ACT 129 STAKEHOLDER MEETING

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

2023 Non-Residential End Use & Saturation Study

February 7, 2024

AGENDA

- Background
- Overview of study methods
- High-level findings
  - Energy use intensities
  - Penetrations and fuel shares
  - General building characteristics

- End use analysis
  - Lighting
  - HVAC
  - Domestic Hot Water
  - Refrigeration
  - Process
  - Cooking
  - Plug Loads

- Adoption research
  - Conjoint survey overview
  - Motivations, barriers, and awareness
  - Willingness to pay

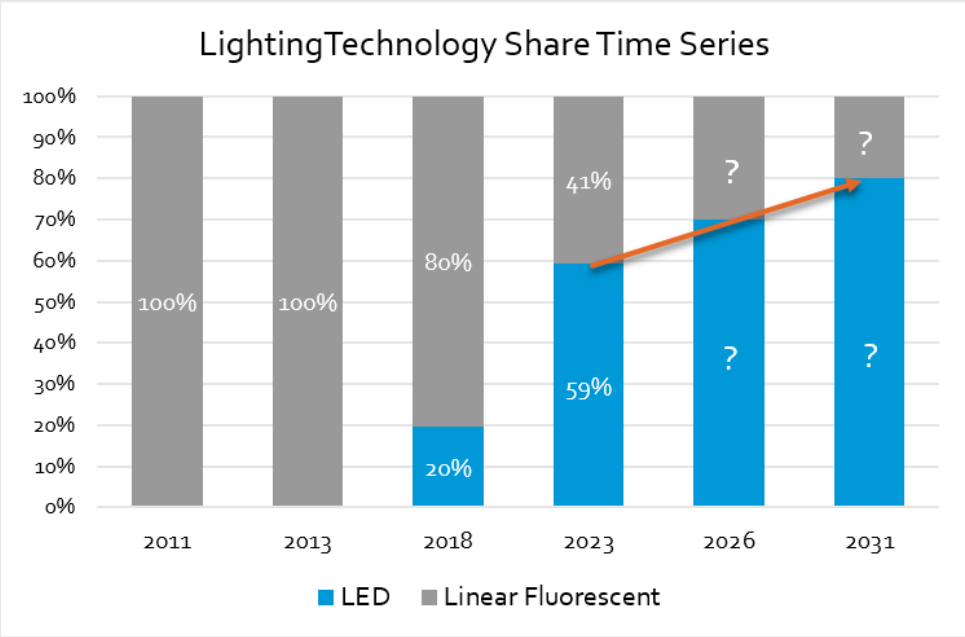
COLLABORATIVE STUDY BETWEEN THE SWE TEAM AND THE SEVEN EDCS SUBJECT TO ACT 129

The PA PUC contracted with NMR Group (NMR), Demand Side Analytics (DSA), Brightline Group, and Optimal Energy (the Statewide Evaluation (SWE) Team) to conduct baseline and potential studies for Pennsylvania's seven largest electric distribution companies (EDCs)

- PECO Energy Company (PECO)
- PPL Electric Utilities Corporation (PPL)
- Duquesne Light Company (Duquesne or DLC)
- Metropolitan Edison Company (FE: Met-Ed or ME)
- Pennsylvania Electric Company (FE: Penelec or PN)
- Pennsylvania Power Company (FE: Penn Power or PP)
- West Penn Power Company (FE: West Penn or WPP)

The EDCs supplied detailed data on their customer base and supported recruitment efforts. The SWE team performed the data collection and analysis.

STUDY OBJECTIVES



- Develop inputs for Phase V market potential studies
  - Disaggregation of sales forecast by EDC, sector, segment, and end-use
  - Study shares set up top-down modeling approach
- Inform areas of program opportunity
  - Assess technology shares and magnitude of potential EE savings
  - Look for leading/lagging sectors and segments
- Explore trends over time
  - This is the fourth Act 129 non-residential baseline study
  - Prior data collection happened in 2011, 2013, and 2018
- TRM improvement
  - Average size, efficiency, and configuration of existing equipment stock

STUDY LEADS

Jesse Smith

Partner

Jesse Smith is an applied statistician whose work is centered around estimating the impacts of demand side interventions to alter the way homes and businesses use energy.

- Key member of the SWE team since 2011
- Founded Demand Side Analytics in 2016
- Third time leading the Act 129 non-residential baseline study
- Involved in all phases of the study from design to data collection to analysis and reporting

He received a BS in Psychology from the University of North Carolina at Chapel Hill and a MS degree in Applied Statistics from Kennesaw State University.

Tim Larsen

Consultant

Tim Larsen is a resource economist who loves policy analysis at the intersection of energy and climate issues. At DSA he applies his academic background to program evaluation and planning studies.

- Taught economics at UC Boulder, Vanderbilt, and Berry College.
- Member of the SWE team since early 2022
- Led the study segmentation including property tax data analysis
- Performed end-use analysis for lighting, refrigeration, domestic hot water, and commercial cooking

He holds a PhD in Economics from the University of Colorado and BA in Economics from Brigham Young University.

ELECTRIC CUSTOMERS AND SALES

NON-RESIDENTIAL ACCOUNTS MAKE UP ~ 60% OF ELECTRIC SALES

Category	Sales (2022 MWh)	Customers (2022 Accounts)
Pennsylvania	145,044,592	6,250,115
Act 129 EDCs	138,643,960	5,855,811
Non-Res Sectors of Act 129 EDCs	85,427,112	702,569

- This study is limited to the seven EDCs subject to Act 129
  - Represent 96% of Pennsylvania electric consumption
- Residential customers make up most accounts, but only 40% of electric consumption
- During the first two years of Phase IV, non-residential programs delivered almost 70% of verified gross MWh and MW savings

FLAT/DECLINING CONSUMPTION DESPITE STEADY ACCOUNT GROWTH SIGNALS IMPROVED ENERGY EFFICIENCY SINCE ACT 129 BEGAN

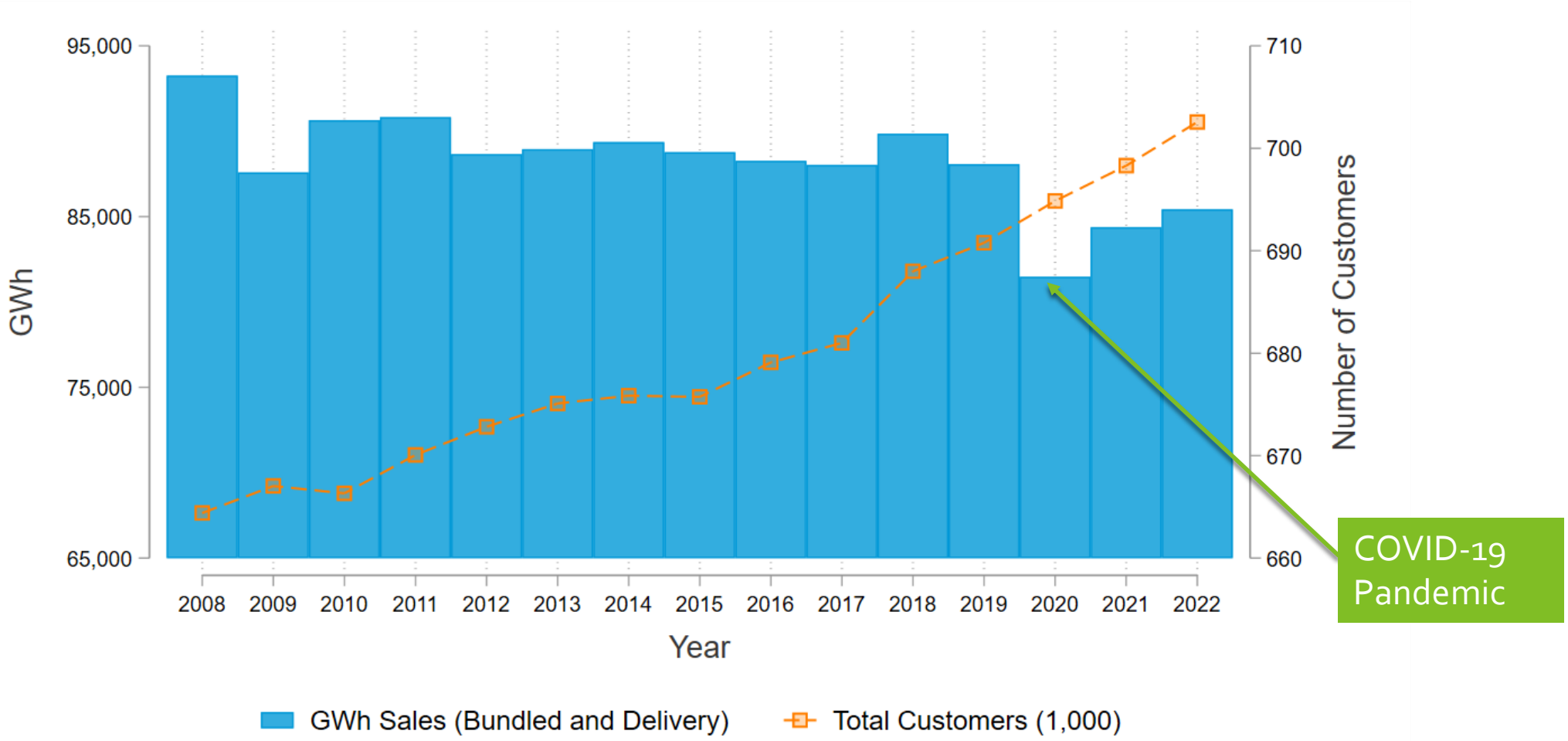


Figure shows data for non-residential accounts across the 7 EDCs subject to Act 129

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STUDY METHODOLOGY

PRIMARY DATA COLLECTED FOR OVER 500 SITES IN 2023

This study covers non-residential customers

Data was collected in February through July 2023

Auditors cataloged equipment and building characteristics in a web-based form

516 sites sampled across a diverse set of industries

EACH ACCOUNT ASSIGNED TO INDUSTRY SEGMENT AND SECTOR

- Segment determined by:
  - Industry codes in EDC data (SIC, NAICS)
  - Matching to property tax data
  - Text mining from customer names
- Small C&I makes up large majority of accounts (98.6%)
- Large C&I uses 124 times more electricity *per account*
- Excluded segments:
  - Master-Metered Multifamily
  - Transportation, Communication, & Utilities (TCU)

Segment	Accounts	Electric Sales (GWh) June 2021-May 2022
Education	14,122	6,524
Grocery	10,990	3,406
Health	22,090	5,696
Industrial	63,070	33,424
Institutional	49,489	5,371
Lodging	10,528	1,389
Miscellaneous	82,121	2,988
Office	133,499	9,579
Religious	21,686	763
Restaurant	21,871	1,882
Retail	48,822	3,470
Warehouse	35,212	3,875
Sector		
Small	506,317	28,266
Large	7,183	50,100
Statewide	**513,500**	**78,366**

NEW FOR 2023 - PROPERTY TAX MATCHING

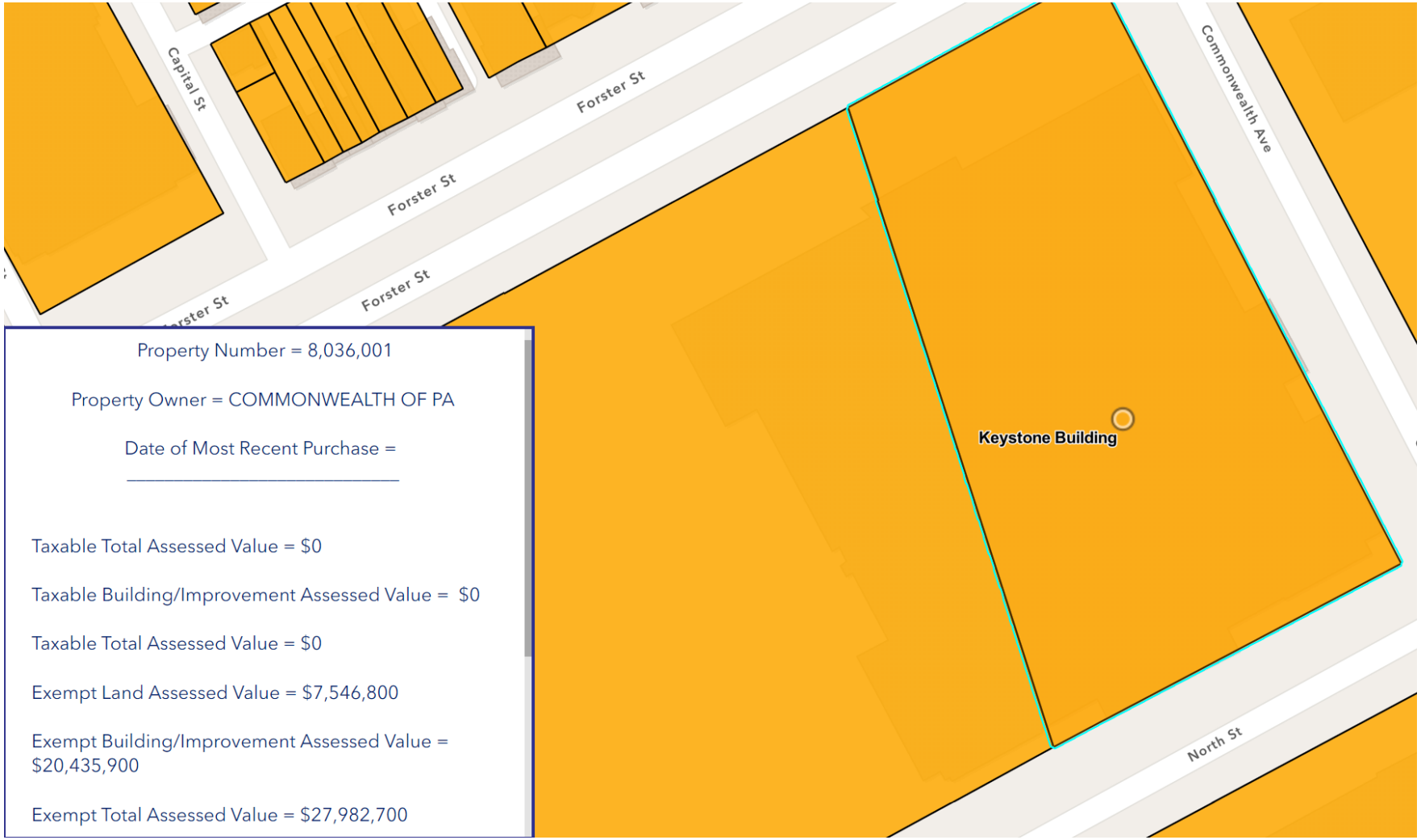
Hierarchy for Segmentation

1. 2018 segment
2. Industry codes/building types from EDC data
3. Property tax data
4. String Classification (using acct. names)
5. Manual classification

Matching Account to Property Tax Data

- Acquired PA property tax data from SMR research
  - Property tax data publicly available by city/county
  - Data provides granular use descriptions that map into study segments
- Distance-matched EDC meters to properties
  - Property tax data comes with coordinates
  - Used EDC coordinates or geocodes service addresses to get meter locations
  - Matched to nearest record in property tax data
- Kept strong matches only
  - Matching sometimes difficult for large sites, industrial parks, etc.

EXAMPLE: PUBLICLY AVAILABLE PROPERTY TAX DATA



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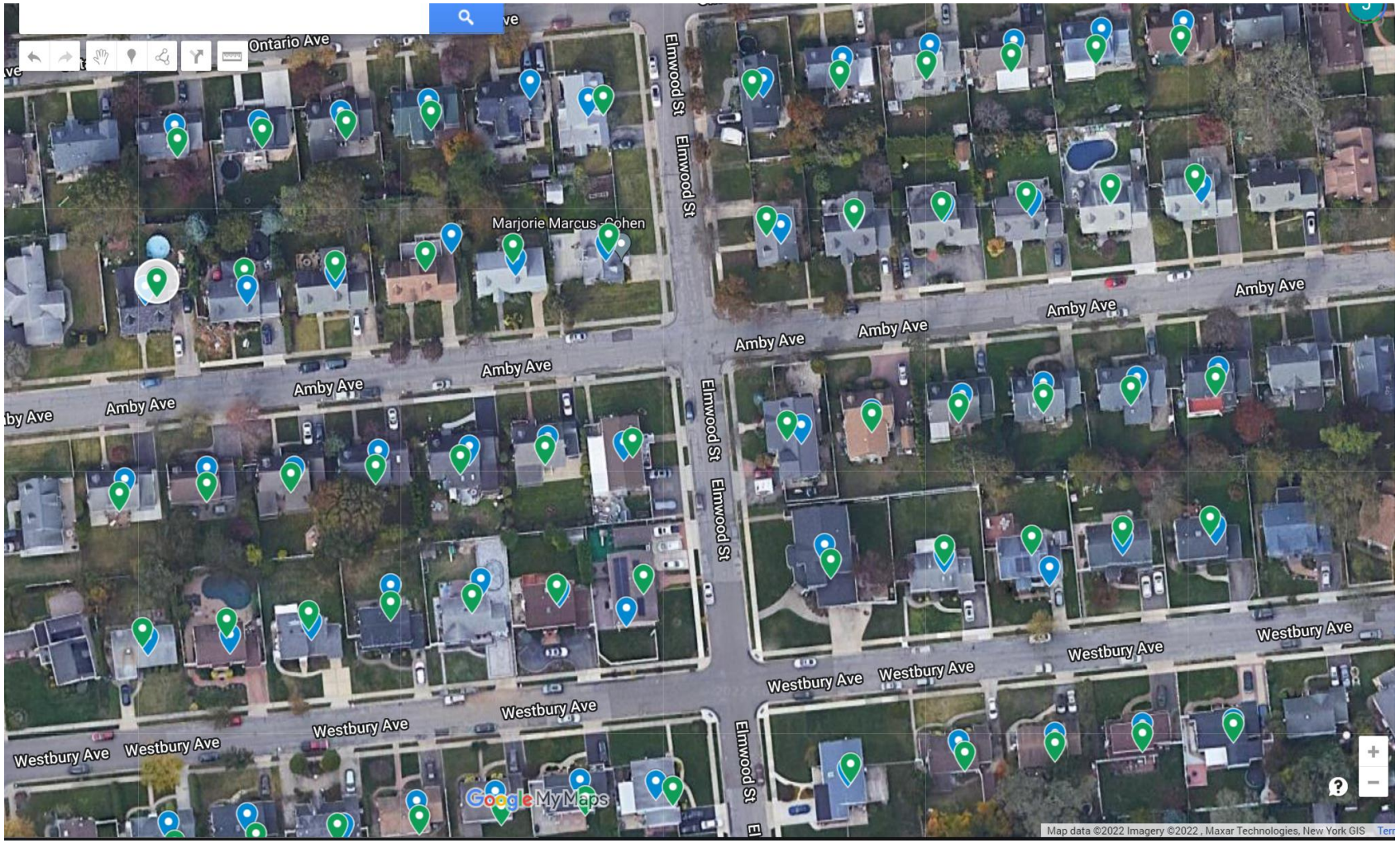
EXAMPLE: MATCHING METERS TO PROPERTIES



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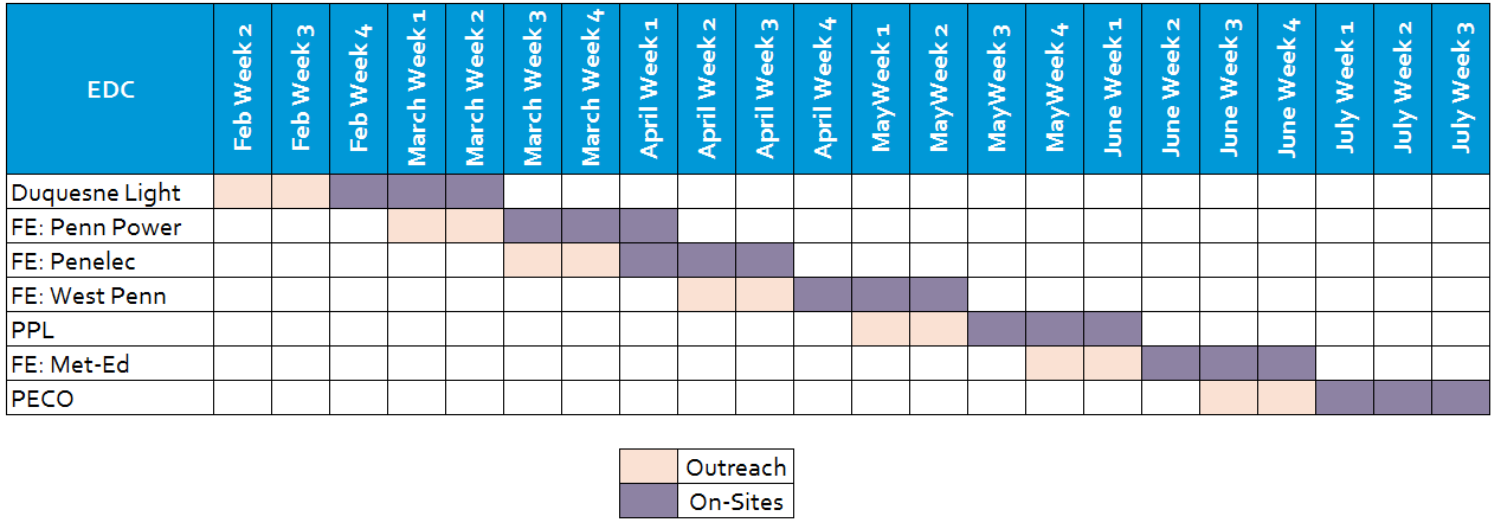
RECRUITING AND SCHEDULING

- Three outreach methods
  - Postcard via USPS
  - Outbound email
  - Outbound phone call
- Separate process for managed accounts
  - Collaboration and support from the EDC account managers was invaluable
- Hit targets for each EDC (70+), segments, and sectors



