Electrify GT Laundry

The Feasibility of Electric Clothes Dryers

Miele PDR908 HP Electric Clothes Dryer

Electrify GT

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Introduction

Georgia Tech operates over 170 natural gas-fired clothes dryers that produce planet-warming greenhouse gasses. The Intergovernmental Panel on Climate Change (IPCC) reports that to limit warming to 1.5 °C global greenhouse gas emissions must be reduced 50% by 2030.[1] Electrify GT hopes to help reduce campus emissions to be consistent with IPCC targets & the vision outlined in Georgia Tech's 2020-2030 Strategic Plan. This report explores the feasibility of replacing Georgia Tech's natural gas-fired clothes dryers with efficient electric alternatives.

Technical Background

This report models the cost and emissions of three types of clothes dryers: natural gas-fired, electric resistance, and heat pump. Natural gas-fired clothes dryers heat air by direct combustion of natural gas to remove moisture from clothes and vent humid air outdoors. Similarly, electric resistance clothes dryers heat air by running electricity through a heating element (e.g., the coils of a toaster) to dry clothes and vent humid air outdoors. Uniquely, heat pump clothes dryers use electricity to circulate air without venting and employ a closed-loop of refrigerant to remove water from the system. Heat pumps operate on the same technology as air conditioners and have seen adoption for heating & cooling in energy-efficient buildings (e.g., the Kendeda Building).

Energy use was calculated for selected models using the Combined Efficiency Factor (CEF) reported by the ENERGY STAR Program.[2] A higher CEF indicates a more efficient clothes dryer. Table 1 reports efficiency ranges by type for all clothes dryers tested by ENERGY STAR. As can be seen, **heat pump clothes dryers are up to three times as efficient as natural gas-fired equivalents**.

Table 1. *Clothes Dryer Efficiency Ranges*[3]

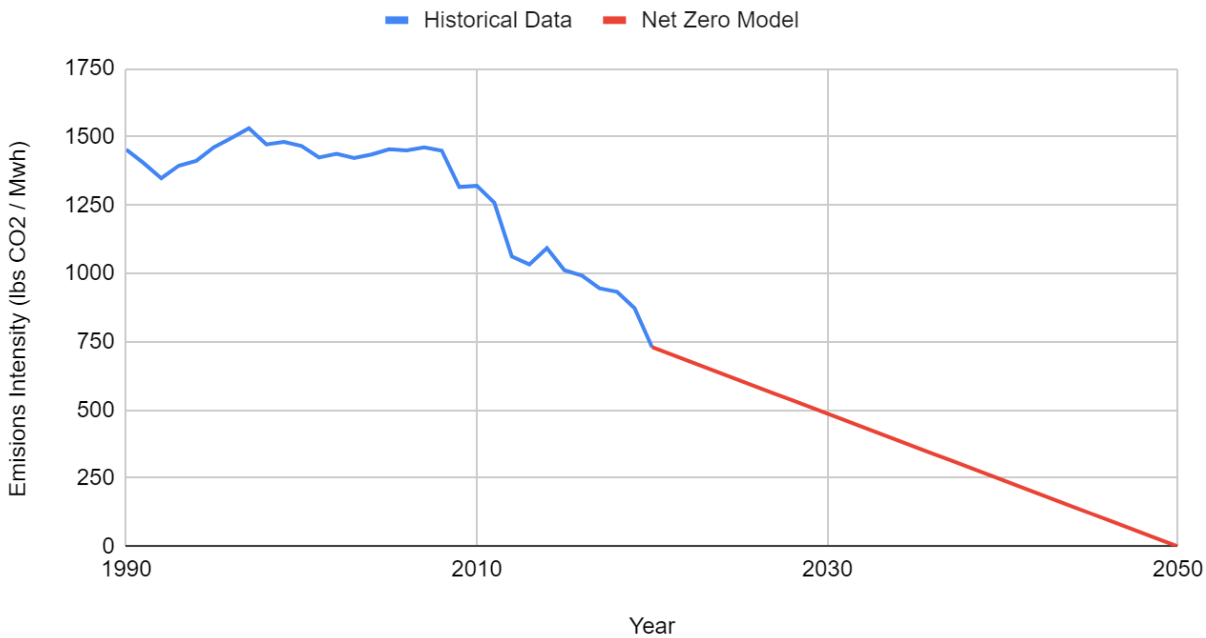
Clothes Dryer Type	Combined Efficiency Factor (CEF) Range
Natural Gas-Fired	3.48 - 3.49
Electric Resistance	3.93 - 4.50
Heat Pump	4.50 - 10.14

This report analyzes two Speed Queen models (used at Georgia Tech) and a representative heat pump model. The natural gas-fired clothes dryer is the Speed Queen Quantum Gold Pro - Gas (CEF = 3.48). The electric resistance clothes dryer is the Speed Queen Quantum Gold Pro - Electric (CEF = 3.93). The heat pump clothes dryer is the Miele PDR908 HP (CEF = 9.75) - a professional model used in laundrymats and universities across the United States.[4]

[1] https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/
[2] https://www.energystar.gov/productfinder/product/certified-clothes-dryers/results
[3] Table 1 reports values only for standard-size (non-compact) clothes dryers.
[4] https://www.mieleusa.com/e/professional-heat-pump-dryer-little-giants-pdr-908-hp-el-stainless-steel-11204490-p

After energy use per model was calculated, annual greenhouse gas emissions and cost were determined for 2022. Natural gas-fired clothes dryers produce emissions locally due to the combustion of natural gas. Alternatively, the emissions of electric clothes dryers are dependent on the emissions intensity of Georgia's grid (i.e., emissions generated per unit of electricity). Georgia Power (Georgia Tech's electricity supplier) has pledged to go "net zero" by 2050 (i.e., to produce electricity entirely by renewables and nuclear).[5] Thus, greenhouse gas emissions were also modeled for 2022 - 2032 (clothes dryers last an average of 10 years) assuming a linear decline in emissions intensity (Graph 1).[6] Note, Georgia Tech's utility rates were used for all cost calculations and are assumed to be constant over the coming decade (excluding inflation).

