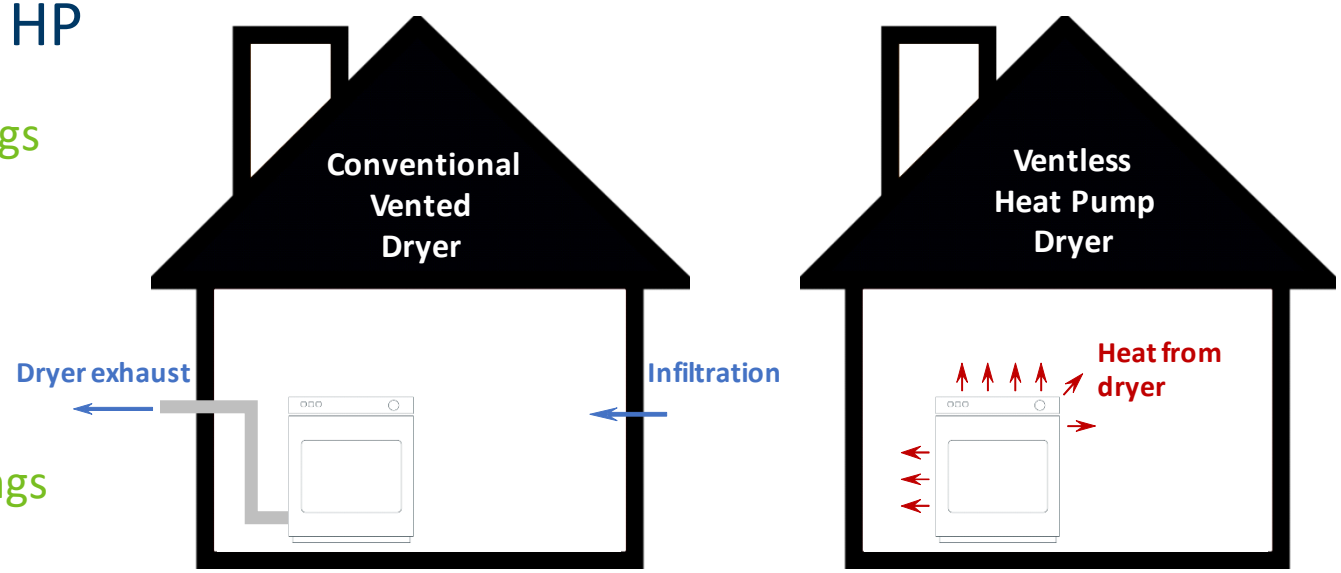
Indirect Space-Conditioning Effects

- MN Single-family home w/ full-size hybrid HP
  - -13 therms/yr
  - +26 kWh/yr

  $22/yr dryer electricity savings
  $6/yr HVAC savings
  $28/yr total savings

- MN Multifamily unit w/ compact HP-only
  - -15 therms/yr
  - +28 kWh/yr

  $45/yr dryer electricity savings
  $7/yr HVAC savings
  $52/yr total savings



Heat Pump Clothes Dryers for Multifamily New Construction

- Most MF new construction has in-unit laundry
  - 16 of 19 mid-rise projects reviewed for a recent code-related study
- Ventless dryers avoid the cost of installing dryer venting
  - …but a "listed and labeled" condensing dryer must then be installed per code
  - Currently rare in MN (1 of 16 reviewed projects)
- Conventional condensing ventless is an option, but will have long dry times and no electricity savings
- Incentivizing ventless heat pump dryers could yield significant electricity (and some gas) savings
  - **375 kWh/unit per year (**400 kWh dryer savings, less 25 kWh space-cooling penalty)
  - **15 therms/unit per year** space-heating savings

Minnesota Technical Reference Manual (TRM) Implications

- MN TRM relies of federal energy rating – Combined Energy Factor (CEF)
- Full-size dryers
  - CEF underestimates actual dryer energy use per lb of moisture by about 30%
  - Also recommend adjusting estimated loads per year to reflect MN households
  - Overall impact on savings would be to increase savings by 60 to 100%
- Compact dryers
  - CEF overestimates performance per lb removed moisture…
  - …but also relies on an unrealistically small load size (3 lbs)
  - Overall impact of recommended adjustments would be to increase savings by 75-80%

Key take-aways

- HP Clothes dryers do save energy
  - Compacts save more than full-size hybrid
- Co-benefits
  - Gentler drying
  - Dryer location flexibility
- HP dryers are not for everyone
  - Longer drying time
  - More maintenance
  - Energy payback not there for small HHs
- Could be a viable option for multifamily new construction
  - …avoid cost for dryer vents
  - …but have to provide the dryers
- MN TRM currently underestimates savings from efficient dryers

Questions?