Survey Response Rates by EDC

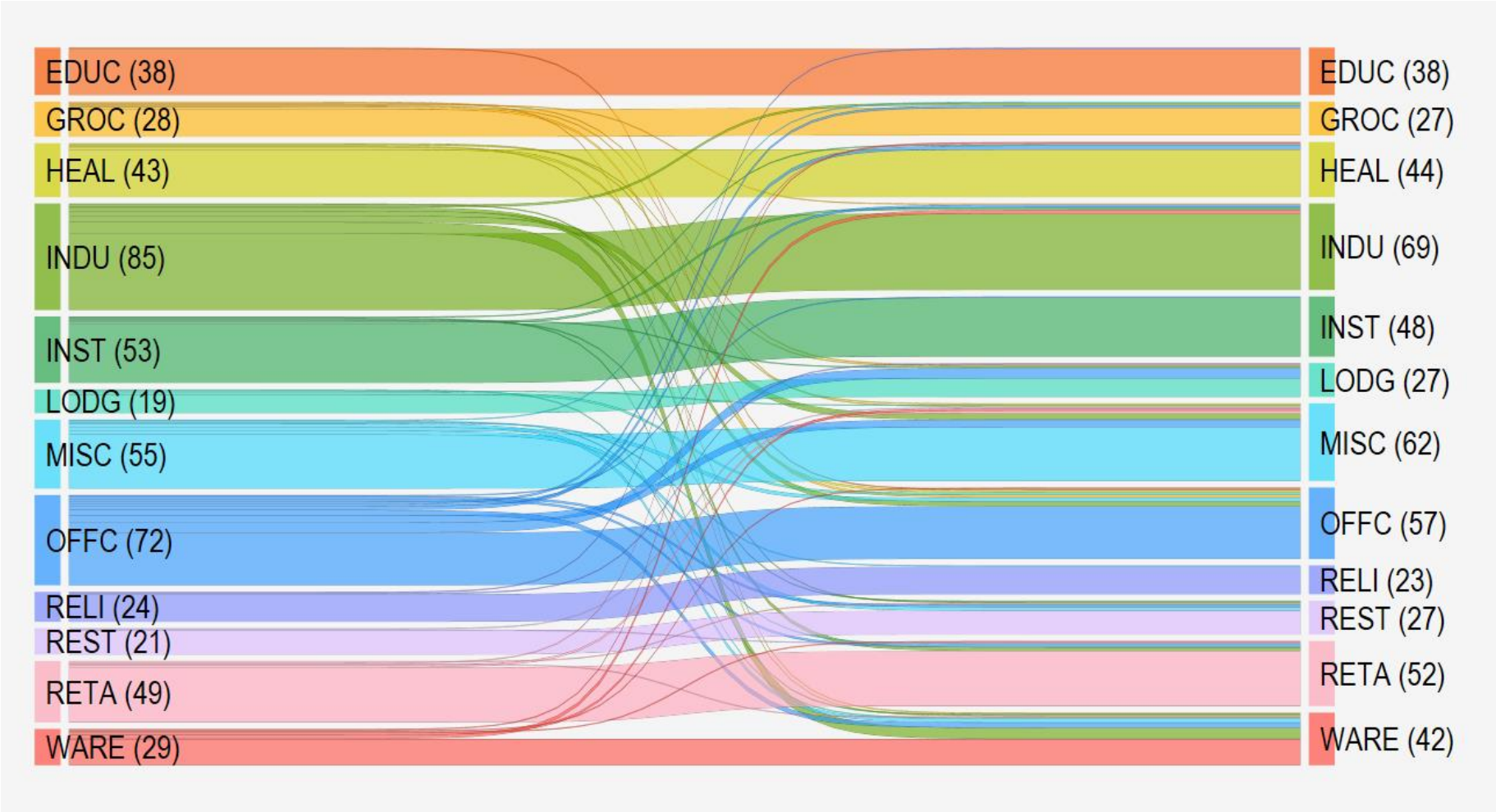
EDC	PECO	PPL	DLC	MET	PN	PP	WPP	Total
Total Sample	7,460	6,884	6,927	6,176	5,930	5,660	5,912	44,949
Incompletes	28	54	46	57	48	40	31	304
Disqualified	3	4	5	2	4	6	4	28
Total Entries	65	111	99	93	136	113	82	699
Email Entries	56	83	85	67	104	86	55	536
Postcard Entries	9	28	14	26	32	27	27	163
Interested Completes	34	53	46	34	84	67	47	365
Total Entry Rate	0.9%	1.6%	1.4%	1.5%	2.3%	2.0%	1.4%	1.6%
Total Interested Complete Rate	0.5%	0.8%	0.7%	0.6%	1.4%	1.2%	0.8%	0.8%

SAMPLING STRATEGY & SITE VISITS

- Table shows the actual number of site visits completed
- The sample was designed to provide ± 10% precision at the 90% confidence level for each EDC
- Deliberate oversampling of Large C&I accounts
- Data was collected on-site
  - ➢ Weekly quality checks helped ensure thorough and accurate information

Segment	PECO	PPL	DLC	FE: Met-Ed	FE: Penelec	FE: Penn Power	FE: West Penn	Statewide
Education	5	4	6	4	7	6	6	**38**
Grocery	3	9	3	4	2	3	3	**27**
Health	13	4	6	5	5	5	6	**44**
Industrial	2	6	13	11	12	12	13	**69**
Institutional	5	3	7	7	9	10	7	**48**
Lodging	8	3	1	1	4	6	4	**27**
Miscellaneous	6	11	8	6	8	11	12	**62**
Office	8	14	8	8	5	7	7	**57**
Religious	2	3	5	5	2	4	2	**23**
Restaurant	6	4	5	1	6	3	2	**27**
Retail	5	7	6	11	8	9	6	**52**
Warehouse	7	7	3	10	5	5	5	**42**
Total	**70**	**75**	**71**	**73**	**73**	**81**	**73**	**516**

UPFRONT SEGMENTATION GENERALLY MATCHED WHAT WE SAW ON-SITE



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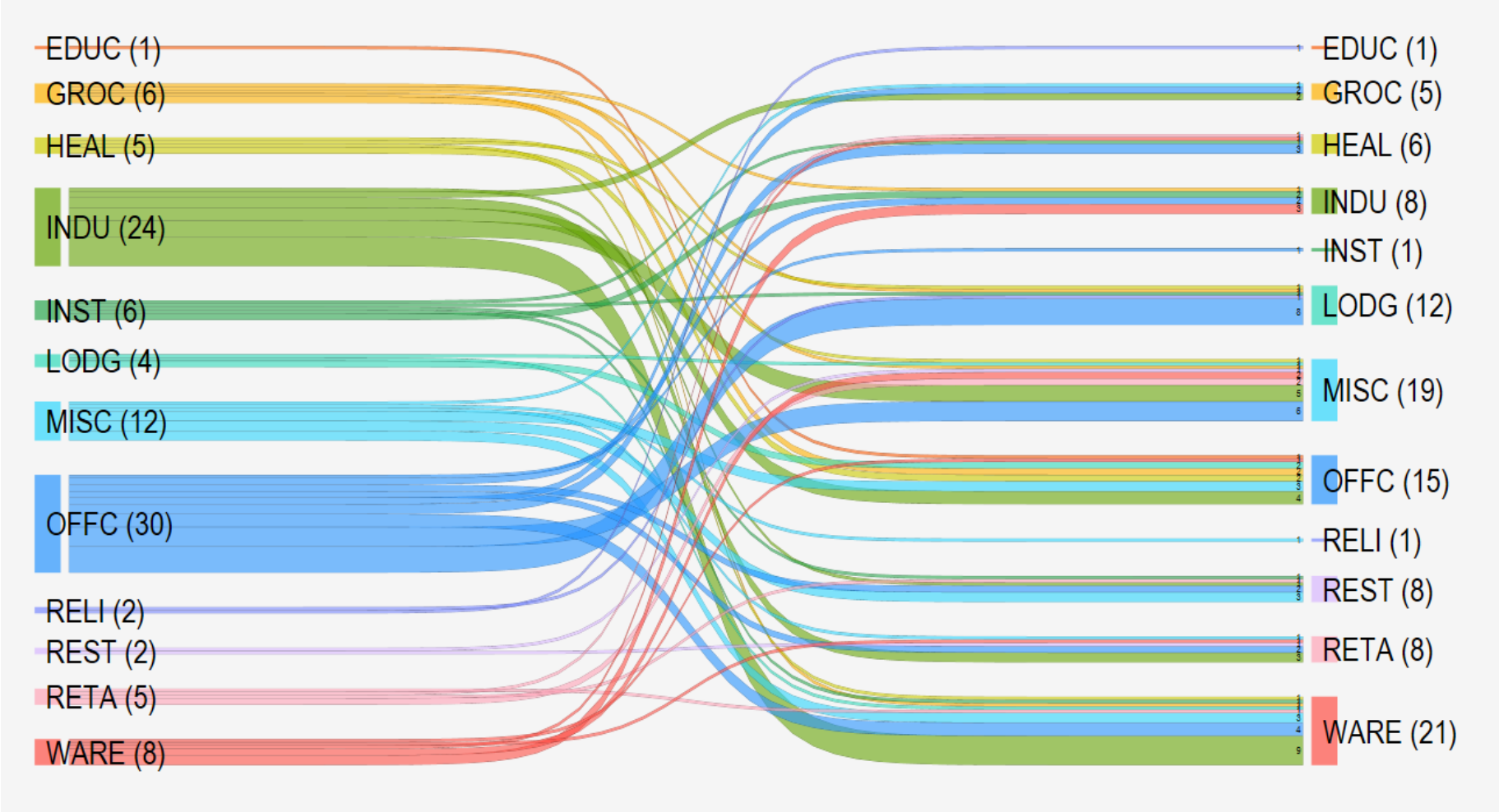
WE SEE SOME PATTERNS IN THE RECLASSIFICATIONS, BUT MOSTLY NOISE

Upfront



On-Site

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WEIGHTING COMPONENTS

- Case weights indicate the number of sites in the population represented by a single sampled site.
- Sales weights consider the share of electric sales for each of the 24 sector-segment pairs
- End use weight adjustments calibrate the sales weights to each end use based on 2018 study results
- Study weights are the product of the sales weights, case weights and end use adjustments

Segment	Large C&I Sector			Small C&I Sector		
	Accounts	Sample	Case Weight	Accounts	Sample	Case Weight
Education	923	16	58	13,199	22	600
Grocery	464	9	52	10,526	18	585
Health	487	15	32	21,603	29	745
Industrial	2,455	46	53	60,615	23	2,635
Institutional	612	8	77	48,877	40	1,222
Lodging	144	5	29	10,384	22	472
Miscellaneous	265	1	265	81,856	61	1,342
Office	1,007	9	112	132,492	48	2,760
Religious	34	0	0	21,652	23	941
Restaurant	36	0	0	21,835	27	809
Retail	323	2	162	48,499	50	970
Warehouse	433	9	48	34,779	33	1,054

Differences in case weights by sector are offset by the significantly larger counts and capacities in Large C&I

KEY DEFINITIONS

- **Penetration**: proportion of sites that have a certain type of technology
- **Saturation**: proportion of equipment of a certain technology type

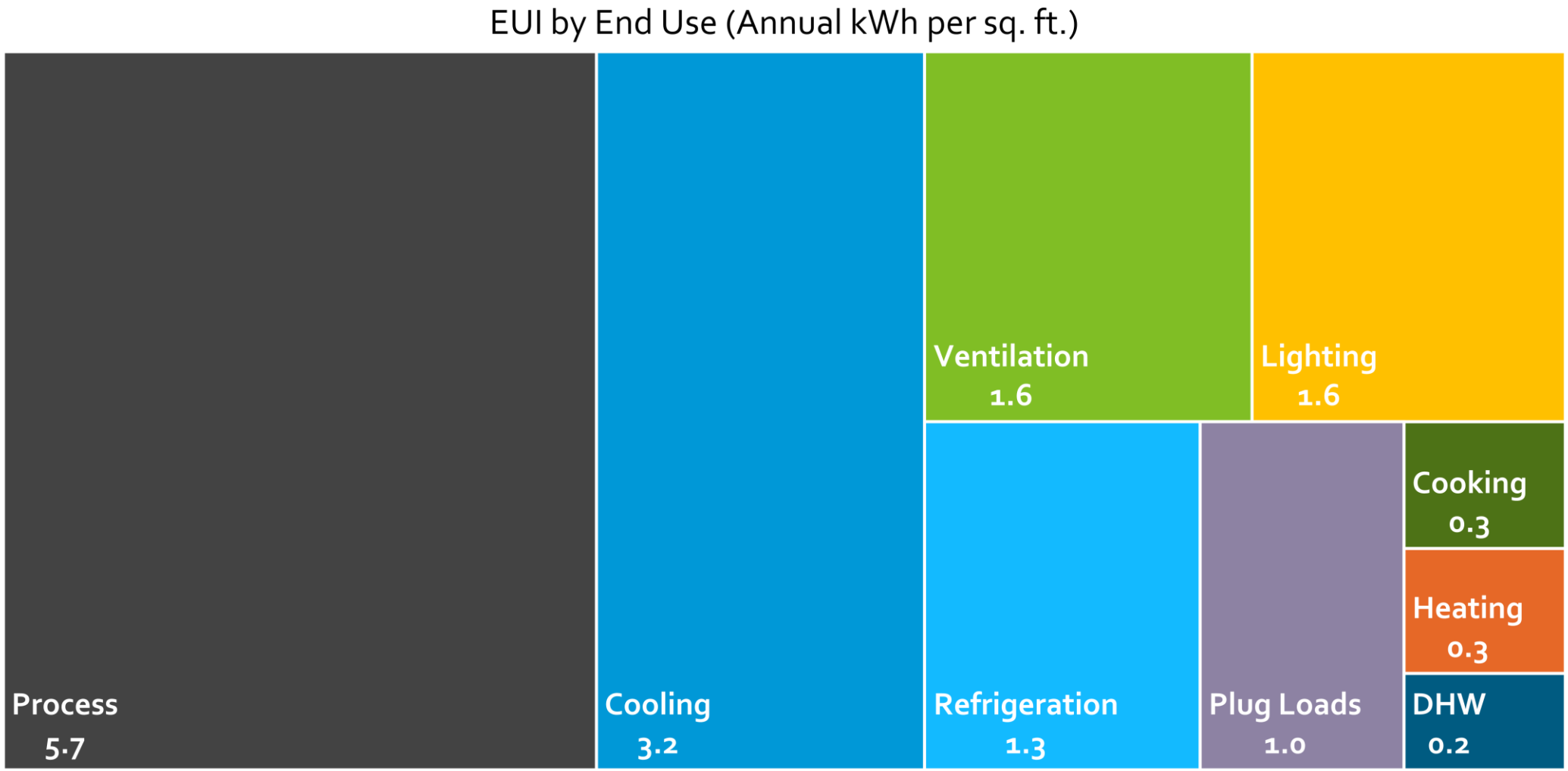
Share of…	N-value	Conceptual calculation	Analysis Application
Sites	Sites	$\frac{\#\ of\ sites\ where\ technology\ is\ present}{total\ \#\ of\ sites}$	Penetration of end uses or technology at the site level
Units	Items of equipment	$\frac{\#\ of\ units\ with\ feature\ or\ characteristic}{total\ \#\ of\ units}$	Saturation of end use technology features or efficiency Distribution of unit sizes Distribution of unit ages
Capacity	Items of equipment	$\frac{capacity\ (kW, kBTU, gal)\ with\ feature\ or\ within\ segment}{total\ capacity\ (kW, kBTU, gal)}$	Distribution of equipment technology Fuel share
Floor Space	Distinct Rooms or Spaces	$\frac{square\ feet\ of\ building\ with\ a\ feature\ or\ characteristic}{total\ square\ footage}$	Saturation of cooling or heating as a share of floor space

ENERGY USE INTENSITY

CALCULATING ENERGY USE INTENSITY

- Energy Use Intensity (EUI) = annual kWh per square foot
- Two complementary approaches:
  - **Top-down:** divides billed 12-month kWh by interior square footage
  - **Bottom-up:** combines calculations based on the equipment inventory and operating schedules collected on-site
- Annual kWh for bottom-up calculations came from:
  - Field data collection (capacity * operating hours): Lighting, Process, On-Site Generation
  - Field data + TRM calculations: Cooling, Heating, Water Heating, Refrigeration
  - ENERGY STAR calculator values by equipment type: Cooking, Reach-In Refrigeration

STATEWIDE EUI BREAKDOWN BY END USE



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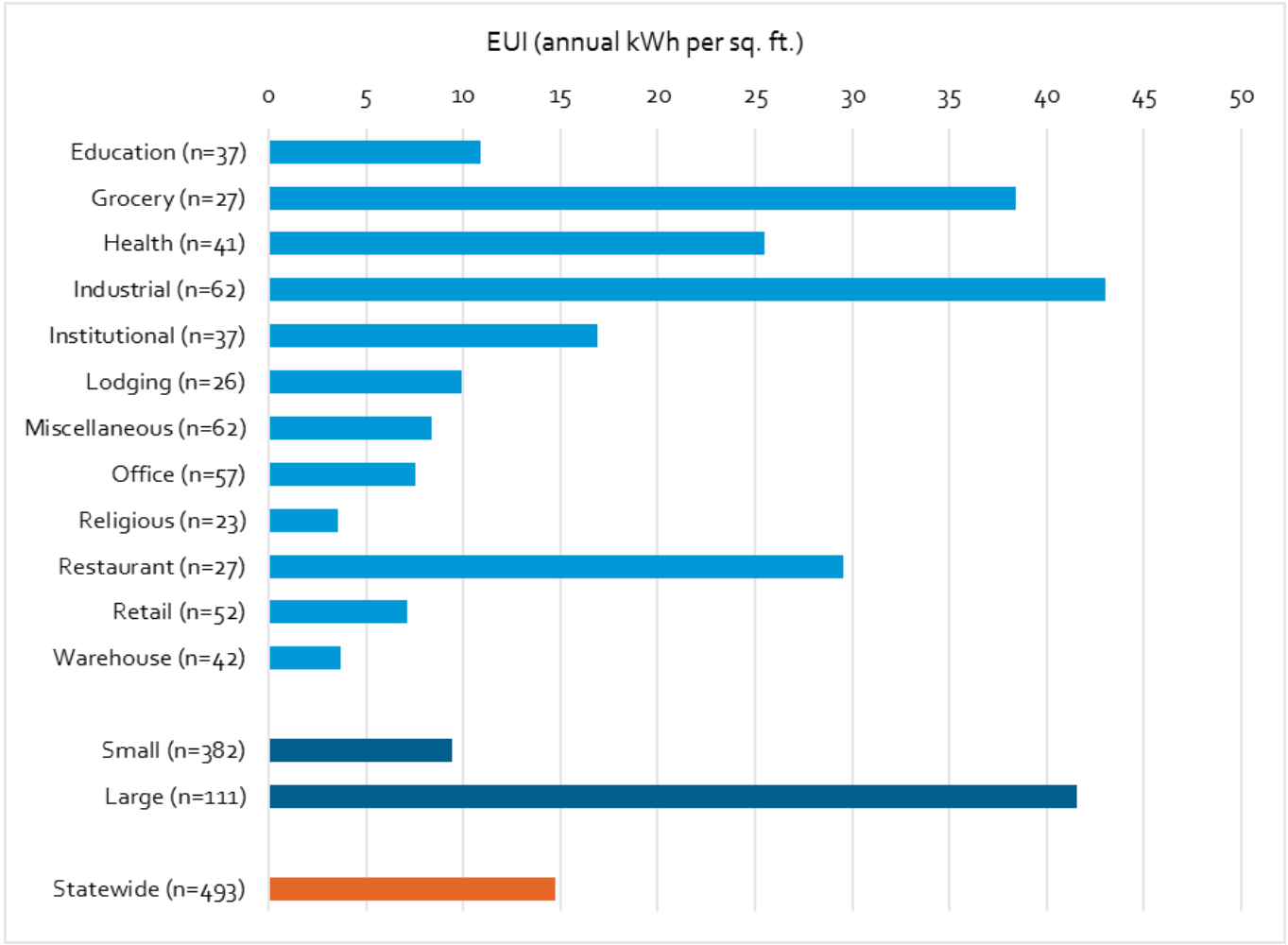
EUI RESULTS BY SECTOR AND SEGMENT

- Statewide EUI is very similar to 2018 (14.75 vs. 14.78)
  - Industrial EUI is higher than 2018
  - Most segments decreased
- Grocery, Industrial, and Restaurant have the highest EUI
- Religious, Retail, and Warehouse have the lowest EUI
- Large C&I EUI is over 4x higher than Small C&I