Graph 1. *Emissions Intensity of Georgia's Grid*



This report considers three use scenarios for on-campus clothes dryers. The scenarios are Low Use, Medium Use, and High Use which assume each clothes dryer on-campus runs 1, 3, and 5 cycles per day, respectively. These scenarios should be used to estimate total campus emissions and costs due to clothes dryers depending on different use cases.

[5] https://www.southerncompany.com/sustainability/net-zero-and-environmental-priorities/net-zero-transition.html
[6] https://www.consumerreports.org/laundry-and-cleaning/how-to-make-your-washer-and-dryer-last-a2393416520/

Gas vs Electric: Emissions Analysis

As shown below in Table 2, **in terms of emissions heat pump clothes dryers are the most efficient option**, producing 35% less greenhouse gases than natural gas-fired clothes dryers. Importantly, **in terms of emissions electric resistance clothes dryers are the least efficient option**, producing 63% more emisions than natural-gas fired clothes dryers. This is primarily because Georgia's grid has not yet integrated a high percentage of renewables. For Georgia's current grid, **an electric clothes dryer must have a CEF of greater than 6.38 to produce fewer emissions than a natural gas-fired clothes dryer**. Based on ENERGY STAR data, no electric resistance clothes dryers have the necessary efficiency to produce fewer emissions than natural gas equivalents. However, almost every heat pump clothes dryer would produce fewer emissions than natural gas equivalents.

Table 2. *Campus Clothes Dryer Emmisions - 2022*

Clothes Dryer Type	Model	Scenario - Emissions (mtco2e / year)		
		Low Use	Medium Use	High Use
Natural Gas-Fired	Speed Queen Quantum Gold Pro - Gas	49	147	246
Electric Resistance	Speed Queen Quantum Gold Pro - Electric	80	239	399
Heat Pump	Miele PDR908 HP	32	96	161

As shown below in Table 3, even accounting for the reduced emissions intensity of Georgia's grid, electric resistance clothes dryers will produce more cumulative emissions than natural gas-fired equivalents over the coming ten years. However, **a cleaner grid further improves the climate benefit of switching to a heat pump clothes dryer**, which is projected to produce 40% fewer greenhouse gases over the coming ten years than natural gas equivalents.

Table 3. *Campus Clothes Dryer Emmisions - 10 Years*

Clothes Dryer Type	Model	Scenario - Emissions (mtco2e / decade)		
		Low Use	Medium Use	High Use
Natural Gas-Fired	Speed Queen Quantum Gold Pro - Gas	491	1474	2456
Electric Resistance	Speed Queen Quantum Gold Pro - Electric	731	2194	3657
Heat Pump	Miele PDR908 HP	295	884	1474

Gas vs Electric: Cost Analysis

As shown below in Table 4, **in terms of utility costs heat pump and natural gas-fired clothes dryers are essentially equivalent.** Even in the most aggressive "High Use" case, there would only be a campus-wide added cost of $1,200 per year to switch to heat pump clothes dryers. However, **the utility cost of electric resistance clothes dryers is 2.5x greater than natural gas-fired alternatives**. For the Speed Queen electric resistance models used by Georgia Tech, electricity rates would need to be a third of their current cost to breakeven with natural gas-fired equivalents - unrealistic in even the most generous projections. At current utility rates, **electric clothes dryers must have a CEF of greater than 10 to breakeven with the costs of natural gas-fired clothes dryers**. Based on ENERGY STAR data, this efficiency is only possible with heat pump clothes dryers.

Table 4. *Campus Clothes Dryer Utility Costs - 2022*

Clothes Dryer Type	Model	Scenario - Emissions ($ / year)		
		Low Use	Medium Use	High Use
Natural Gas-Fired	Speed Queen Quantum Gold Pro - Gas	$6,400	$19,100	$31,800
Electric Resistance	Speed Queen Quantum Gold Pro - Electric	$16,400	$49,200	$81,900
Heat Pump	Miele PDR908 HP	$6,600	$19,800	$33,000

For completeness, 10-year cost projections are included in Table 5. However, the costs of utilities are assumed to be constant over the coming decade, so these values are simply the annual costs above multiplied by a factor of ten. Even though we make conservative assumptions, over the long term renewables have the potential to lower electric utility costs.

Table 5. *Campus Clothes Dryer Utility Costs - 10 Years*

Clothes Dryer Type	Model	Scenario - Emissions ($ / decade)		
		Low Use	Medium Use	High Use
Natural Gas-Fired	Speed Queen Quantum Gold Pro - Gas	$63,600	$190,800	$318,000
Electric Resistance	Speed Queen Quantum Gold Pro - Electric	$163,800	$492,000	$819,200
Heat Pump	Miele PDR908 HP	$66,000	$198,100	$330,200

Conclusion

Natural gas-fired clothes dryers produce plant-warming emissions and prolong Georgia Tech's reliance on unsustainable fossil fuels. Advances in heat pump clothes dryers have enabled a solution that produces 35-40% fewer carbon emmisions at the same costs as natural gas equivalents. However, we highly recommend that Georgia Tech does not consider electric resistance dryers as an alternative due to their high emissions and cost relative to natural gas-fired models. **Electrify GT highly recommends that Georgia Tech rapidly replaces all natural gas-fired clothes dryers with efficient, cheap heat pump alternatives.**