HP Clothes Dryer Field and Consumer Research Findings



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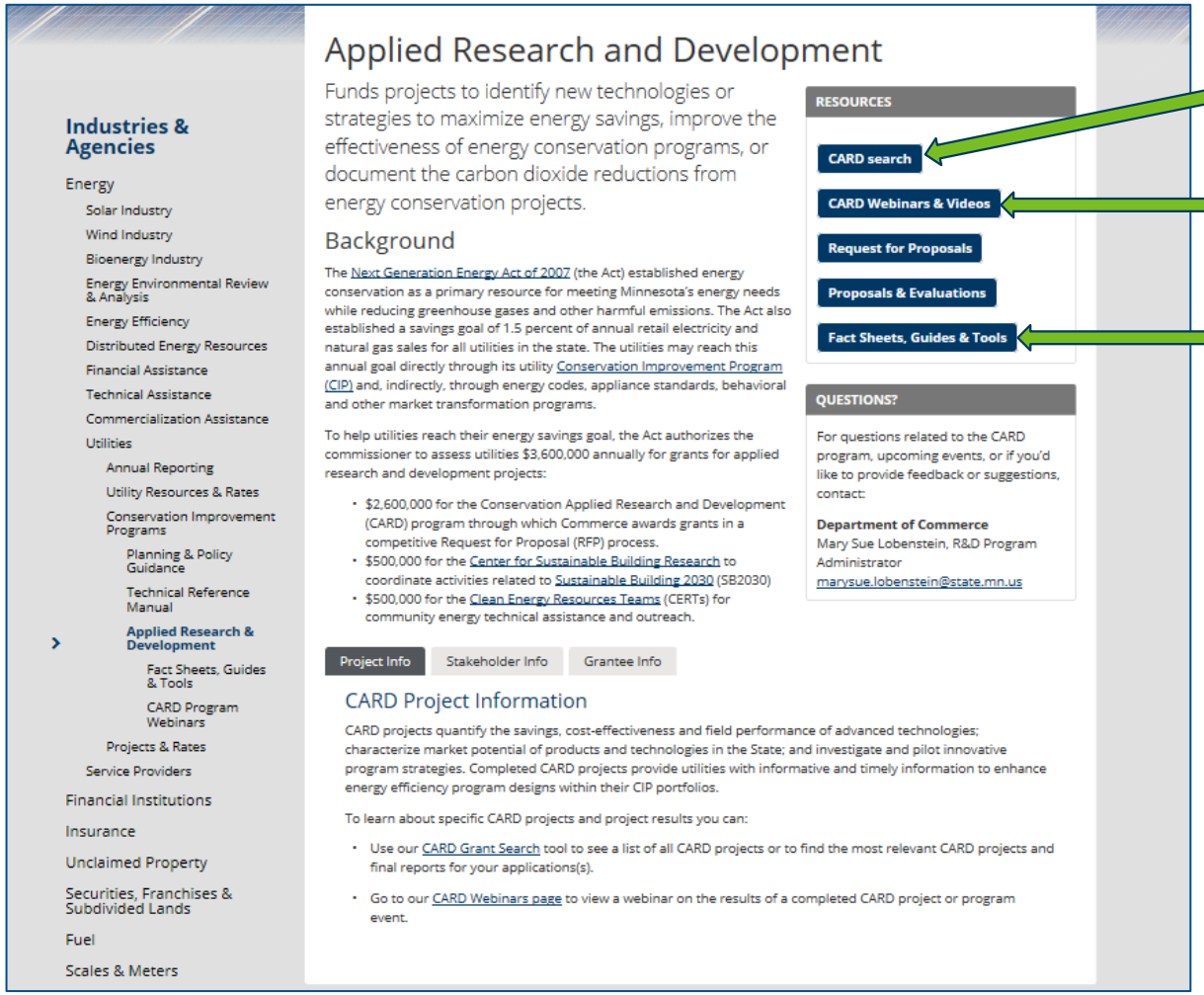
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Send us your questions using the Q&A panel

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Webinar Recording & Final Report available in couple months

R&D Web Page (https://mn.gov/commerce/industries/energy/utilities/cip/applied-research-development/)

Thanks for Participating!

Upcoming CARD Webinars:

- **June 8, 2021: MnTAP – Energy Efficiency Opportunities at Minnesota Water Utilities**
- **TBD: Center for Energy and Environment – Expanded Scope of Boiler Tune-ups**

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