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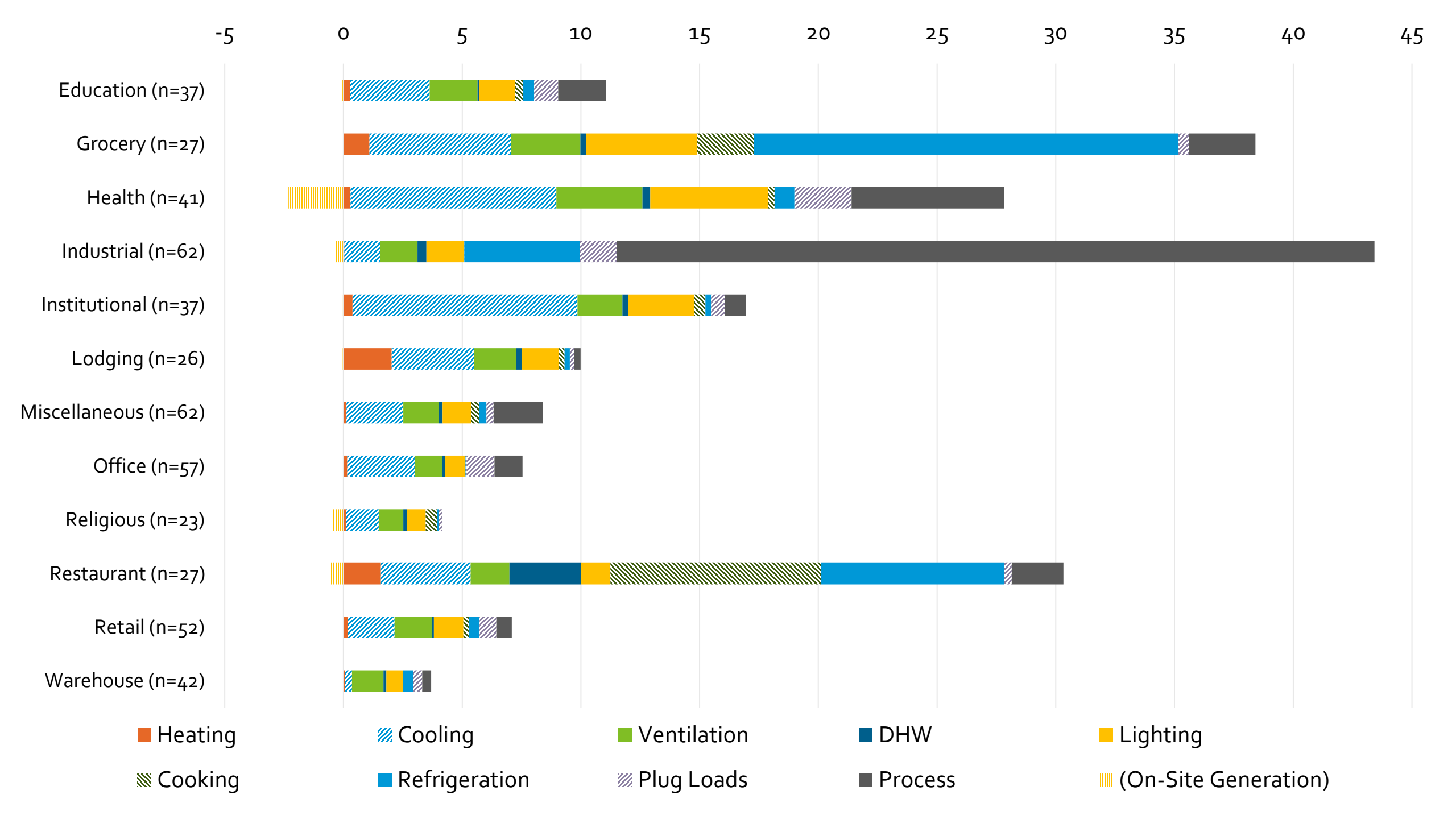
-5
0
5
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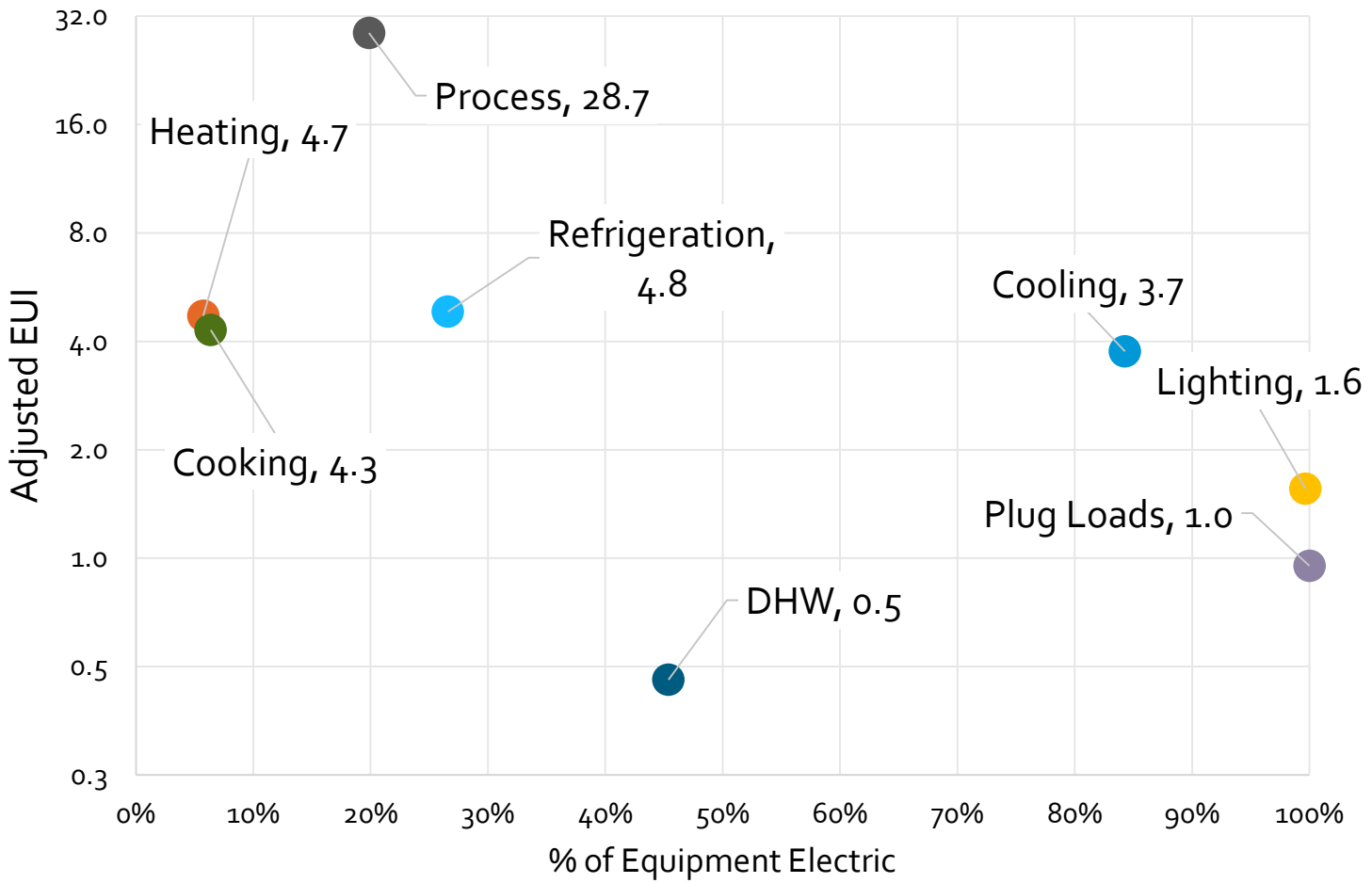
45
Education (n=37)
Grocery (n=27)
Health (n=41)
Industrial (n=62)
Institutional (n=37)
Lodging (n=26)
Miscellaneous (n=62)
Office (n=57)
Religious (n=23)
Restaurant (n=27)
Retail (n=52)
Warehouse (n=42)
Heating
Cooling
Ventilation
DHW
Lighting
Cooking
Refrigeration
Plug Loads
Process
(On-Site Generation)

END USE PENETRATION AND ELECTRIC FUEL SHARE INFLUENCE EUI

End Use	Penetration	Fuel Share			
		Natural Gas	Electric	Propane	Other
Heating	96%	83%	6%	6%	5%
Cooling	83%	0%	100%	0%	0%
DHW	93%	48%	49%	3%	0%
Lighting	100%	0%	100%	0%	0%
Cooking	17%	50%	38%	12%	0%
Refrigeration	27%	0%	100%	0%	0%
Plug Load	100%	0%	100%	0%	0%
Process	42%	52%	47%	0.3%	0%

Lighting, Plug Load, Cooling, Refrigeration are all fully electric end uses

EUI LOOKS DIFFERENT IF WE ACCOUNT FOR PENETRATION RATES, ELECTRIC EQUIPMENT ONLY



- Adjusted EUIs in graph: Re-scaled by:
  - % of sites with given end use (penetration rate)
  - % of equipment electric
- Heating EUI = 4.7 amongst sites with electric heat.
  - Compared to 0.3 overall
- Cooking EUI = 4.3 amongst sites with electric cooking equipment
  - Compared to 0.3 overall

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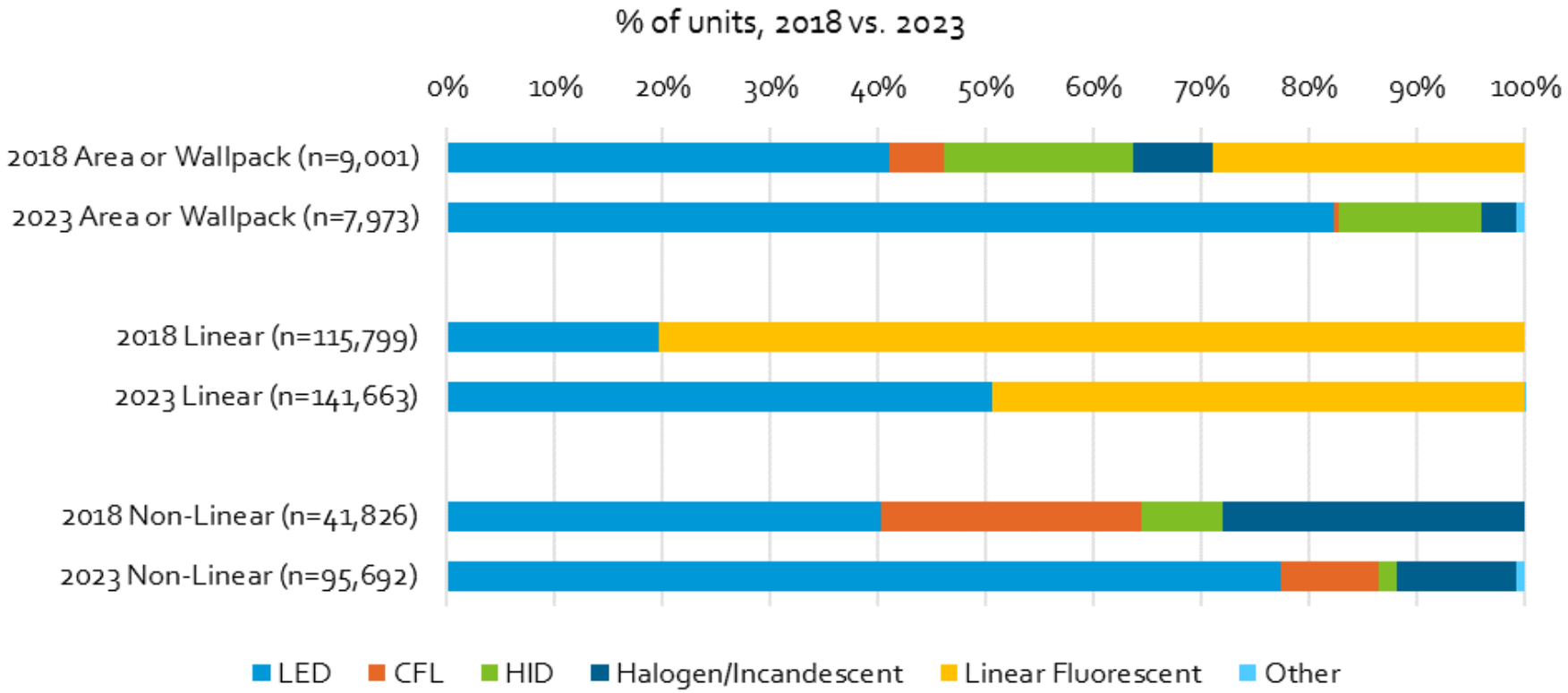
LIGHTING

LIGHTING EQUIPMENT TAXONOMY

- Lighting **Technology**
  - Mechanism of producing light from electricity
  - Example: Linear Fluorescent
- Lighting **Style**
  - Type of luminaire housing the technology
  - Example: High-bay non-linear
- Lighting **Application**
  - Use and location
  - Example: Indoor screw-based

CFL		LED	
Halogen / Incandescent		Exterior Area and Wall Pack	
Linear Fluorescent		High Bay Non-Linear	
High Intensity Discharge		Low Bay Linear	

LED SATURATION MORE THAN DOUBLED SINCE 2018



LED lighting accounts for approximately 40% of non-residential connected load. LEDs are more efficient so results on a connected load basis show lower LED share than unit count results

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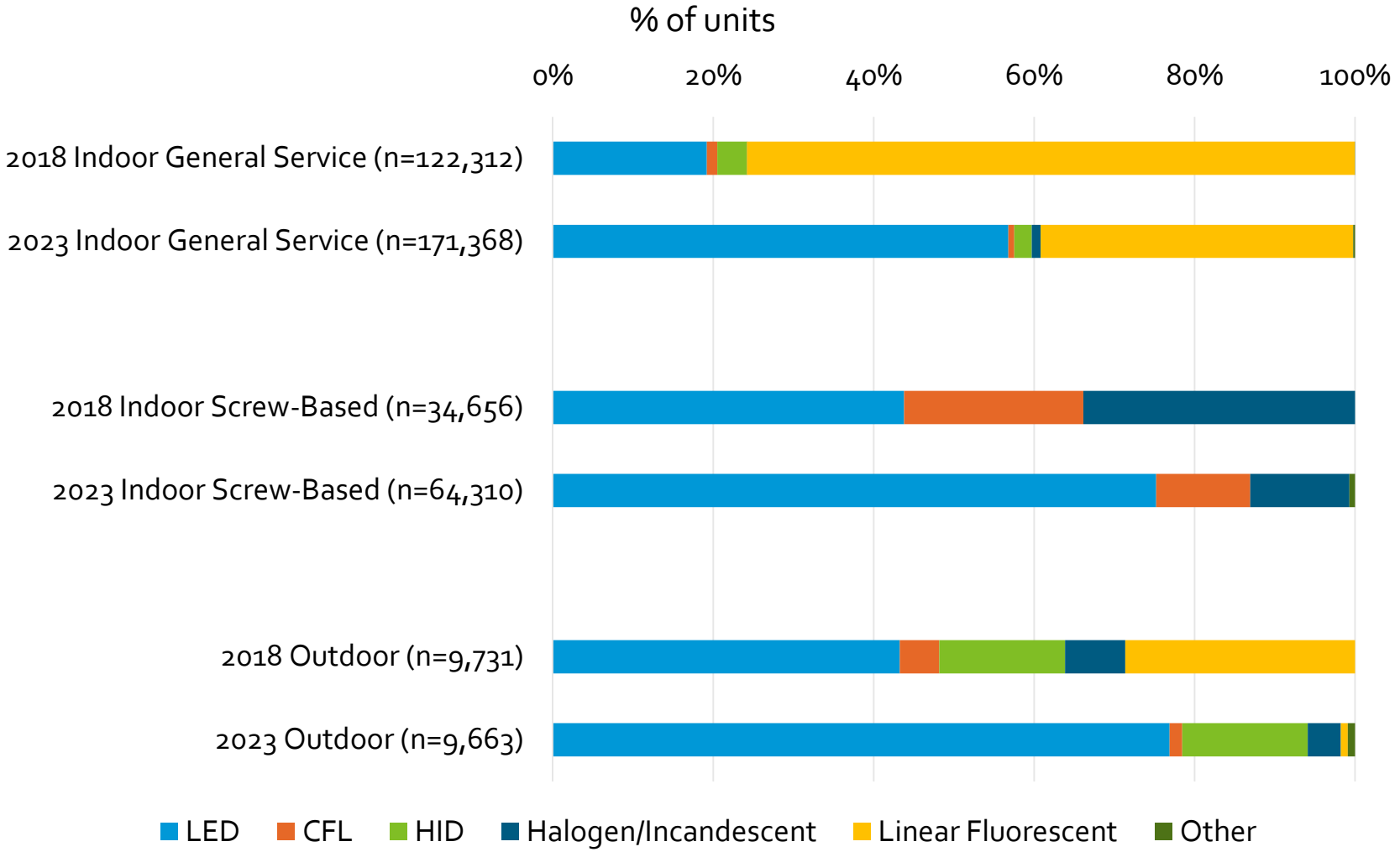
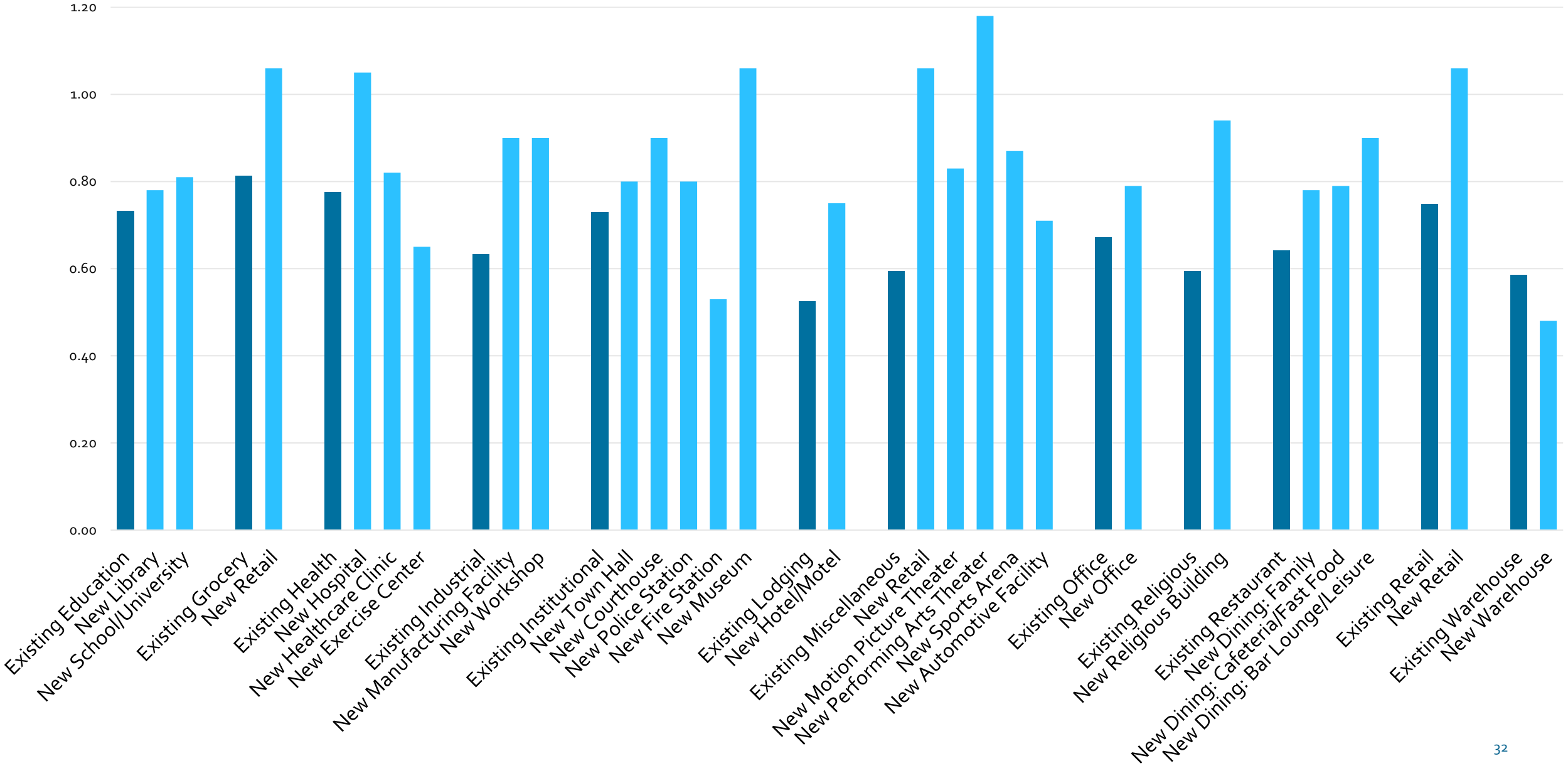
LEDS HAVE BECOME THE DOMINANT LIGHTING TECHNOLOGY

- No longer an emerging technology
  - Successful EDC programming
  - Declining costs
  - Diverse product options
- Outdoor and indoor screw-based applications are further transformed than indoor general service



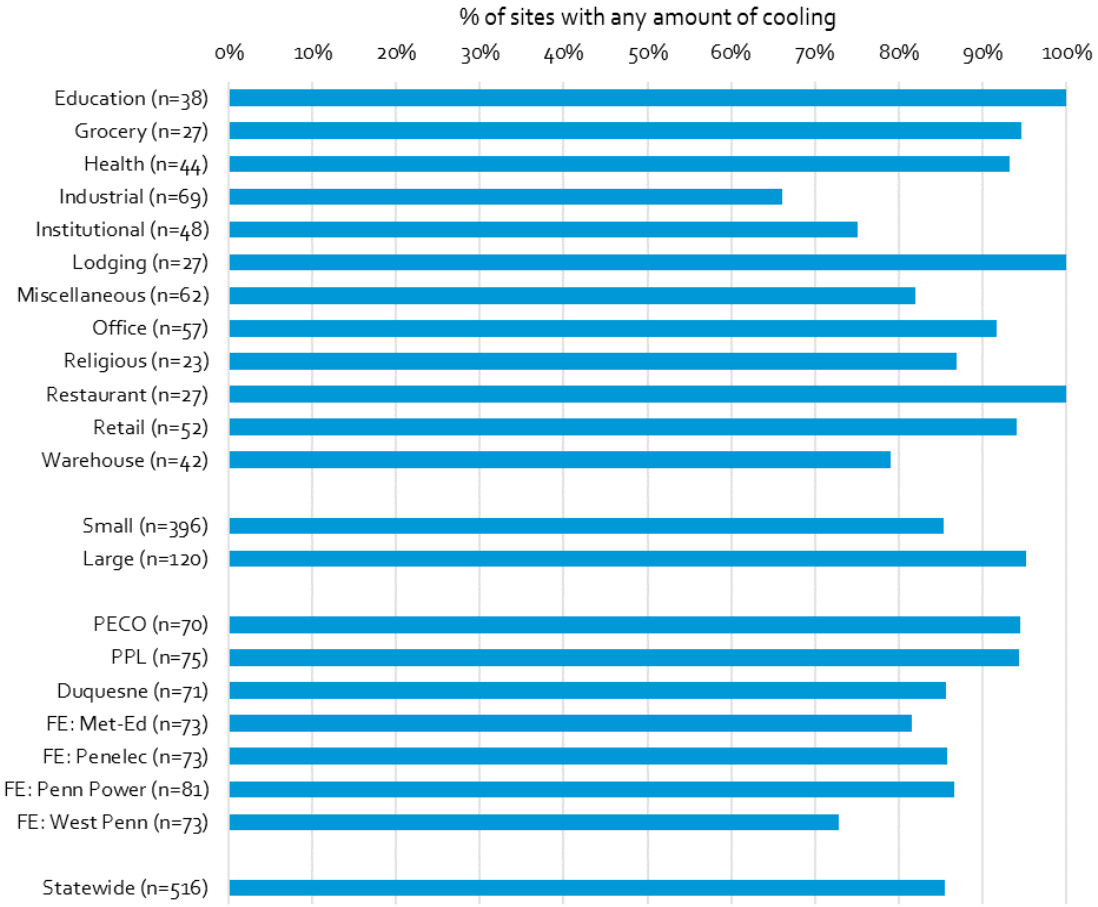
AVERAGE LPD FOR EXISTING BUILDINGS VS. IECC 2018 STANDARDS



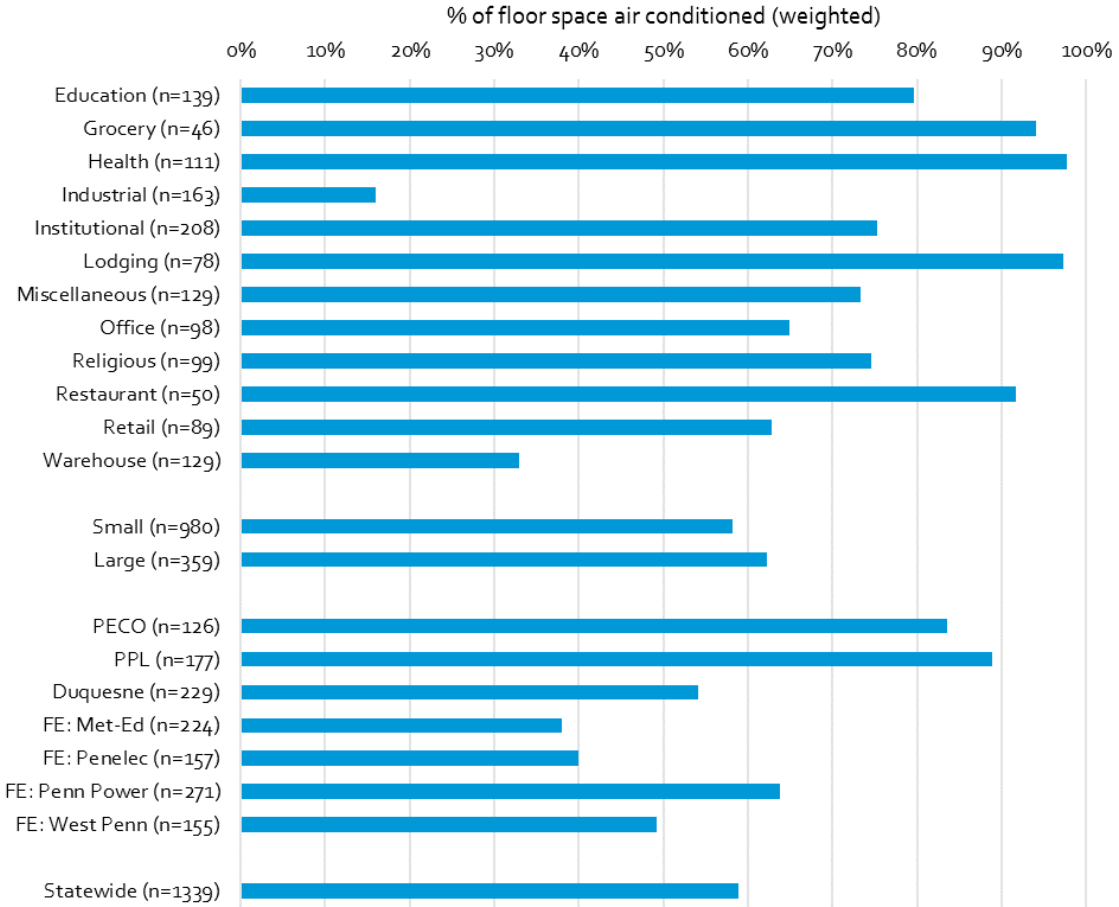
HVAC - COOLING

85% OF SITES HAVE SOME COOLING. 59% OF FLOOR SPACE IS AIR CONDITIONED

Cooling Penetration



Cooling Saturation



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COOLING ANALYSIS IS SEGMENTED BY EQUIPMENT TYPE

- **Central plant (Chillers)**: Unit covers a larger area, potentially an entire building and controls a distribution of cooling to different rooms
  - Study results are segmented by air-cooled or water-cooled
  - Account for 75% of cooling capacity for Large C&I customer sites, compared to only 15% for Small C&I
- **Unitary**: Individual unit installed to serve a dedicated space
  - Direct expansion rooftop units (RTUs) are the most common. Unitary systems include heat pump variations, window units, and packaged terminal air conditioners.
  - Make up 65% of cooling capacity statewide

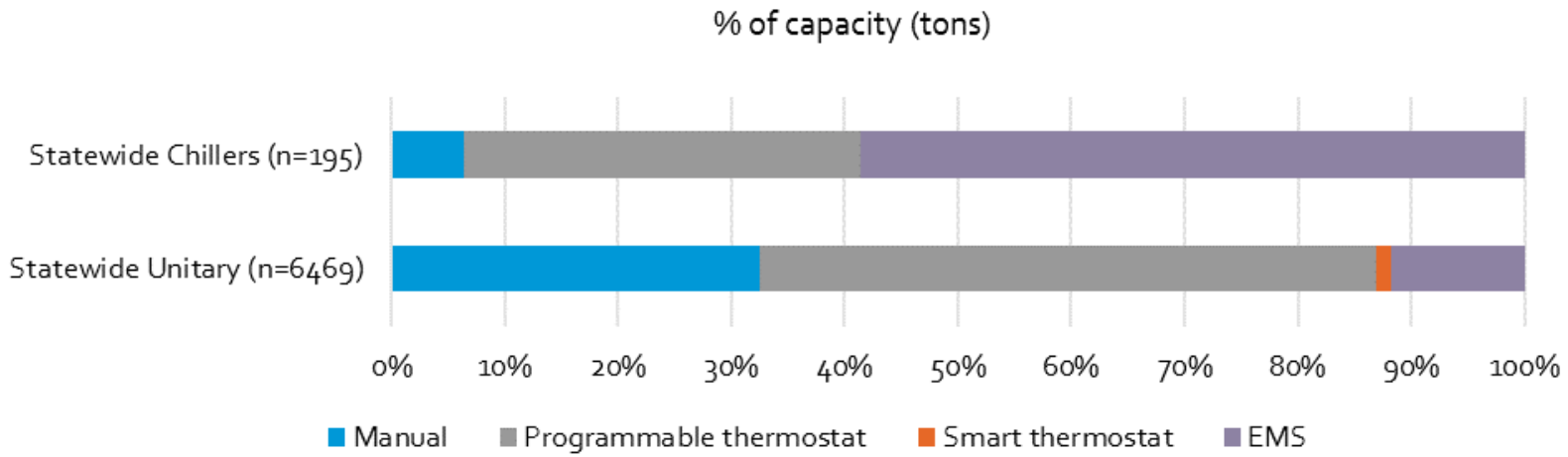
AVERAGE SIZE AND EFFICIENCY BY COOLING SYSTEM TYPE

- Engineers collected capacity and efficiency from equipment nameplates
- We use tons as the capacity metric (12,000 BTU/hour)
- Efficiency ratings were collected in various metrics (SEER, EER, IPLV, CEER) and converted to kW-per-ton for analysis

System Type	Average Tonnage	kW per Ton	n-value
Air-Cooled Chiller	53.6	0.99	71
Water-Cooled Chiller	410.5	0.57	68
All Chillers	**112.4**	**0.80**	**139**
Air Source Heat Pump	3.7	0.84	730
DX Cooling only	6.0	0.96	1,838
Ductless Mini Split	1.5	1.13	266
Ground Source Heat Pump	2.4	0.80	377
Packaged Terminal/Window Unit	0.9	0.97	3,191
All Unitary	**4.1**	**0.93**	**6,402**

CONTROLS BY COOLING SYSTEM TYPE

- Chillers are far more likely to be controlled by EMS
- One-third of unitary cooling capacity is controlled manually
- Wi-Fi smart thermostats are rare, but show promise for cooling savings



Set points (F°) by AC control type

AC Control Type	Unoccupied	Occupied	Difference
Manual (n=1,294)	72.8	71.4	+1.4
Programmable (n=1,001)	71.8	71.0	+0.8
Smart (n=24)	79.7	73.6	+6.1
EMS (n=1,156)	74.4	71.9	+2.5

Setback is highest for smart thermostats

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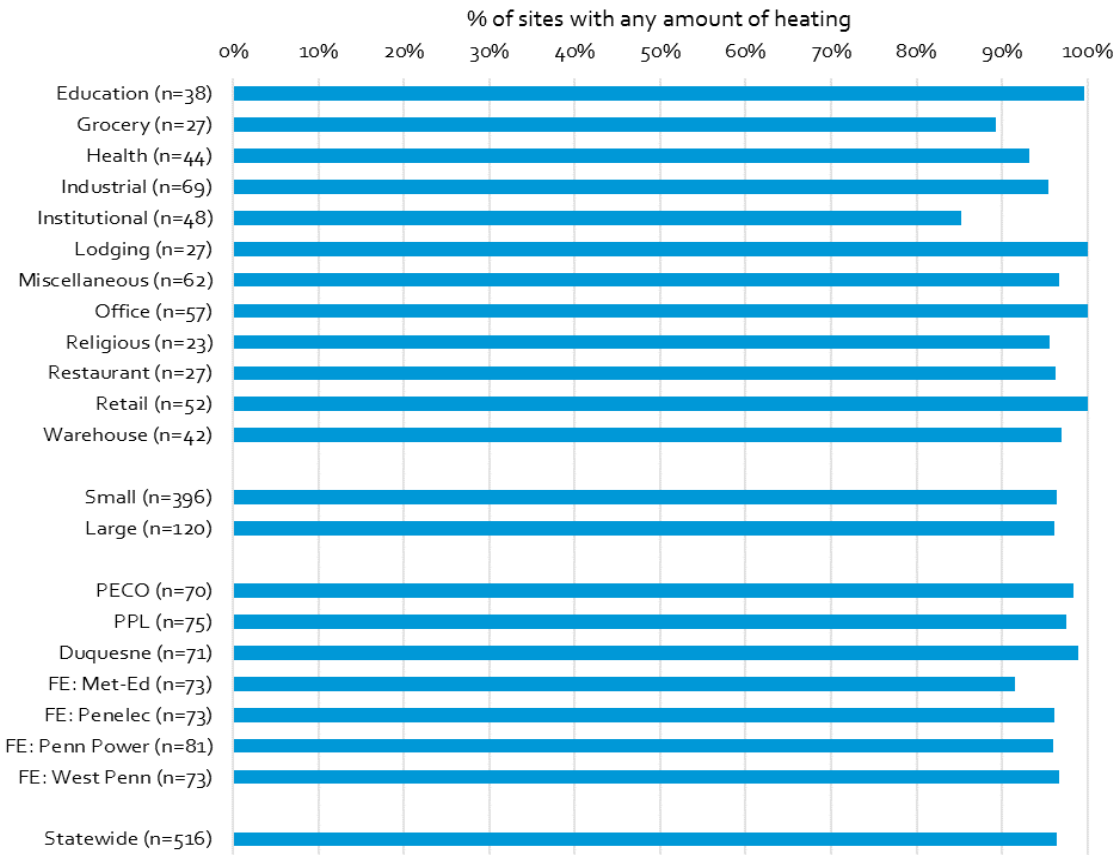
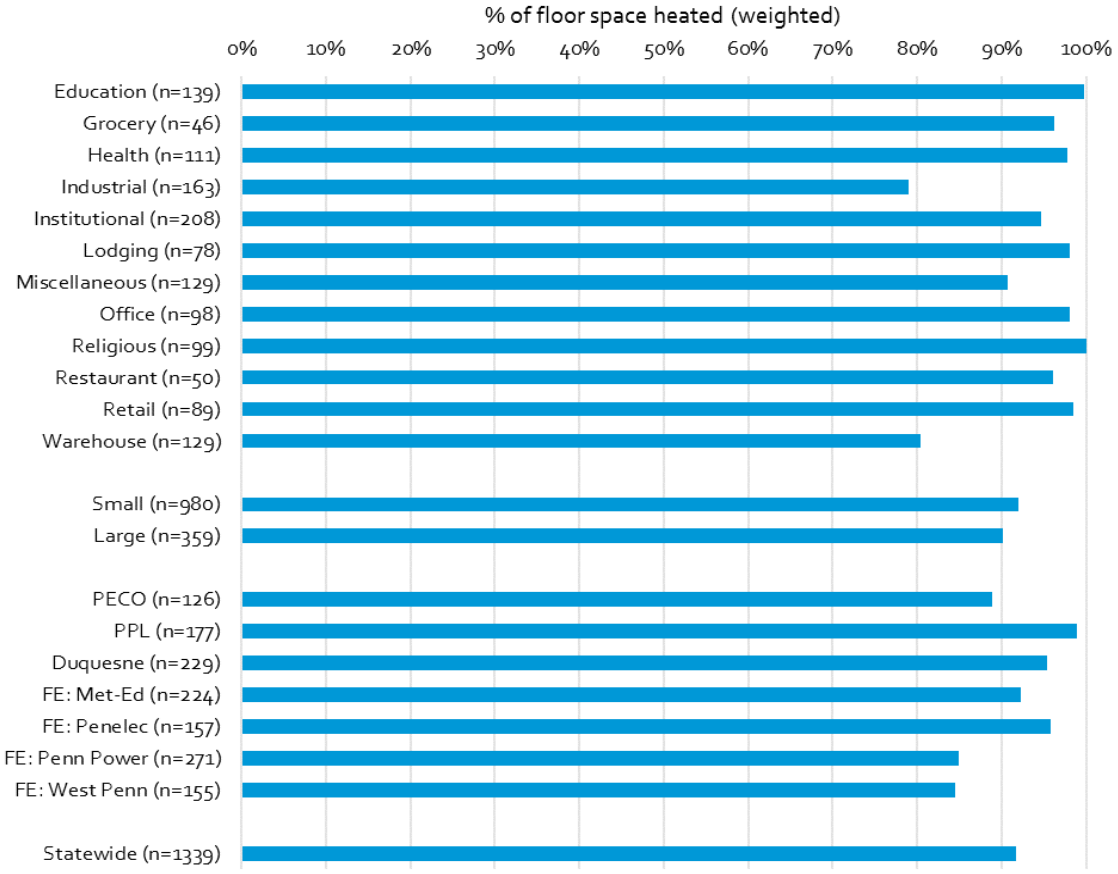
HVAC - HEATING

THE DIFFERENCE BETWEEN PENETRATION AND SATURATION IS LESS PRONOUNCED FOR HEATING

Heating Penetration



Heating Saturation



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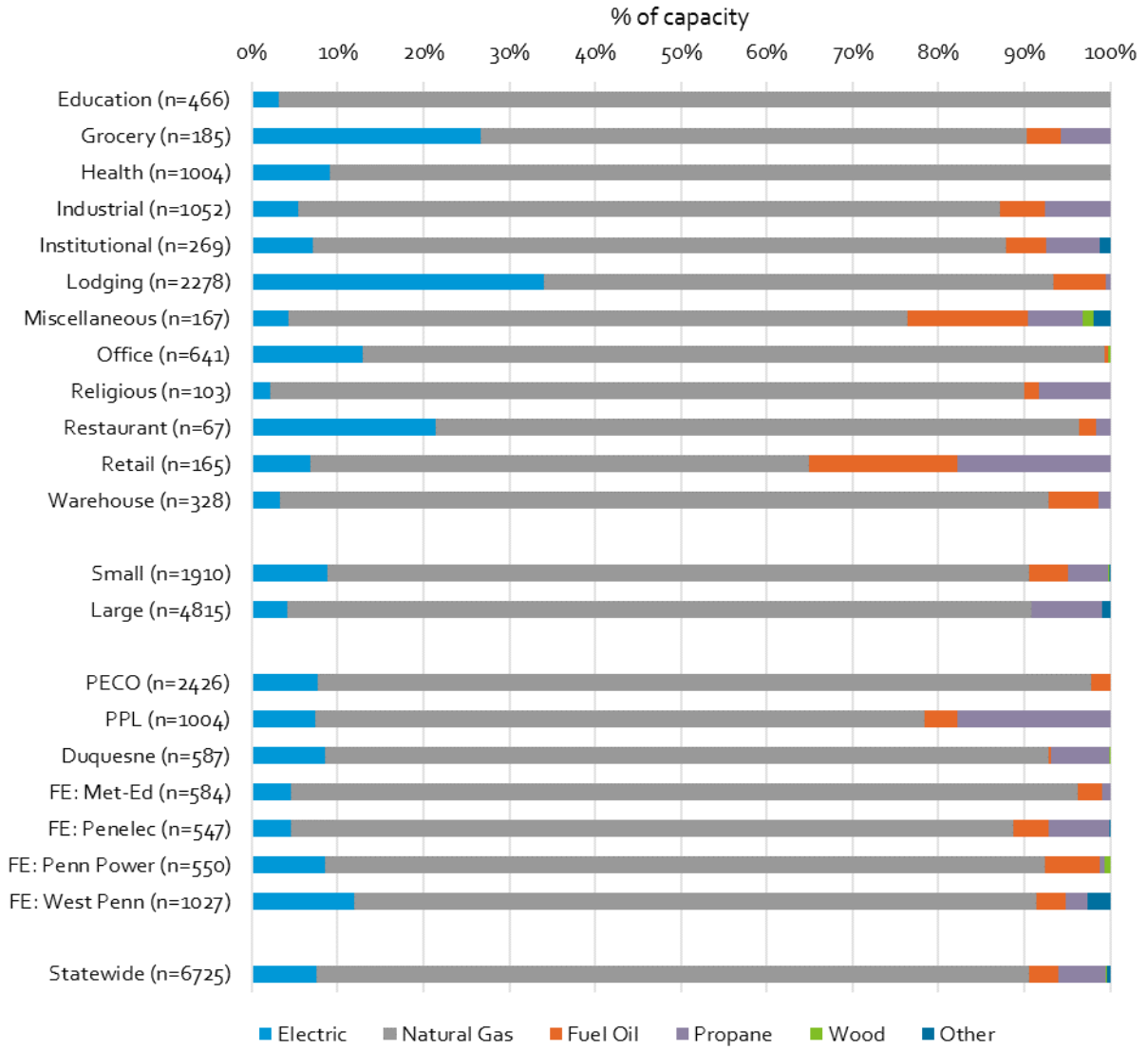
NON-RESIDENTIAL HEATING IS MOSTLY ON-SITE FOSSIL FUEL COMBUSTION

- Standardize input and output capacity across fuels
- 83% of heating capacity is natural gas
- Only 7% is electric statewide
  - More common in the Small C&I sector
  - Lodging, Grocery, and Restaurant exceed 20% electric heat



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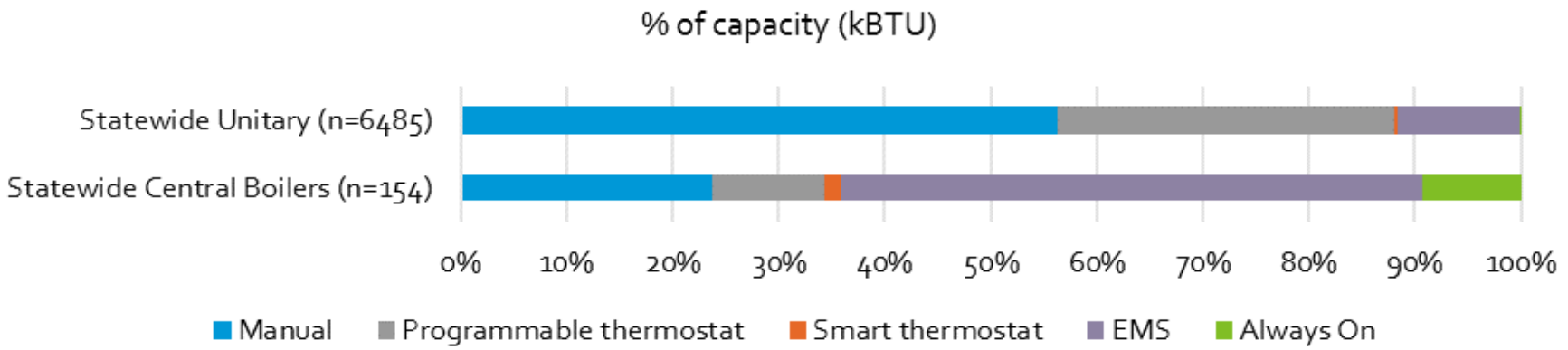
OVER HALF OF UNITARY HEATING SYSTEMS MANUALLY CONTROLLED



Set points (F°) by Heating control type

Heating Control Type	Unoccupied	Occupied	Difference
Manual (n=1,344)	63.9	65.3	-1.4
Programmable (n=688)	66.4	69.0	-2.6
Smart (n=8)	62.9	64.2	-1.2
EMS (n=1,254)	67.8	68.0	-0.2

Very few smart thermostats. EMS are often not programmed to lower the heating setpoint during unoccupied periods

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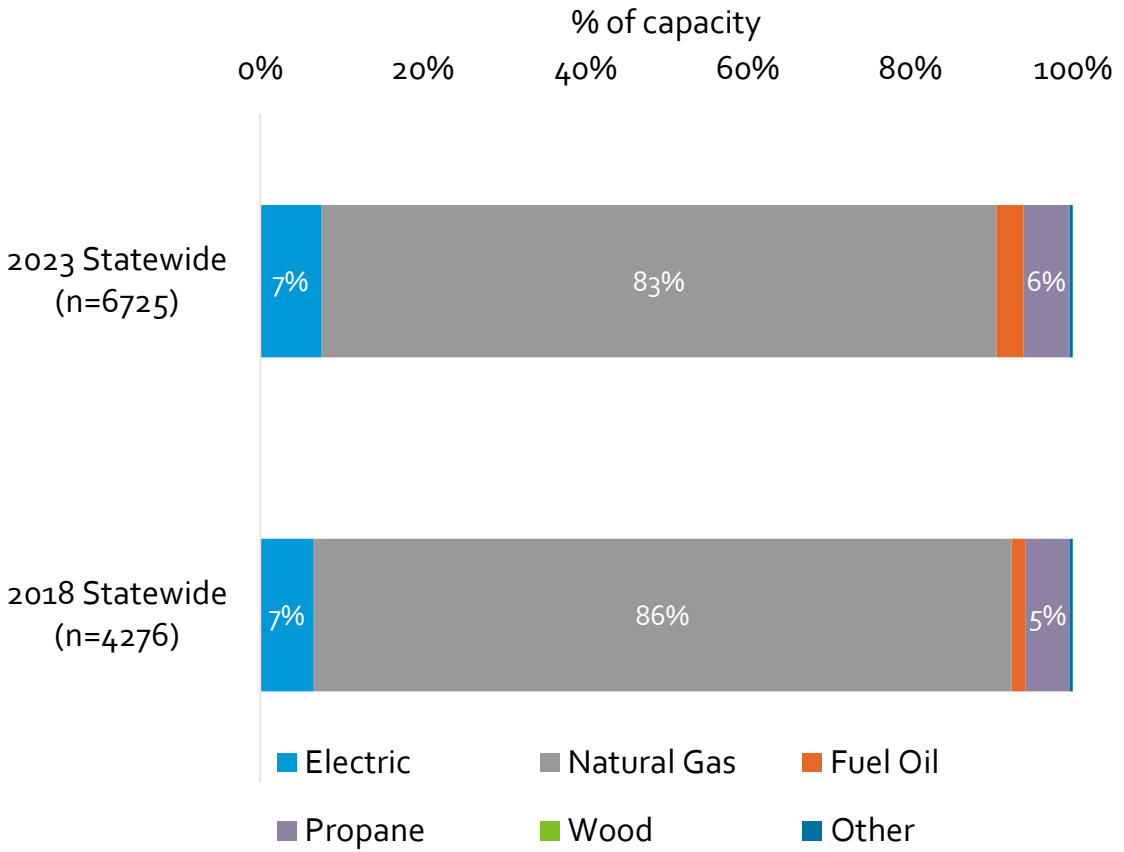
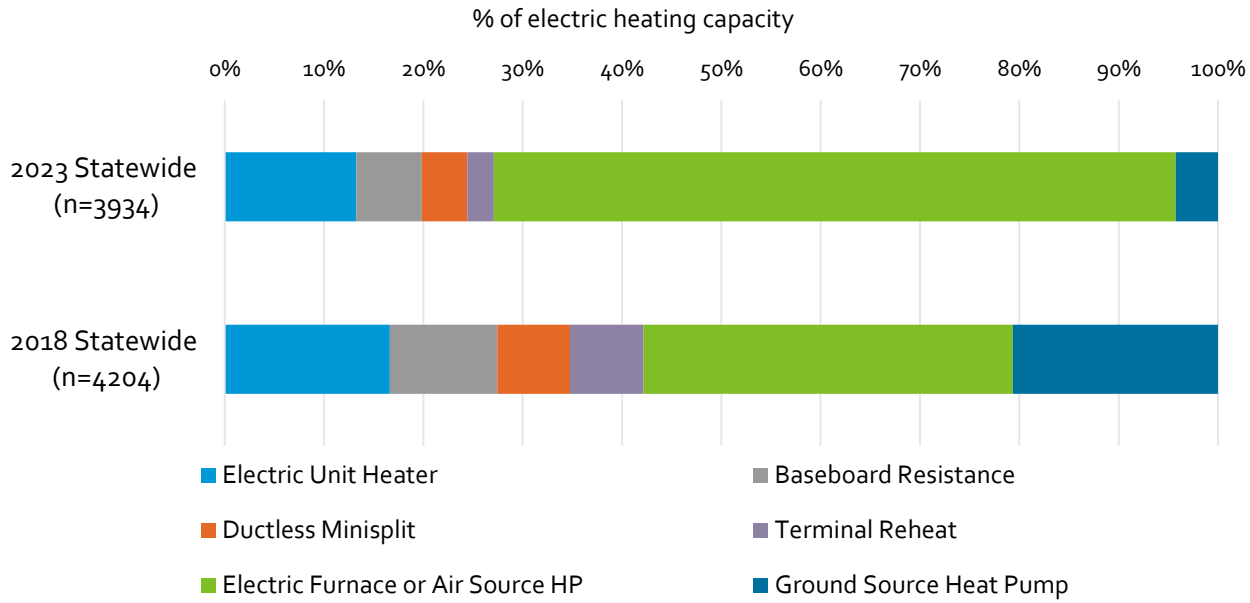
MINIMAL CHANGES IN HEATING SINCE 2018

Comparison of Heating Fuel Shares: 2023 vs. 2018



Electric Unitary Breakdown

- Capacity shares of heat pumps are lower in the 2023 study than the 2018 baseline study.
- Program opportunity to convert resistance heat to heat pump



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HVAC EQUIPMENT AGES

HVAC System Age (by Equipment Type)

Equipment Type	n	Mean Age	Median Age
Heating			
Central Boiler	105	21	18
Unitary (Combustion)	624	10	8
Unitary (Electric)	1,443	18	18
Cooling or Cooling + Heating			
Chiller	139	11.5	8
Air Source Heat Pump	268	9	11
DX Cooling	969	12	13
Ductless Mini Split	62	6	5
Ground Source Heat Pump	24	18	18
Packaged Terminal	1,076	13	13

Cooling Unit Age (by Sector)

Sector	Mean Age	Median Age
Large (n=1,711)	14.2	13.0
Small (n=746)	9.9	9.0
Statewide (n=2,457)	**10.3**	**10.0**

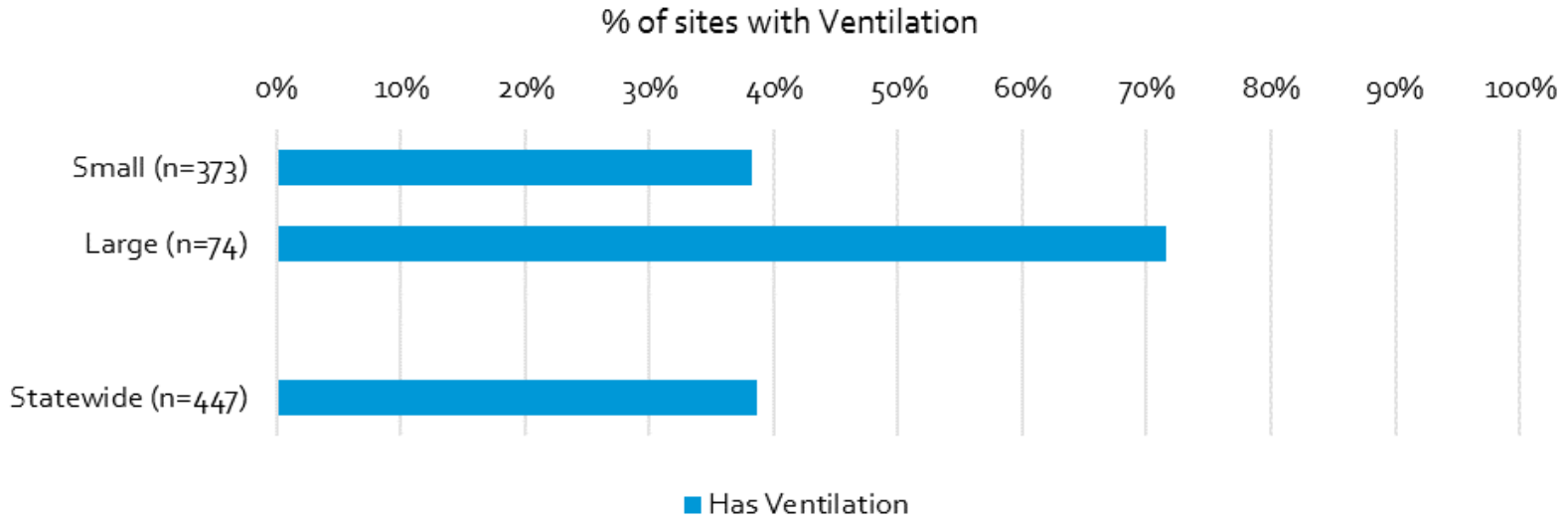
Heating Unit Age (by Sector)

Sector	Mean Age	Median Age
Large (n=1,455)	23.2	22.0
Small (n=716)	13.8	10.0
Statewide (n=2,171)	**20.1**	**13.0**

VENTILATION

VENTILATION GETS A DEDICATED CHAPTER IN THE 2023 STUDY

- Excludes Industrial ventilation. That is assigned to the process end use
- Technicians only recorded "built-up" ventilation equipment
  - Excludes the fans integrated in rooftop or other package units
- Twice as common in Large C&I inventories compared to Small C&I (38%)



EUI Inputs

1 HP of ventilation for every 1400 ft² of floor space

1 HP of ventilation for every 2.58 tons of cooling

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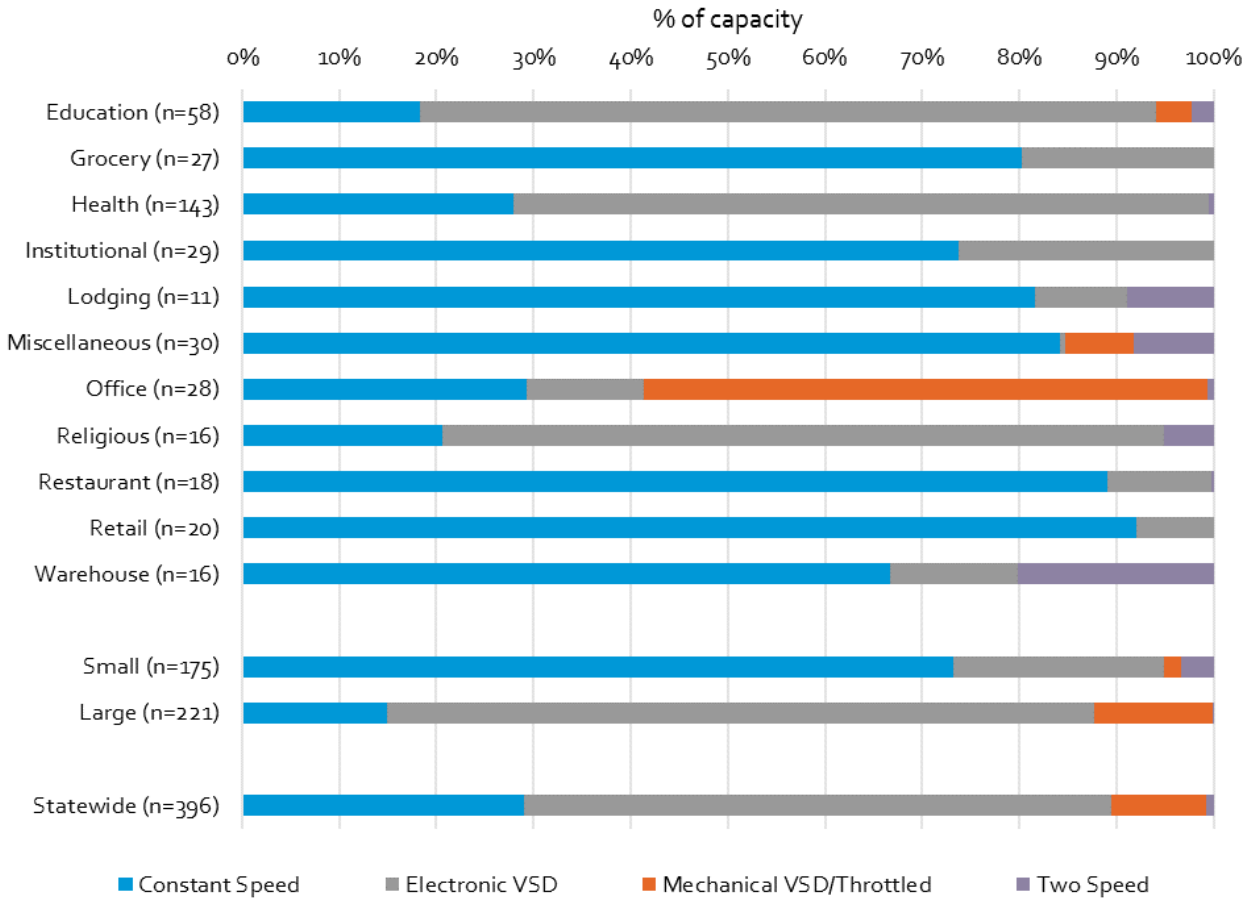
VARIABLE SPEED FANS ARE FAR MORE PREVALENT IN THE LARGE C&I SECTOR

- Capacity = Horsepower
- Chart omits ventilation equipment with missing capacity
- Mechanical = pneumatics
  - ➢ Results for the Office segment are driven by two large sites

Distribution of Motor Control Type (by Capacity)



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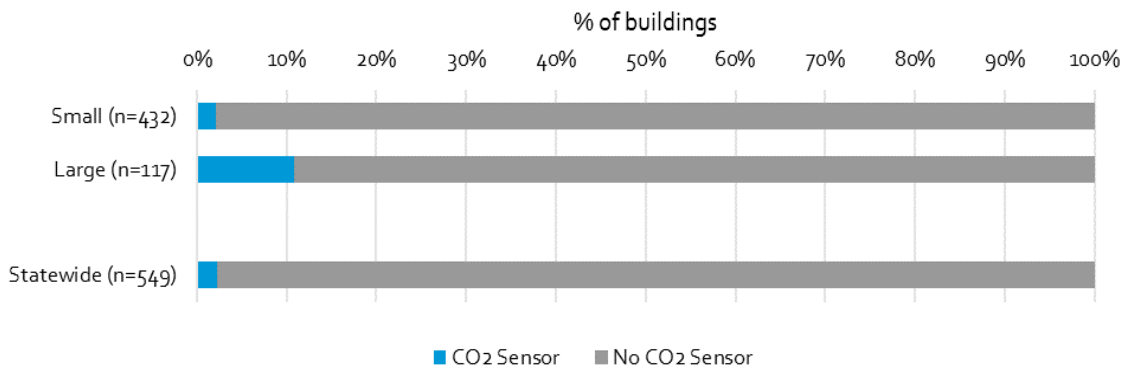
PREVALENCE OF POTENTIAL CONSERVATION TECHNOLOGIES

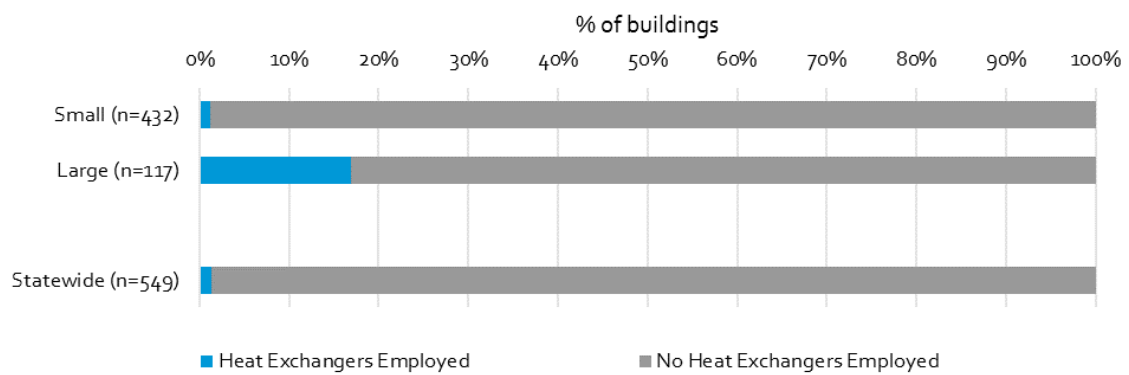
Air Quality and Efficiency Features were Uncommon in the Sample

- CO_2 sensors help balance the need for fresh outside air with retention of conditioned air
- Heat exchanger technology like energy recovery ventilators (ERVs) or heat recovery ventilators (HRVs) transfers heat between incoming and outgoing airstreams

Ventilation Controlled by CO_2 Sensors



Share of Buildings with Heat Exchangers



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DOMESTIC HOT WATER

> 90% OF PA BUSINESSES HAVE AT LEAST ONE WATER HEATER

- We analyze hot water heating systems by:
  1. **Type**
     - Large/Central (including boilers)
     - Unitary (Residential style)
     - Small/Point-of-Use
  2. **Tank Type**
     - Tank
     - Tankless
  3. **Fuel**

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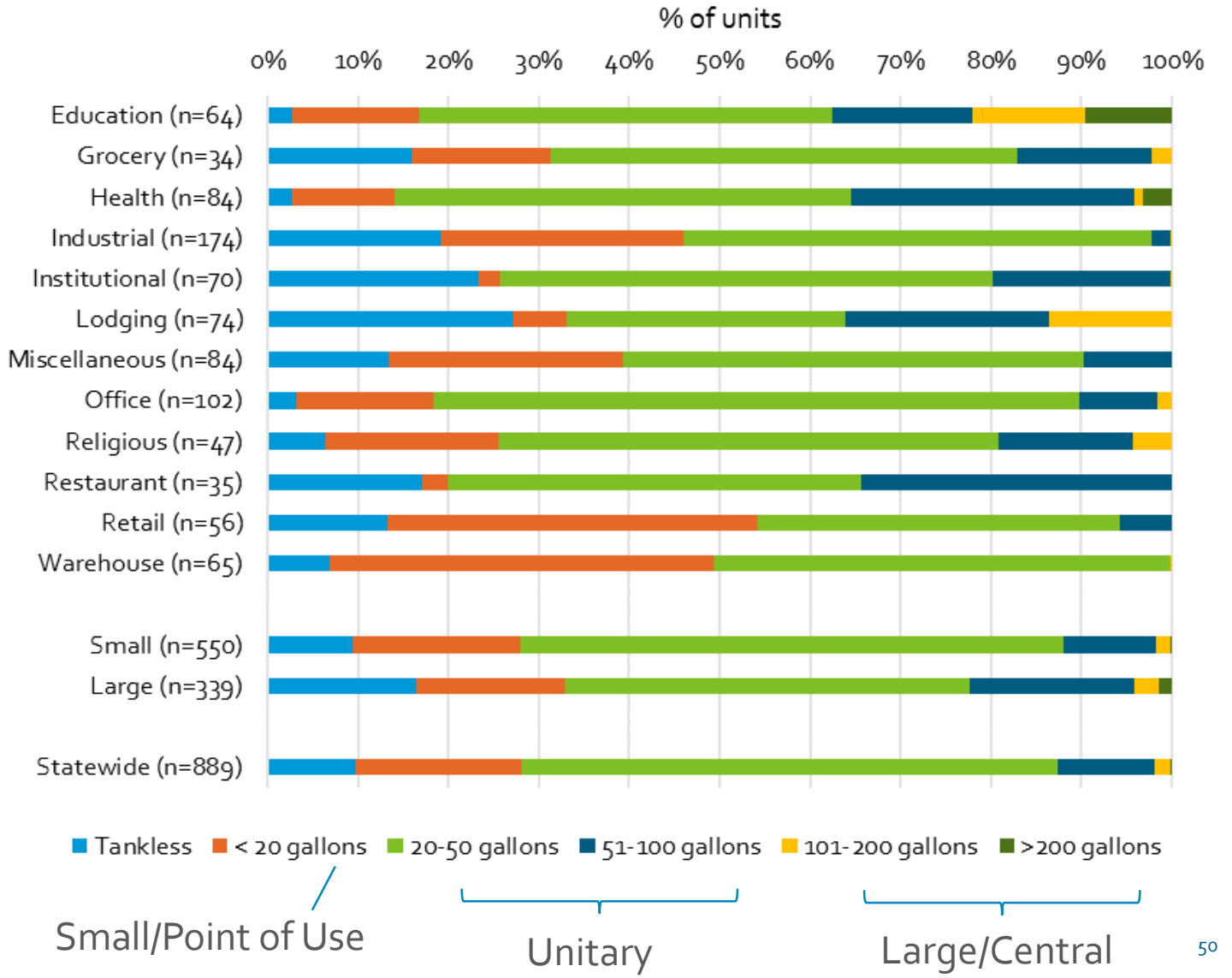
MOST WATER HEATERS UNITARY WITH TANK

- 10% of units are tankless
  - Increase from 2018
  - Lodging had the highest fraction of tankless water heaters
- Most units unitary with tank (green + navy in graph)
- Significant number of Small/Point-of-Use



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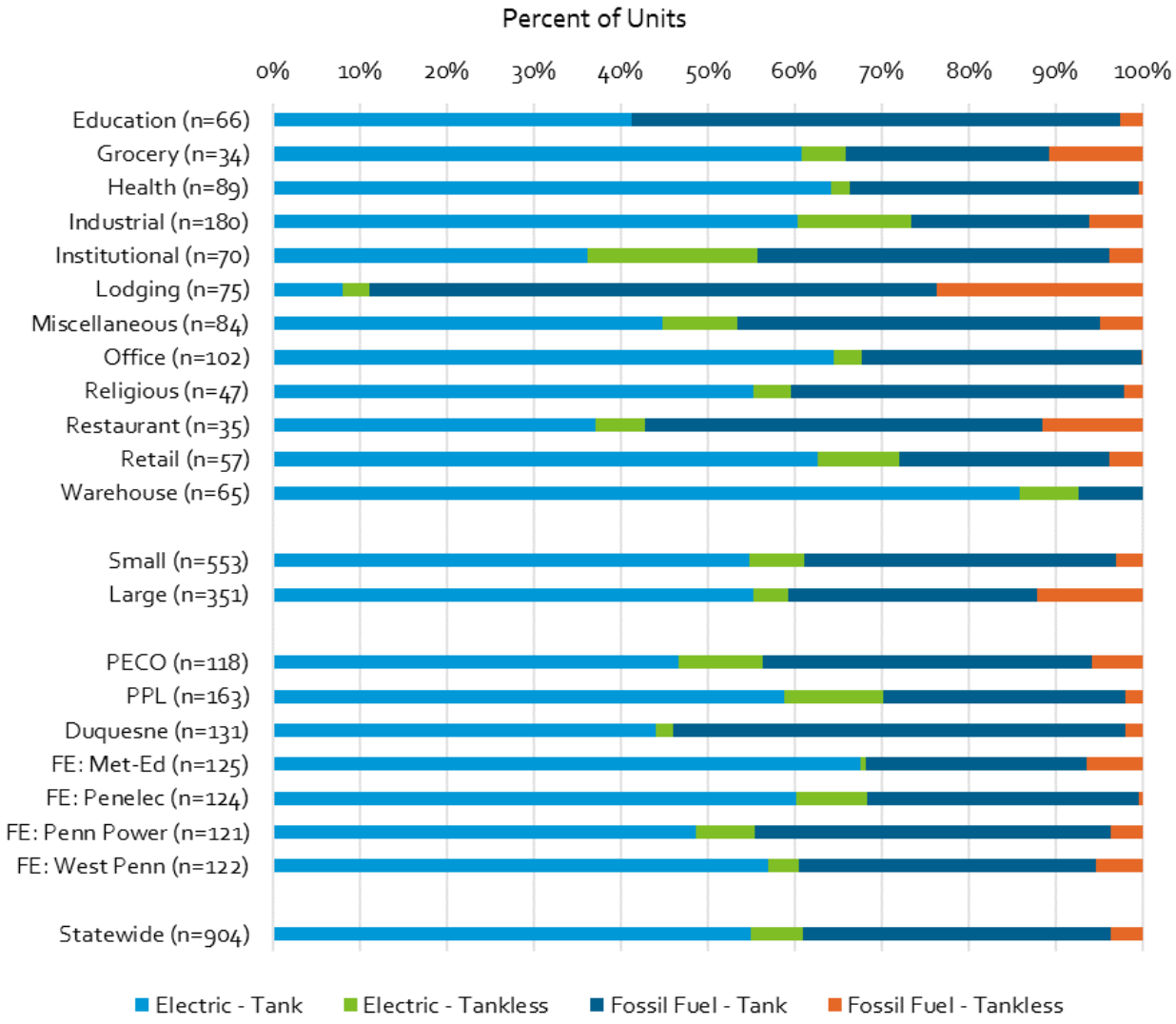
61% OF WATER HEATING UNITS ARE ELECTRIC

- 61% of water heaters are electric
  - ➢ Most Large/Central water heaters use fossil fuels
  - ➢ 49% of water heating electric by capacity (gallons)
- About same splits for unitary water heaters (58% electric)
  - ➢ Only one heat-pump water heater in the sample
- All small/point-of use water heaters were electric



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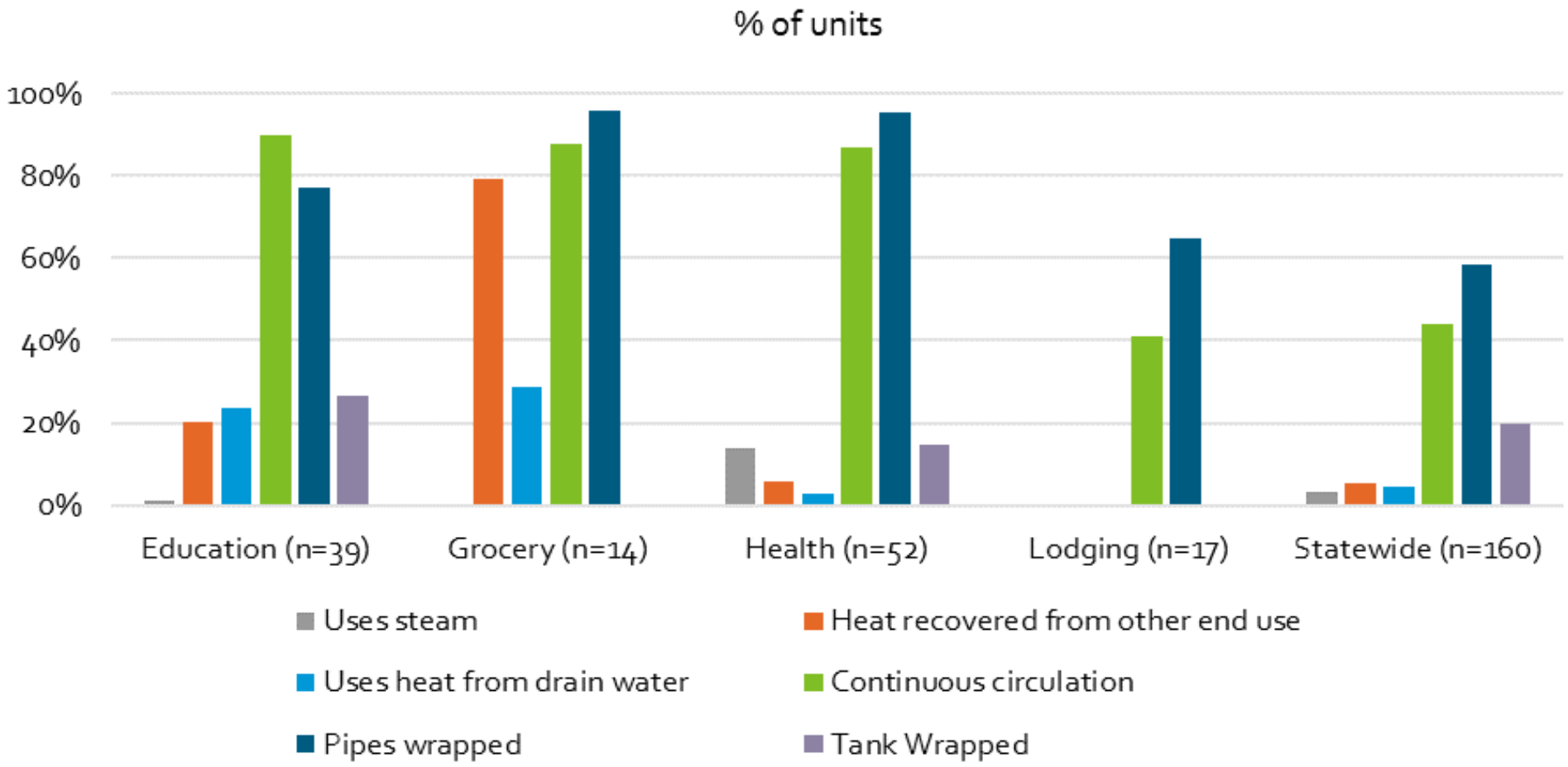
EFFICIENT CHARACTERISTICS FOR LARGE/CENTRAL UNITS



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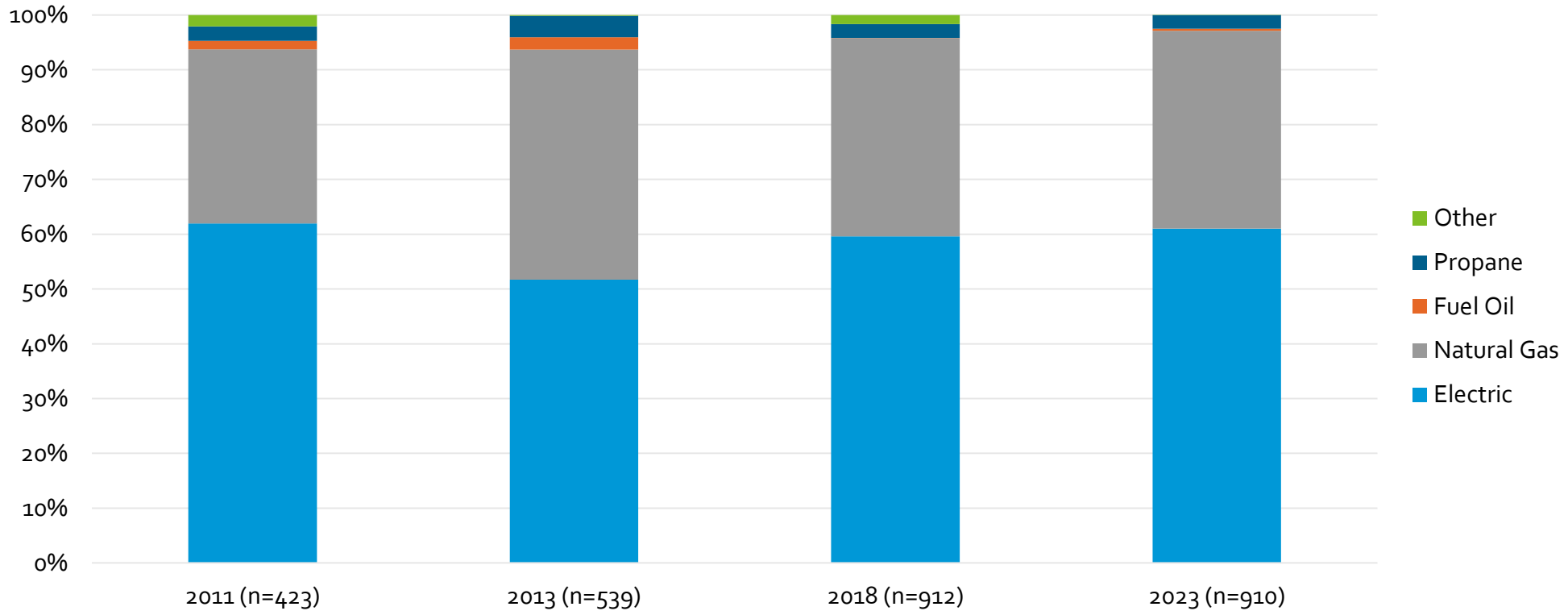
DHW FUEL SHARES HAVE BEEN STABLE OVER TIME



Comparison of Domestic Hot Water Fuel Shares by Equipment Count, 2011-2023

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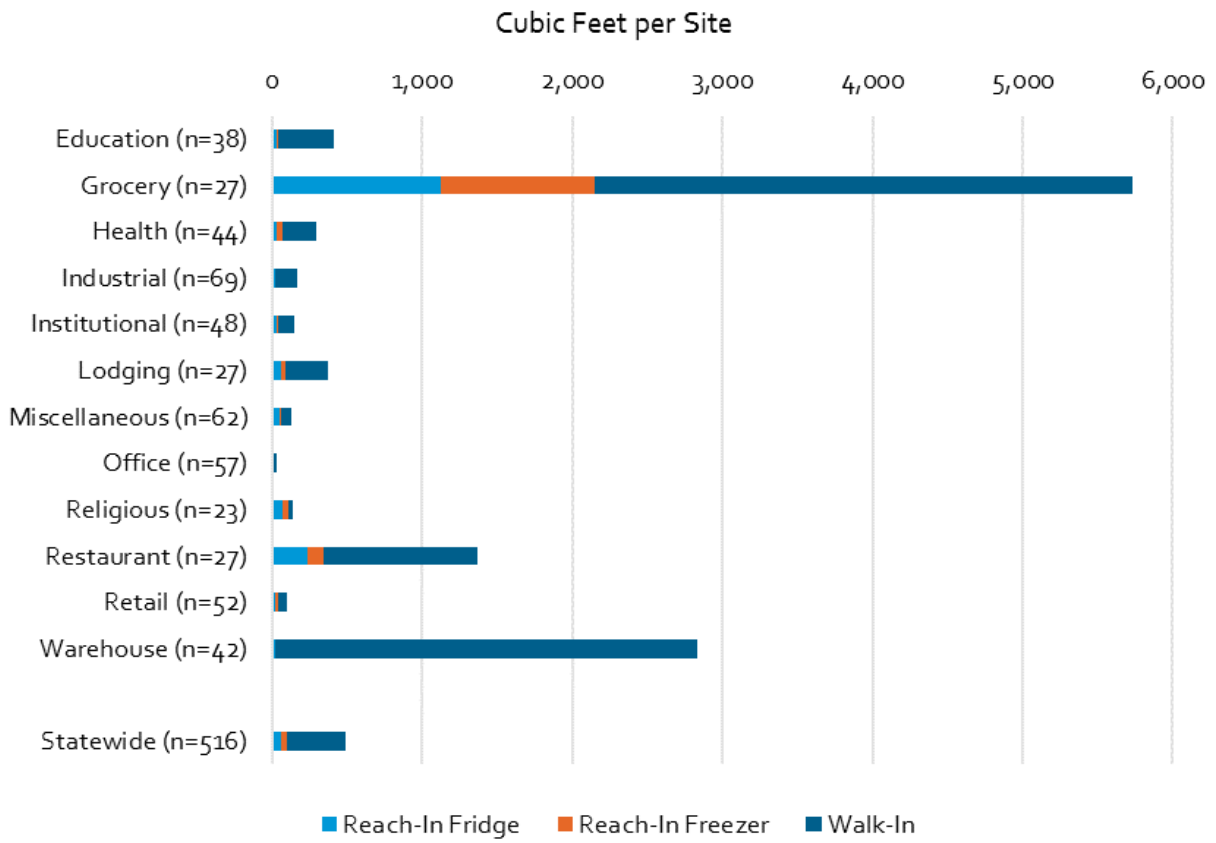
REFRIGERATION

COMMERCIAL REFRIGERATION IS CONCENTRATED IN SPECIFIC SEGMENTS



Refrigeration Types

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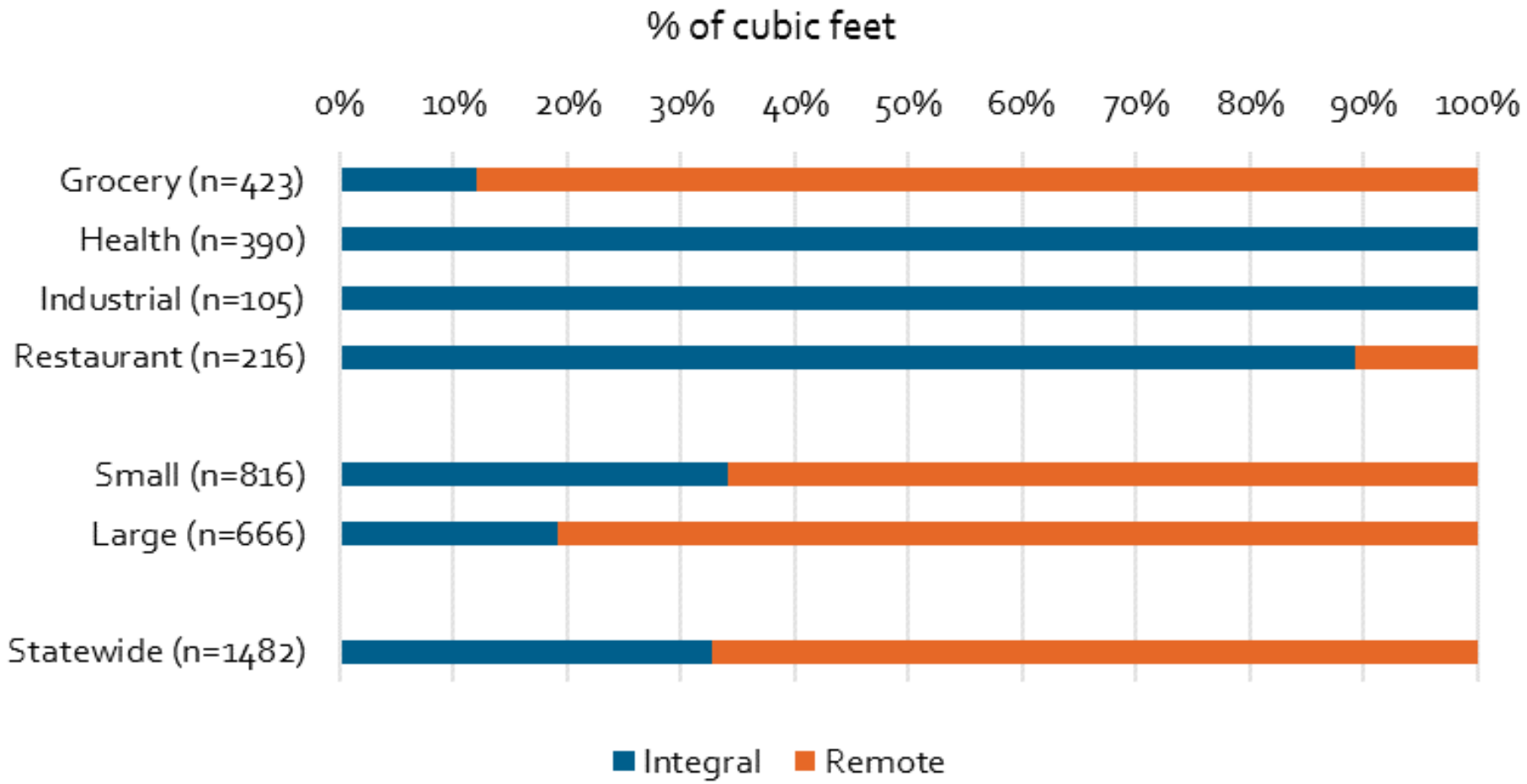
MOST REACH-IN FRIDGES HAD REMOTE COMPRESSORS



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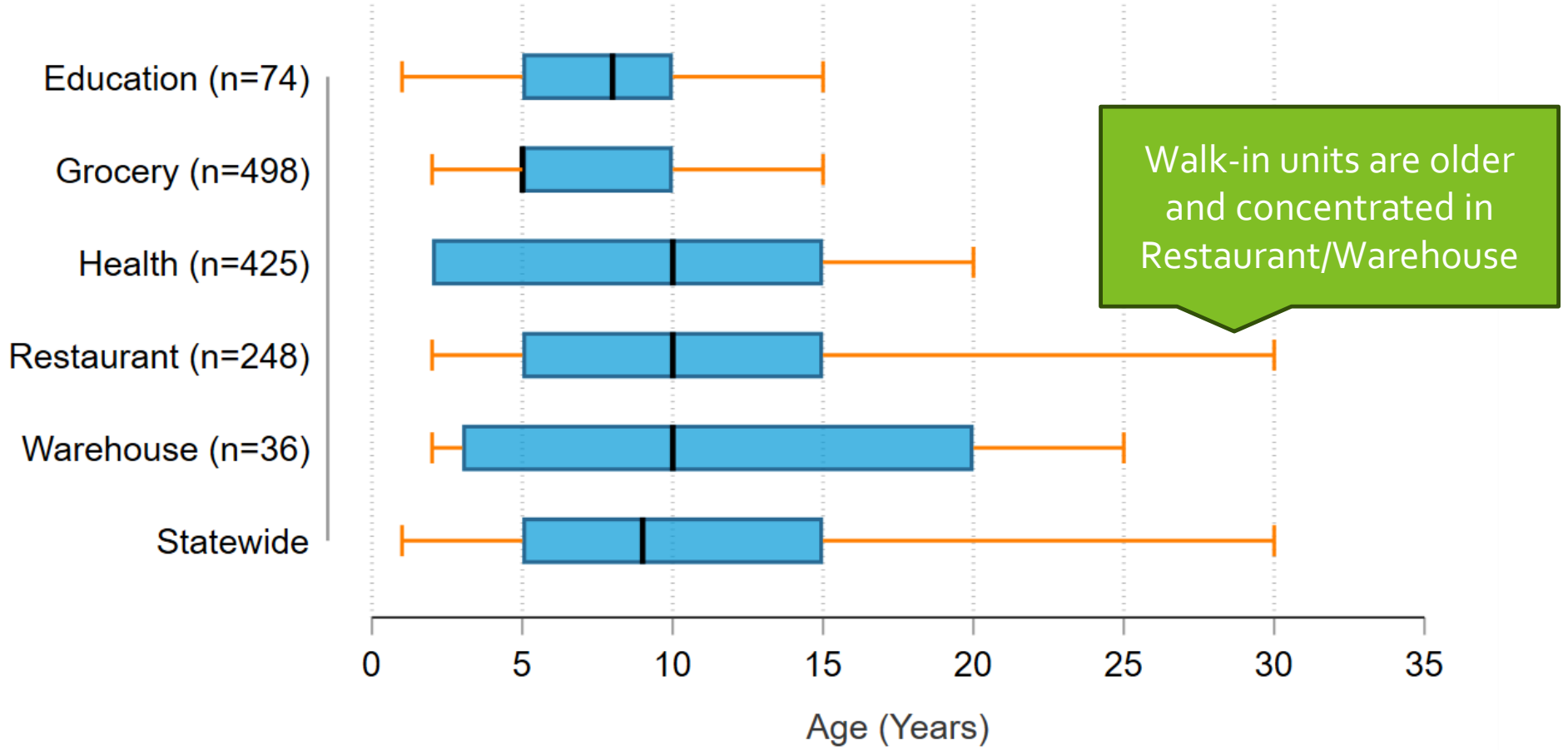
MOST REFRIGERATORS/FREEZERS < 10 YEARS OLD



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OPTIONAL CHARACTERISTICS FOR REACH-IN UNITS

- LEDs in most units
- Most glass doors have anti-sweat heaters
  - Add to load
  - Most don't have controls
- Motion sensors uncommon

Category	LED Lights	Motion Sensors	Demand Defrost Controls (Freezers)	Anti-Sweat Heaters (Glass doors)	Anti-Sweat Heating Control
Education (n= 50)	64%	1%	38%	95%	9%
Grocery (n= 423)	87%	9%	8%	88%	25%
Health (n= 390)	47%	7%	35%	0%	52%
Restaurant (n= 216)	55%	3%	21%	75%	50%
Small (n= 816)	71%	6%	13%	81%	26%
Large (n= 666)	72%	15%	49%	70%	86%
Statewide (n= 1,482)	**71%**	**7%**	**14%**	**80%**	**28%**

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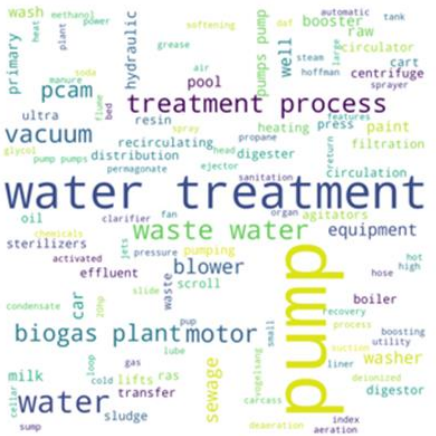
PROCESS

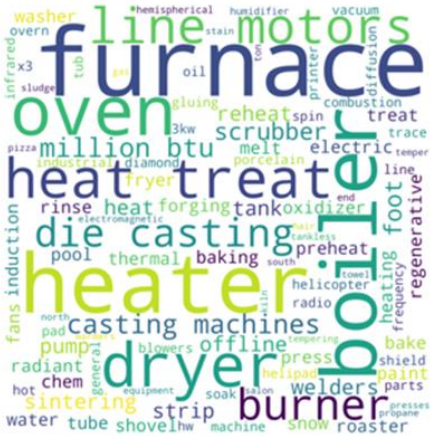
LARGEST ELECTRIC END USE IN THE INDUSTRIAL SEGMENT

- Examples of processes:
  - Chemical Treatment
  - Distillation/Refining
  - Grinding/Milling/Extraction
  - Metal Formation
  - Molding
  - Sanding and Painting
  - Process Cooling
  - Process Heating/Cooking
  - Product Assembly
  - Pumping
  - Compressed Air
  - Battery Charging
- Present in other segments, but over 90% of the capacity statewide lies in Industrial

Pumping

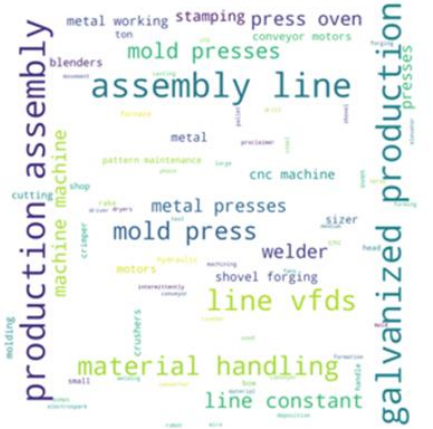


Process Heating/Cooking



Grinding/Milling/Extraction

Metal Formation



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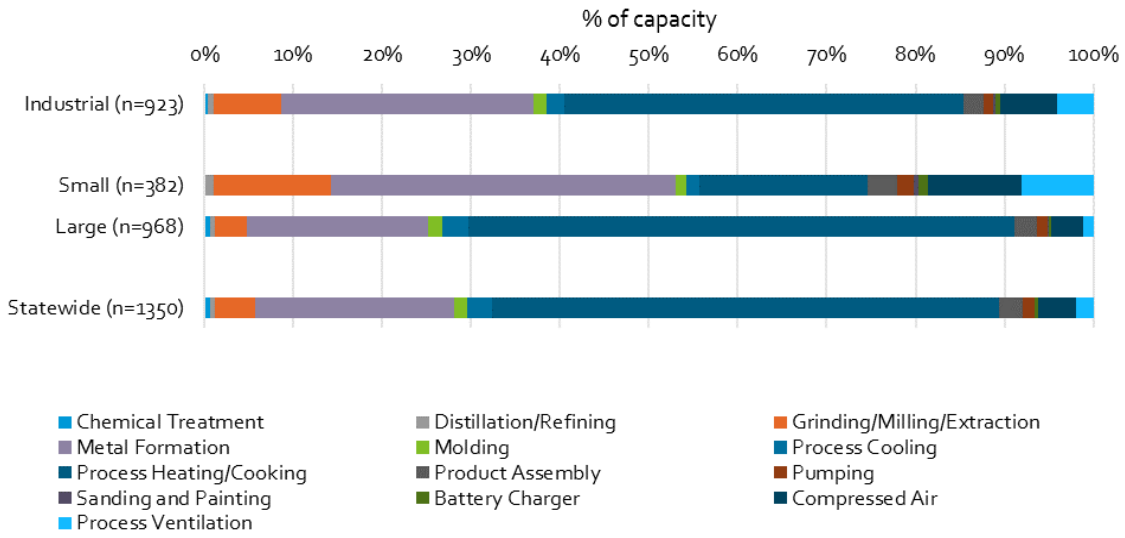
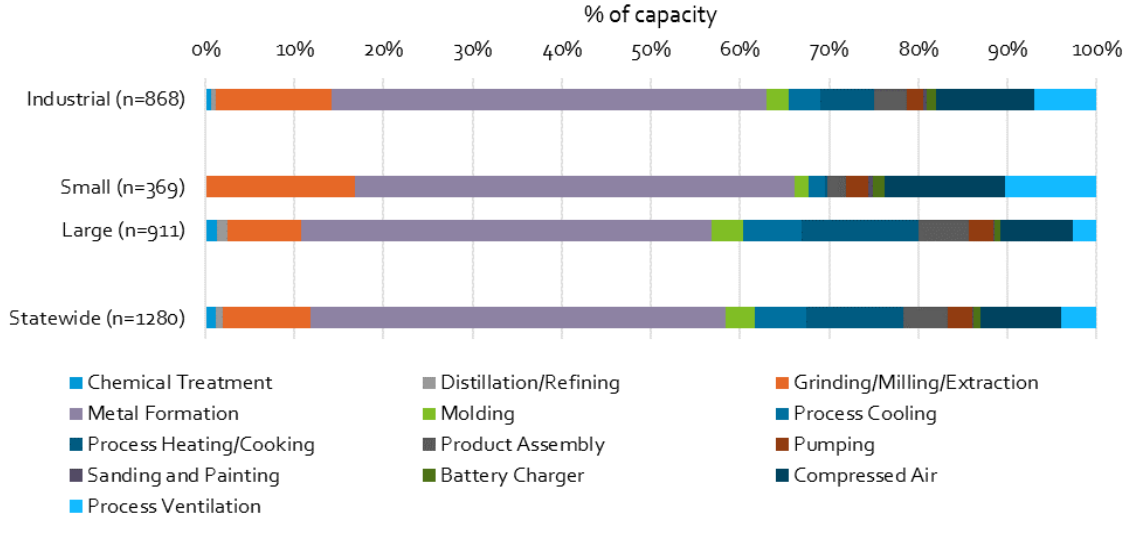
DISTRIBUTION OF PROCESS TYPE (BY CAPACITY)

All Fuels



Electric Only



Process Heating and Cooking is mostly Fossil Fuel. Other process types have a large share of electric capacity

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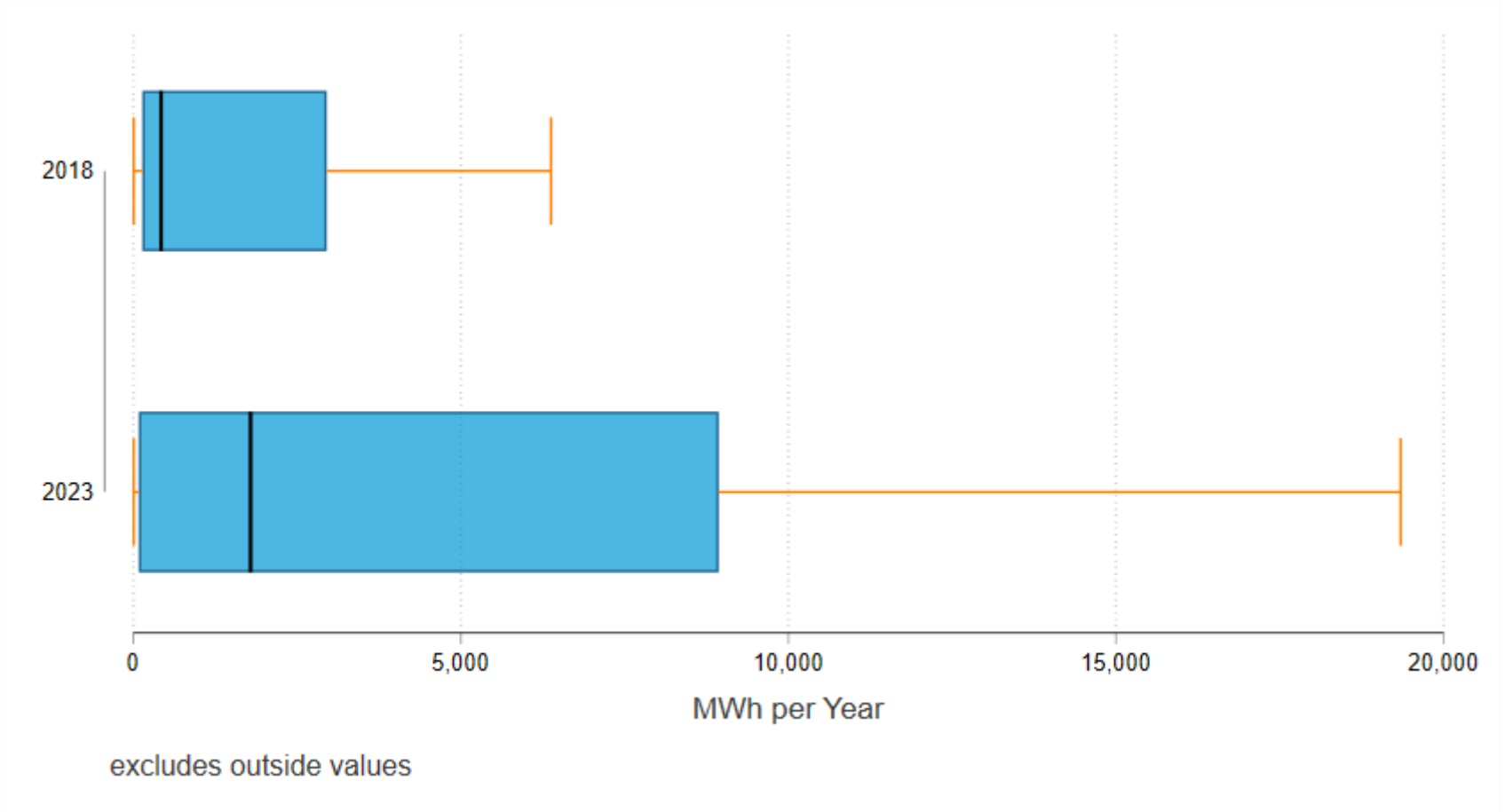
INDUSTRIAL SITES IN THE 2023 SAMPLE WERE LARGER THAN 2018



Annualized MWh for Industrial Sites, 2018 vs. 2023

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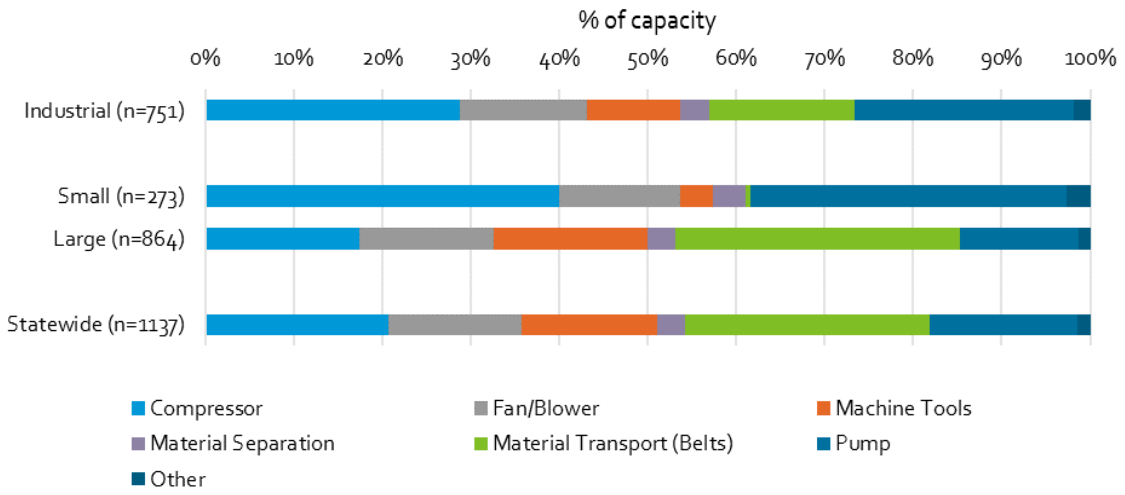
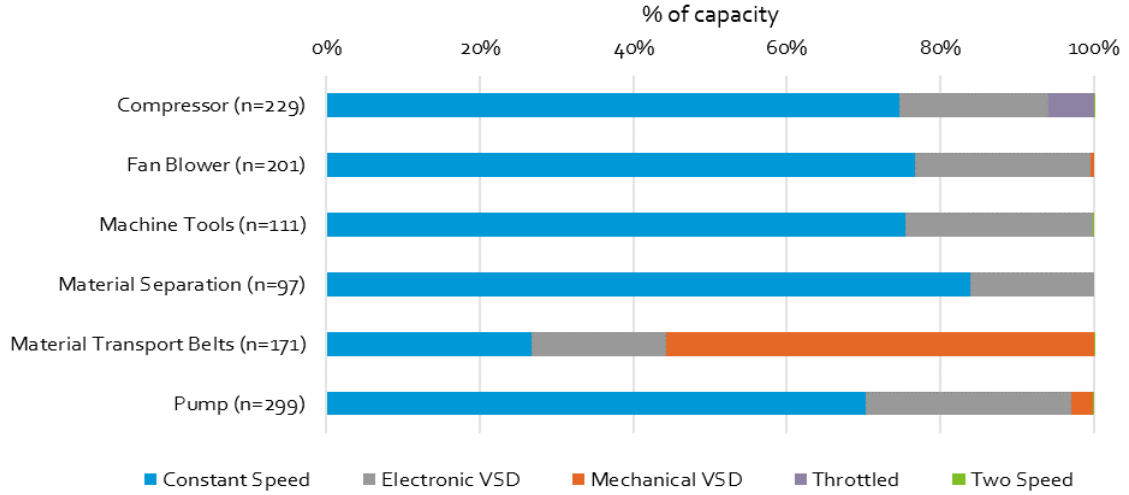
MOTOR SERVICE TYPE AND CONTROLS

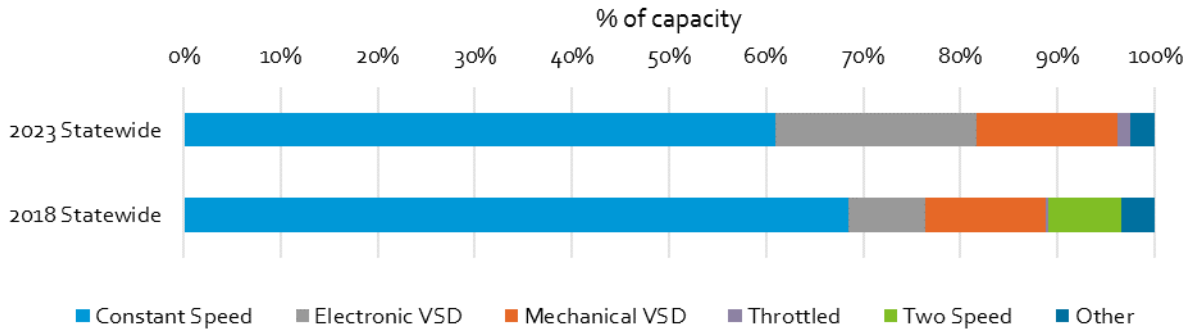
Distribution of Service Type



Motor Control by Service Type



Growth in Variable Speed Drives Since 2018



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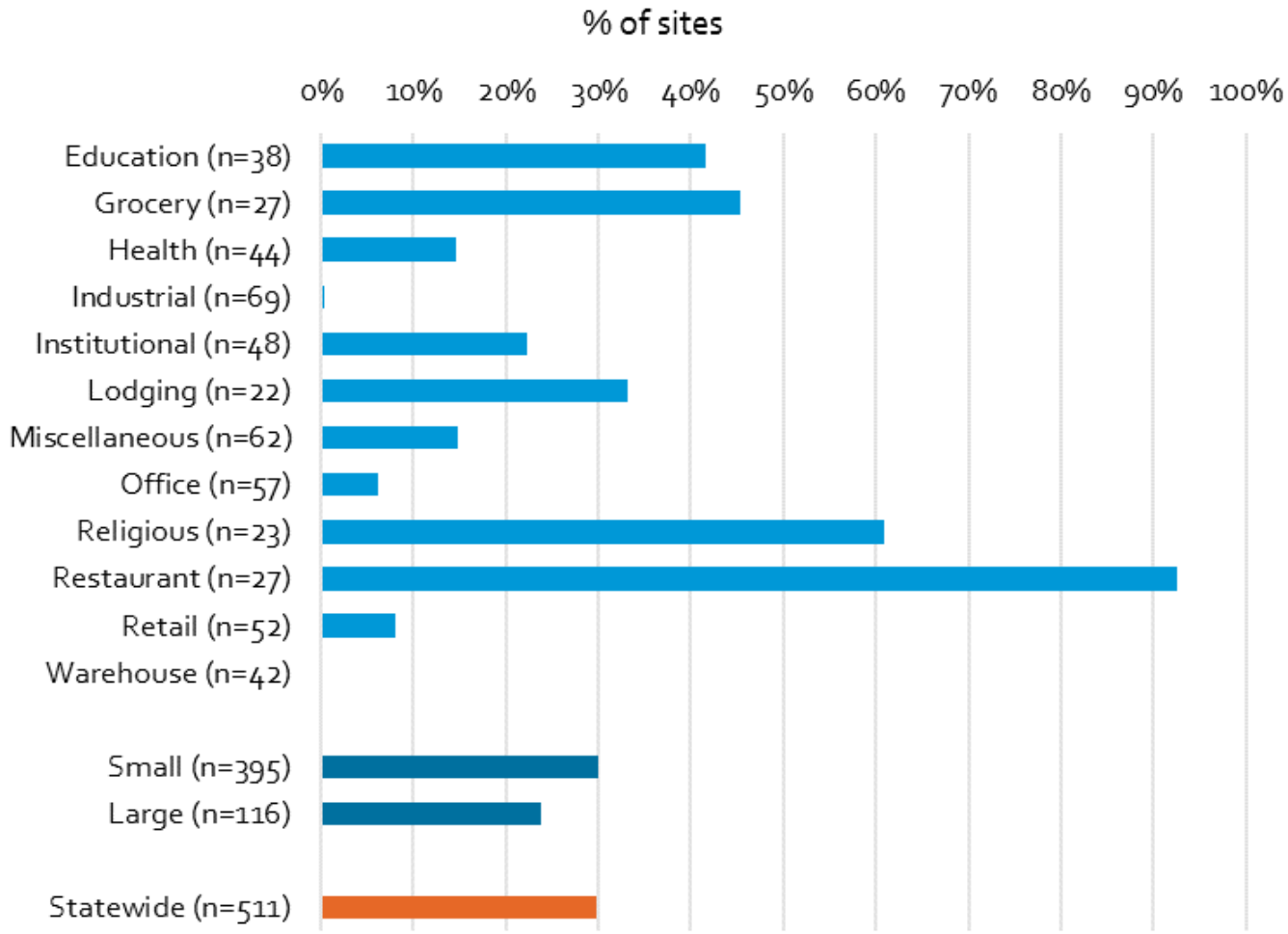
COOKING

COOKING IS CONCENTRATED IN A FEW SEGMENTS

- Restaurants, churches, grocery stores and schools most often have commercial cooking equipment
- Most appliances available in both fossil-fuel and electric models
- Penetration is low, but usage is high when present



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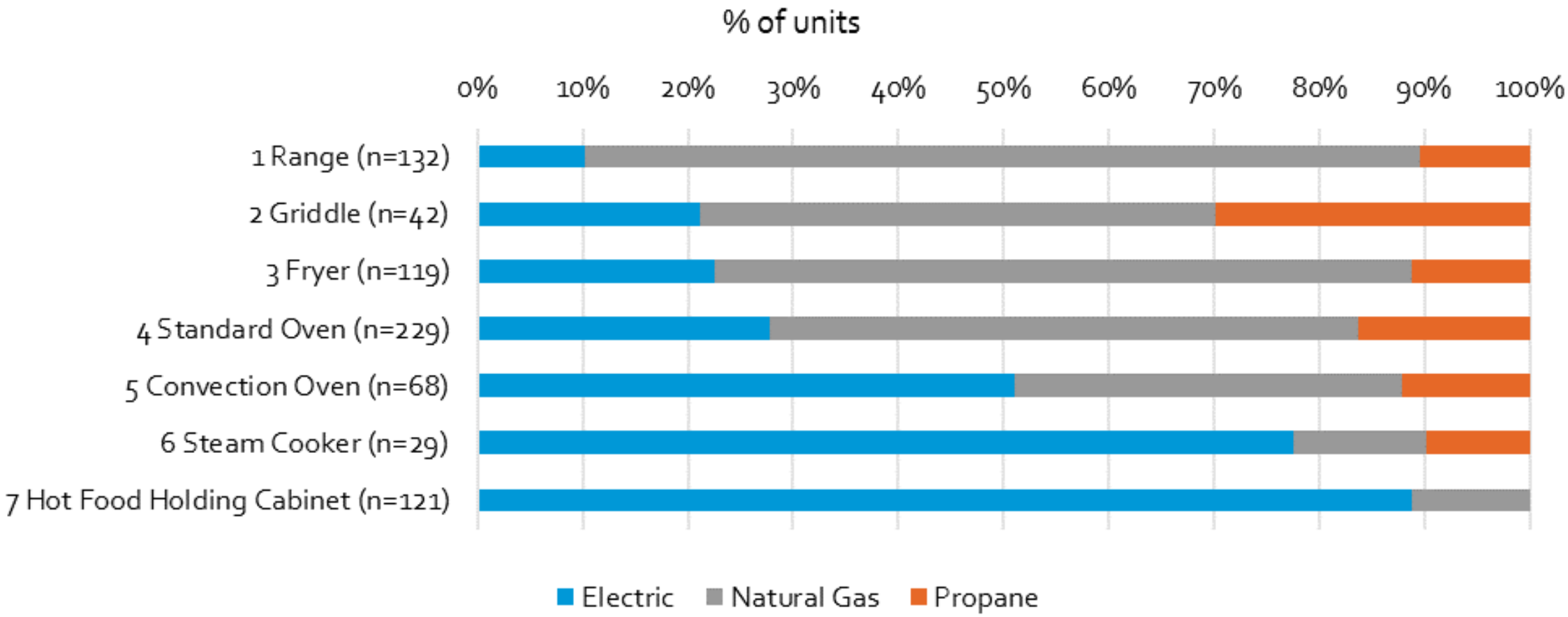
ENERGY-INTENSIVE APPLIANCES DOMINATED BY FOSSIL FUEL



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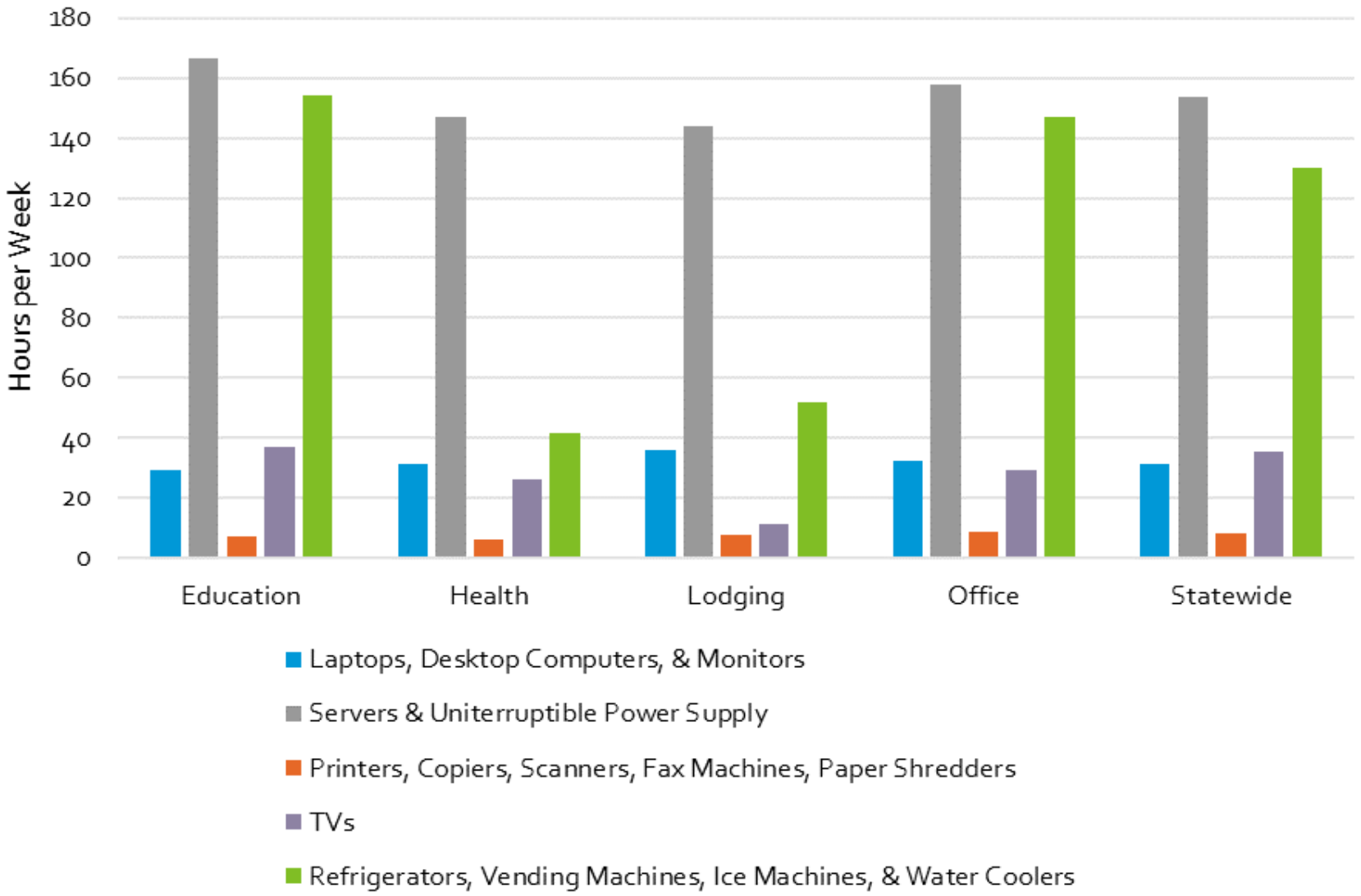
(Dishwashers, all electric, are excluded here)

PLUG LOAD

PLUG LOADS

- Standard 120V electrical plugs found in:
  - Computers & Computer Infrastructure
  - Document Processing
  - Refrigeration
  - TVs
- Devices can sit idle for many hours, so hours of use per week better estimates load
- Some newer tech pushing out old (laptops replacing monitors)



COMPARISON WITH ENERGY STAR SHIPMENT DATA

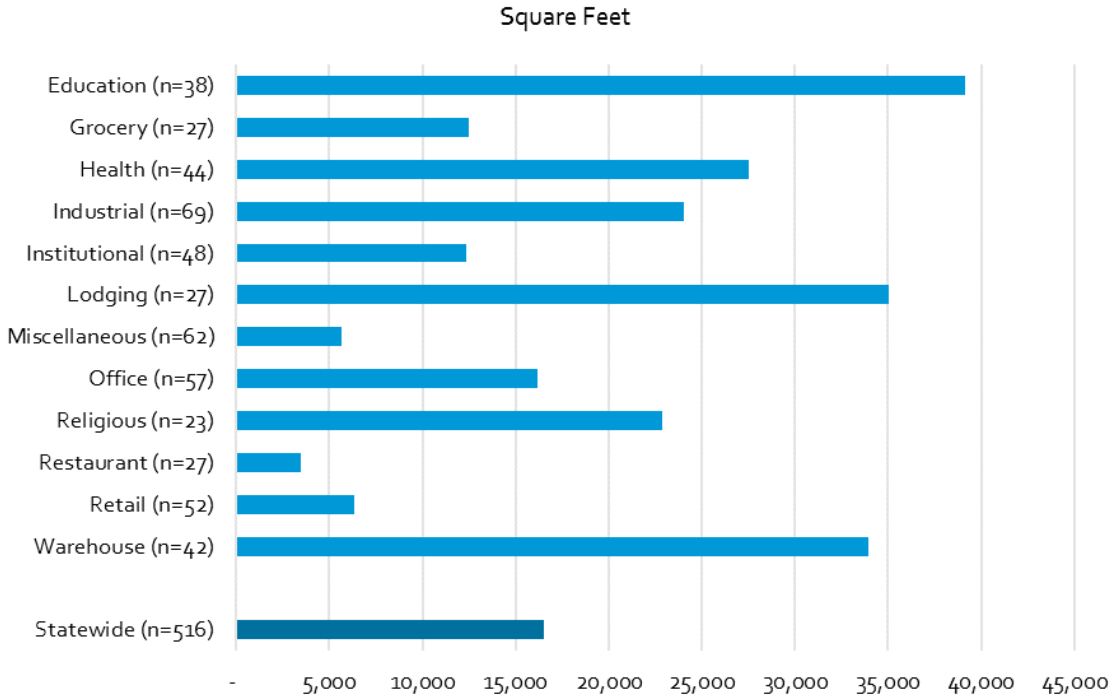
- Plug load was a lower priority end use for field data collection
- ENERGY STAR certification is not always observable
- EPA shipment data is a useful point of comparison
  - ➢ Current plug load stock is likely somewhere in between

Plug Load Type	% ENERGY STAR (On-Sites)	% ENERGY STAR (2022 Shipment Data)
All-in-one Office Imaging Units (n=564)	12.1	N/A
Ice Makers (n=196)	4.6	28
Laptops (n=4,046)	4.5	71
Monitors (n=8,652)	10.8	65
Non-Refrigerated Vending Machines (n=90)	2.2	27
Paper Shredders (n=267)	0.0	N/A
Personal Computers (n=4,435)	14.7	55
Refrigerated Vending Machines (n=201)	20.6	27
Residential Style Refrigerators (n=2,331)	18.6	66
Servers (n=531)	0.0	19
Standalone Fax Machines (n=87)	0.0	N/A
Standalone Photocopiers (n=58)	51.7	N/A
Standalone Printers (n=1,058)	9.9	N/A
Standalone Scanners (n=67)	1.5	N/A
Televisions (n=3,142)	10.9	1%
Uninterruptable Power Supply (n=65)	0.0	N/A
Water Coolers (n=272)	0.4	39%

GENERAL BUILDING CHARACTERISTICS

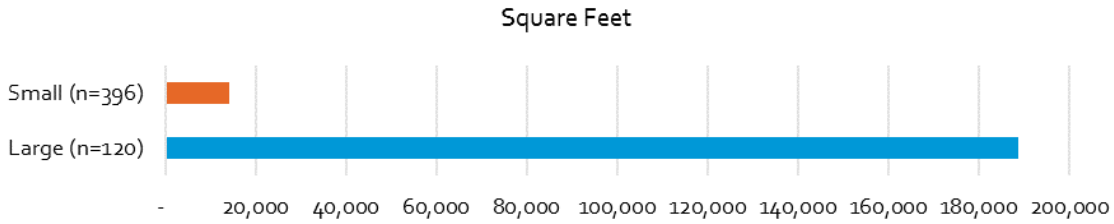
STUDY COLLECTED BUILDING CHARACTERISTICS, INCL. SIZE

Average Size per Site, by Segment



- Some sites have multiple buildings
- Restaurants have the smallest footprint

Average Size per Site, by Sector



- Largest 10% of buildings make up 70% of square footage in the sample

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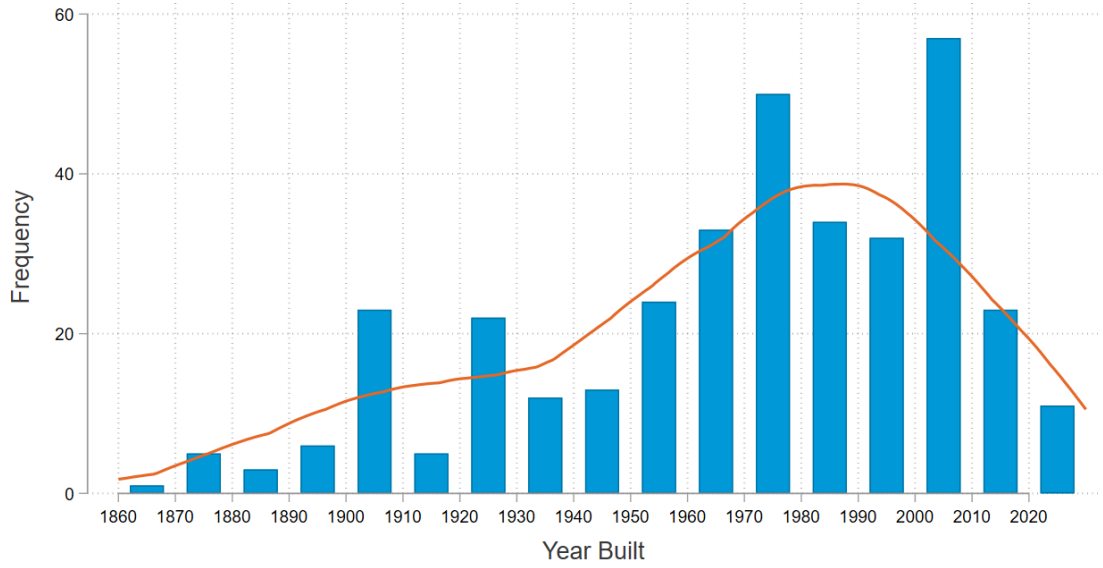
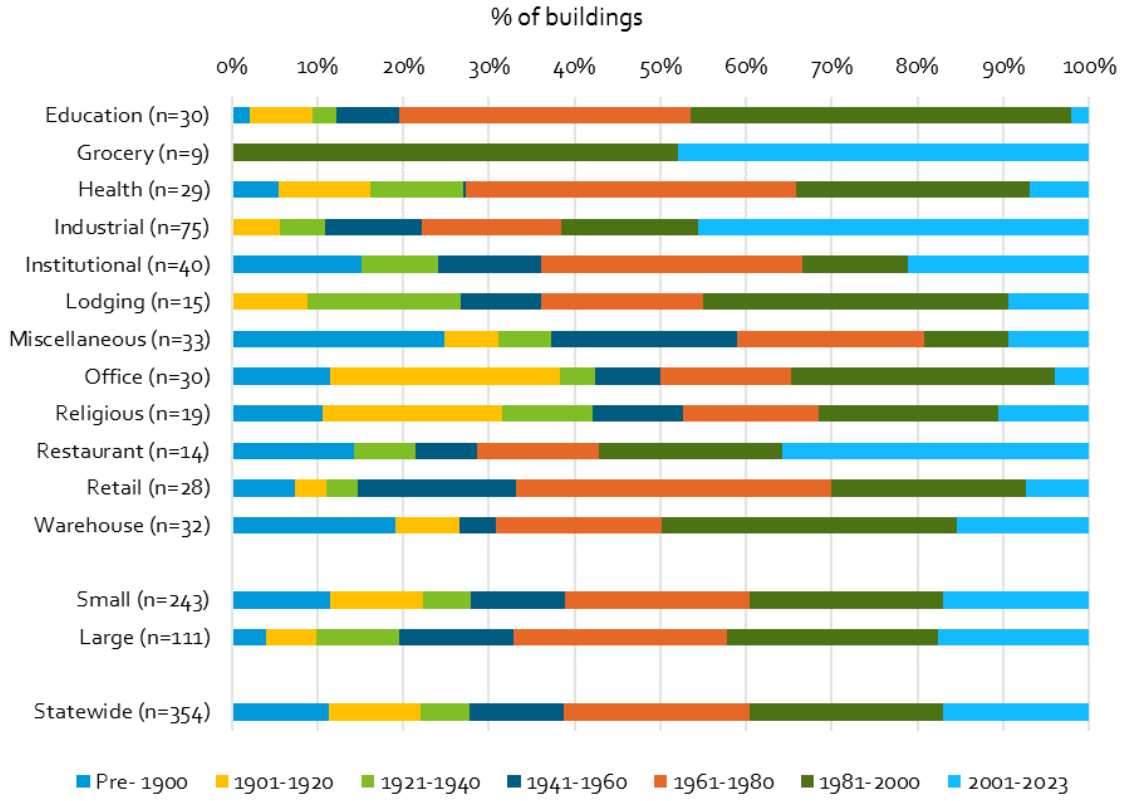
GROCERY, INDUSTRIAL HAD NEWEST BUILDINGS





- Building age correlates with energy usage due to insulation and technology innovation
- Over 10% of the building stock was built in the 1800s

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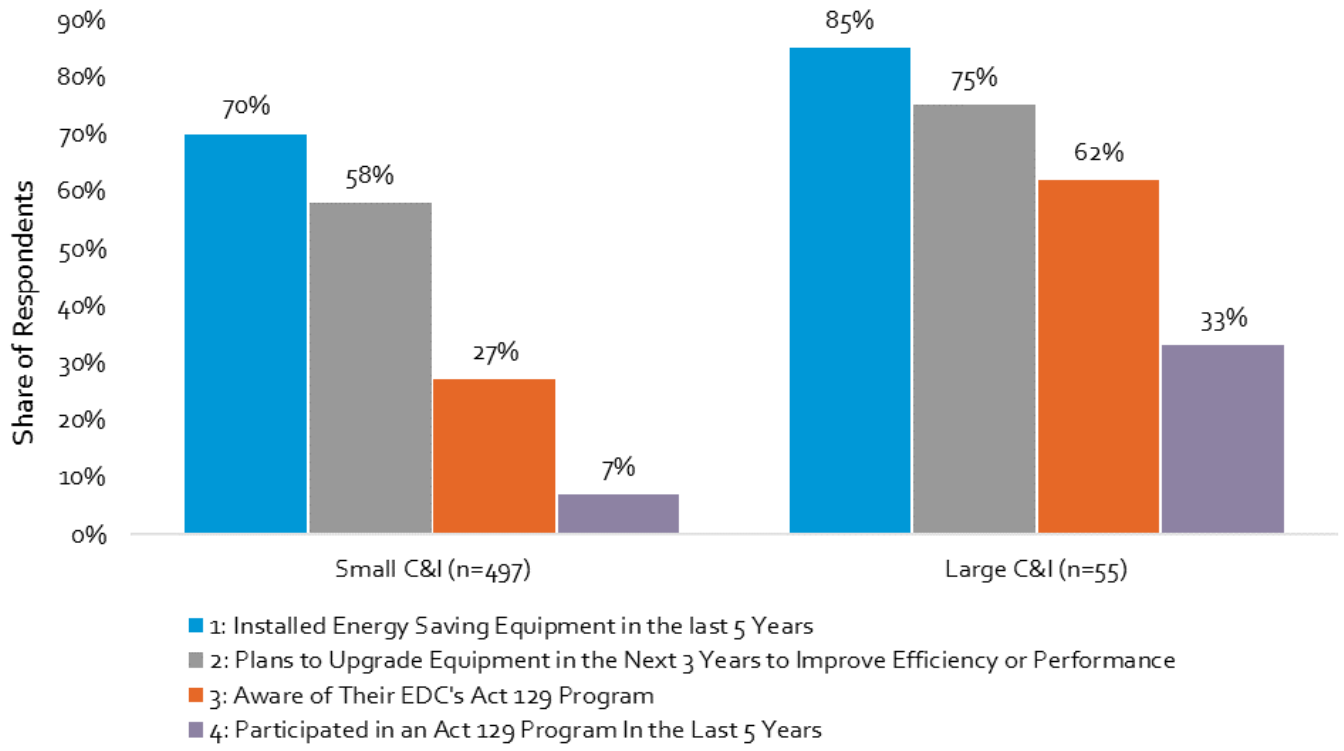
ADOPTION RESEARCH

ADOPTION RESEARCH SURVEY

- Fielded online in two waves
  - Embedded in site visit outreach
  - A second standalone effort to bolster sample size
- Direct questions on energy efficiency topics
- Large C&I customers are twice as likely to be aware of Act 129 programs and almost 5 times as likely to have participated



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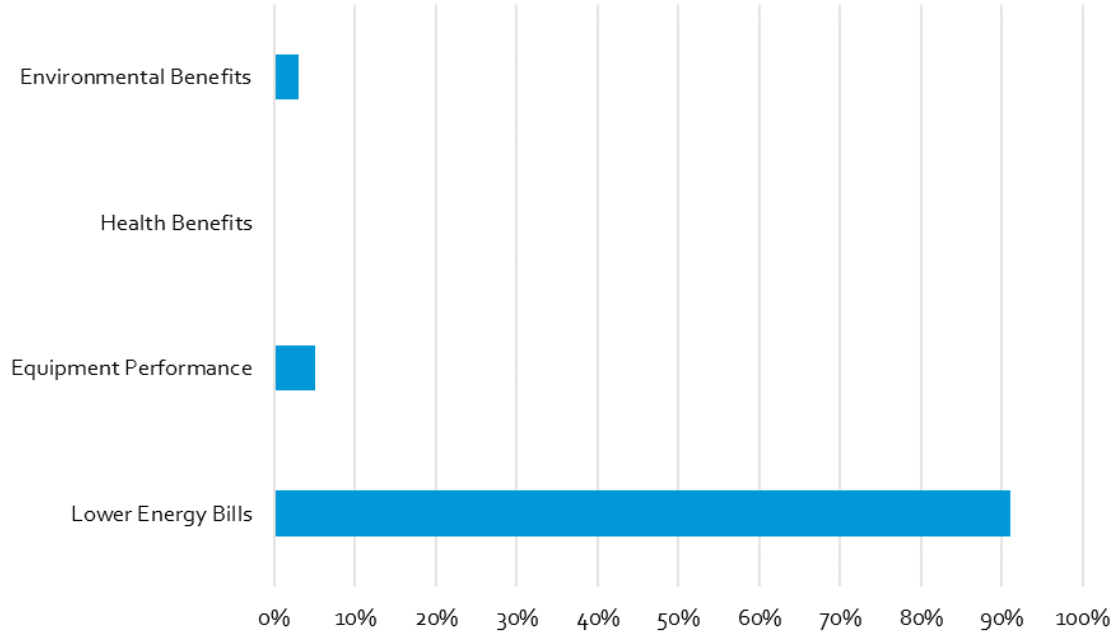
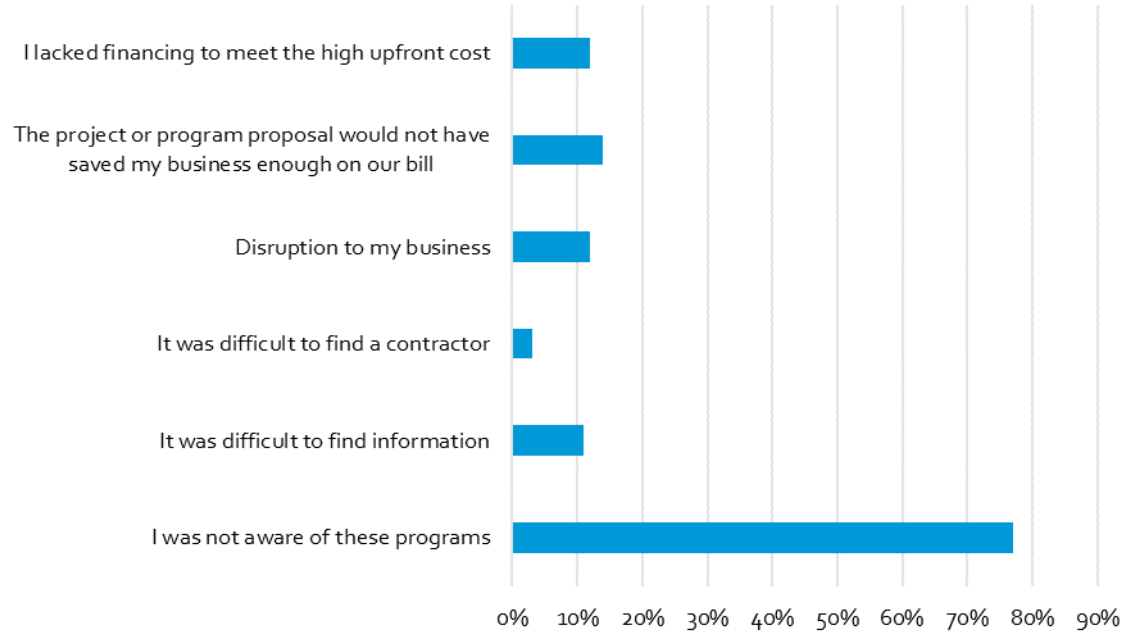
MOTIVATIONS AND BARRIERS TO ENERGY EFFICIENT UPGRADES

Motivation for Participating in Act 129 Program



Barriers to Act 129 Participation



EE&C programs are designed to reduce the barriers to efficient purchasing decisions

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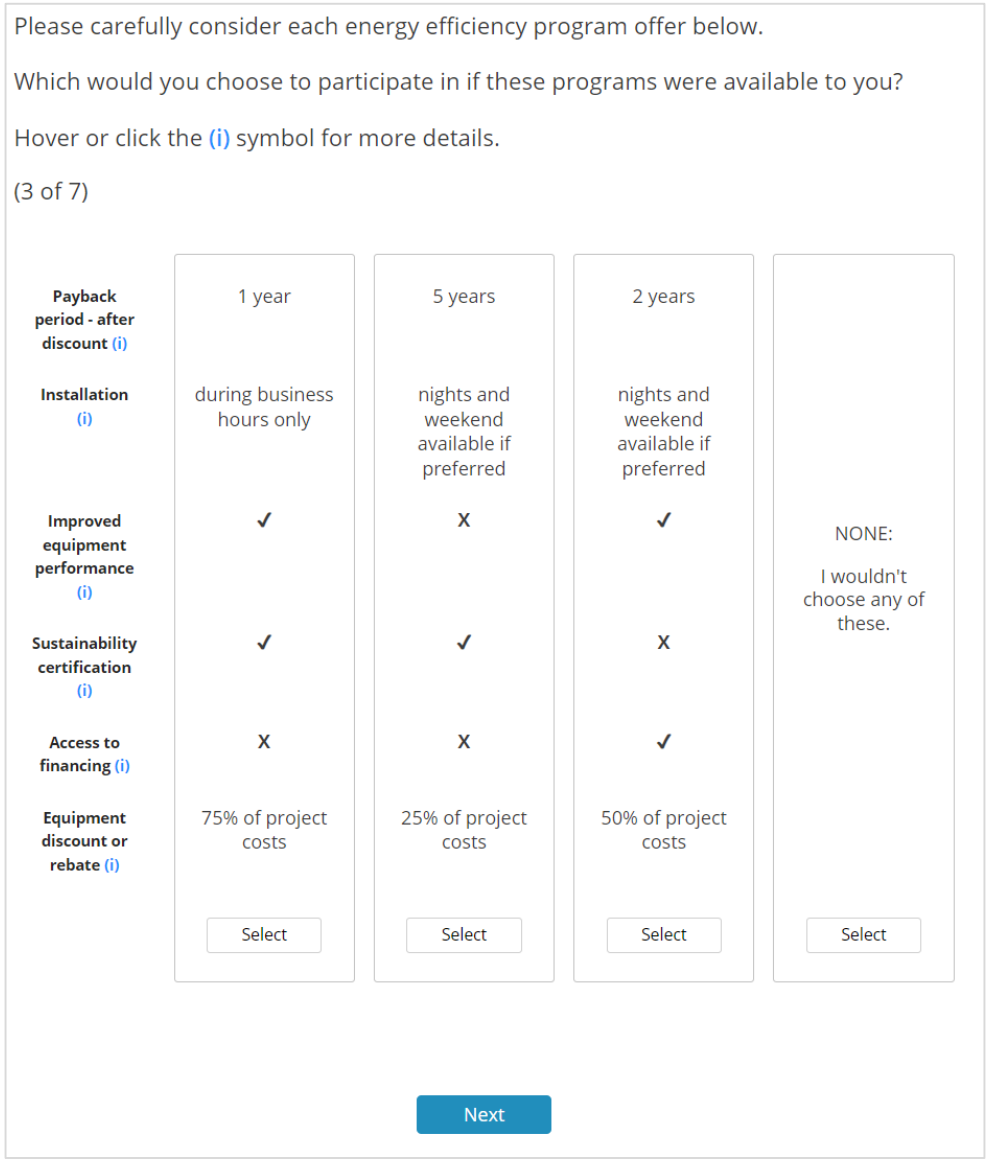
CONJOINT METHODOLOGY

- A choice experiment, or conjoint survey, isolates and **quantifies the influence of individual factors on a decision**
- The goal is to identify relative preferences of different program design parameters to inform MPS adoption curves
- Respondents are shown choice sets (one per screen) with multiple design configurations **simulating a real-world choice** the respondent might be faced with
  - ➢ Random assignment of combinations
- Choice experiment questions were framed agnostic to end use or equipment



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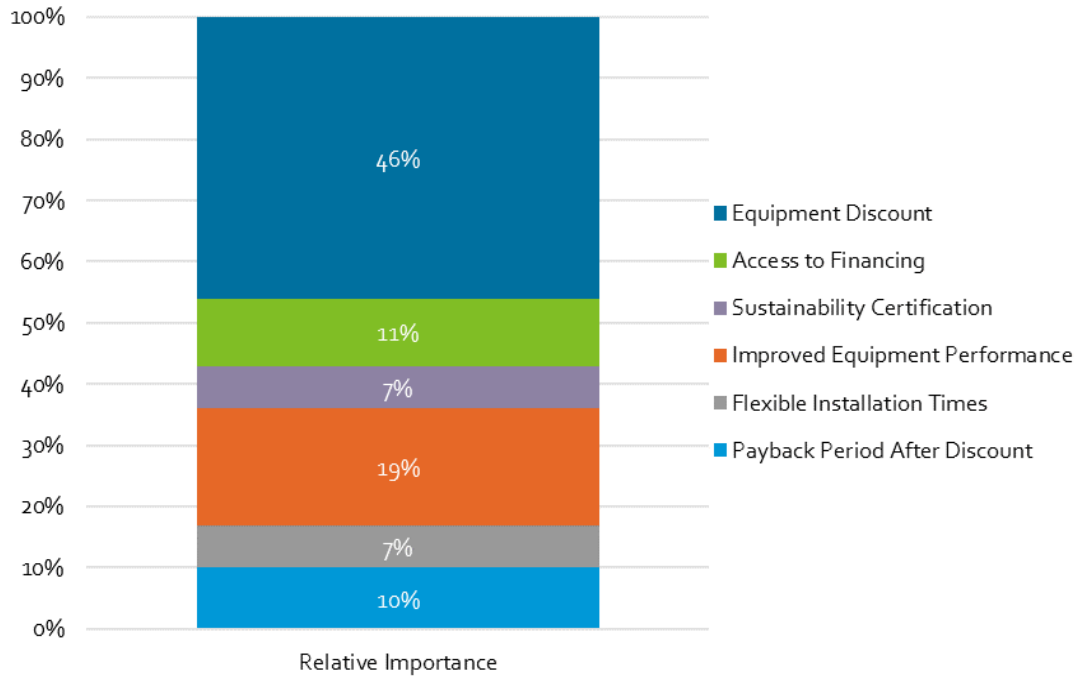
RELATIVE IMPORTANCE OF CHOICE EXPERIMENT ATTRIBUTES

- Logistic regression analysis of respondent choices reveals relative importance
- Financial attributes (discount, payback period, and financing) make up two-thirds of the importance
- Improved equipment performance is the second most important attribute



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PROGRAM DESIGN SIMULATOR

Attribute	Level	Base Level	Pref Share	% Change Over Base
Payback Period - after discount	1 year		34%	6%
	2 years	✓	32%	0%
	5 years		24%	-26%
Installation	during business hours	✓	32%	0%
	outside of business hours		31%	-3%
Performance	No	✓	32%	0%
	Yes		41%	28%
Certification	No	✓	32%	0%
	Yes		34%	6%
Financing	No	✓	32%	0%
	Yes		35%	11%
Discount or rebate	None		17%	-46%
	25% of project costs	✓	32%	0%
	50% of project costs		43%	34%
	75% of project costs		49%	54%

- Identify baseline offering (shaded)
  - 32% of respondents said that they would participate in the baseline program
  - Calibrate for MPS. 30% of respondents aware, 10% participated in the last 5 years
- Differences between levels interpreted as the relative marginal effect on participation
- Doubling the rebate amount from 25% to 50% of project cost is expected to increase uptake by 34%
- Upgrades that improve performance in addition to saving energy increase uptake by 28%

QUESTIONS?

Jesse Smith
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