

ACT 129 STAKEHOLDER MEETING

2018 Non-Residential End Use & Saturation Study

JANUARY 30, 2019



Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS



STUDY TEAM

- Study Design and Coordination
 - EcoMetric Consulting
- Field Data Collection
 - Abraxas Energy Consulting
 - NMR Group
 - EcoMetric Consulting
- Analysis and Reporting
 - Demand Side Analytics



AGENDA

- Background
- Overview of the study
- 2018 Findings
 - Energy use intensities
 - End use penetrations and fuel shares
 - General building characteristics
- End use analysis
 - Lighting
 - Heating and cooling
 - Water heating
 - Refrigeration
 - Process
 - Cooking
 - Plug load
- Willingness to pay
- Motivation and barriers for EE investments
- Procurement policies and program awareness

STUDY OBJECTIVES

- Develop inputs for Phase IV market potential studies
 - Disaggregation of sales forecast by EDC, sector, segment, and end-use
- TRM improvement
 - Average size, efficiency, and configuration of existing equipment stock
- Inform areas of program opportunity
 - Assess technology shares and magnitude of potential energy efficiency savings
 - Are there sectors or segments that appear “behind” with regard to adoption of efficient technologies

SIMILARITIES AND DIFFERENCES FROM PRIOR STUDIES

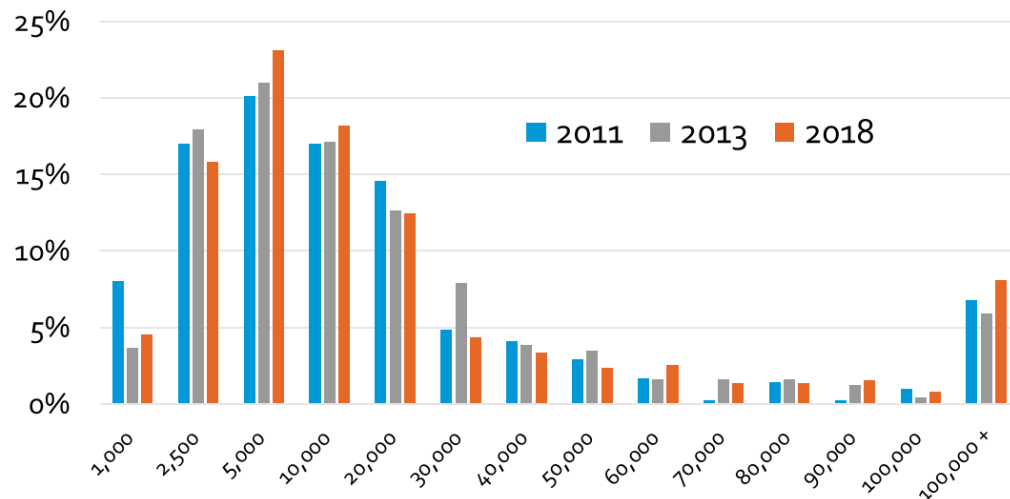
Many shared aspects across the three studies

- Non-residential baseline studies were conducted previously in 2011 and 2013
 - Limited to the 7 EDCs subject to Act 129
 - End-use categories analyzed
 - Recruiting and on-site data collection methods

What is different in the 2018 study?

- Definition of **sectors** is consistent with EDC rate classes
 - Small C&I = service at secondary voltage
 - Large C&I = service at primary voltage
- Report organization
- Increased focus on capacity shares as opposed to equipment counts
 - More useful for top-down disaggregation of EDC sales forecasts across end-uses

Distribution of Building Square Footage



OVERVIEW: GROUPING

- Segment determined through a mix of text-mining, premise types, and average kWh consumption
 - All ~ 700,000 accounts assigned to a sector and segment
- Transportation, Communications, and Utilities (TCU) accounts and Master-Metered Multifamily accounts

Small C&I and Large C&I sectors have inverse population size – electric sales relationship

Segment	Electric Sales, June 2016- May 2017 (GWh)	Accounts
Education	5,739	14,488
Grocery	4,802	12,397
Health	5,346	19,705
Industrial Manufacturing	31,512	73,821
Institutional/Public Service	6,093	52,328
Lodging	1,192	7,669
Miscellaneous/Other	5,573	69,416
Office	8,244	106,727
Religious	1,021	22,703
Restaurant	1,821	16,961
Retail	7,256	62,808
Warehouse	1,849	14,062
Sector		
Large	50,195	6,845
Small	30,252	466,240
EDC		
PECO	21,186	108,278
PPL	20,674	127,215
Duquesne	7,789	43,779
FE: Met-Ed	7,818	47,111
FE: Penelec	8,574	62,102
FE: Penn Power	2,779	15,326
FE: West Penn	11,626	69,274
Statewide	80,447	473,085

OVERVIEW: SAMPLING & METHODOLOGY

- The sample design was to provide $\pm 10\%$ precision at the 90% confidence level for each EDC.
- Deliberate oversampling of Large C&I accounts
 - This is mitigated in the weighting strategy.
- Data was collected on-site
- Weekly quality checks helped ensure thorough and accurate information.

Segmented Sample Points (by EDC)

Segment	PECO	PPL	DLC	ME	PN	PP	WPP	State
Education	7	5	5	4	6	3	5	35
Institutional/Public Service	5	10	2	5	8	4	9	43
Grocery	3	4	4	2	2	1	4	20
Health	4	10	2	7	4	3	8	38
Industrial Manufacturing	6	13	11	12	11	11	11	75
Lodging	3	4	4	4	4	1	1	21
Miscellaneous / Other	8	6	7	7	11	10	9	58
Office	11	10	11	3	5	10	5	55
Religious	0	0	1	3	0	1	0	5
Restaurant	5	9	10	8	11	7	10	60
Retail	10	5	5	6	9	12	10	57
Warehouse	5	4	9	3	6	9	4	40
Total	67	80	71	64	77	72	76	507

OVERVIEW: WEIGHTING COMPONENTS

1. A weight corresponding to the share of sales for each of the 12 segments included in the study
 - Within each EDC to reflect differences across EDCs
2. An adjustment for the count of the sampled accounts relative to the accounts in the population.
 - Within each sector and segment
- Case weights indicate the number of sites in the population represented by a single sampled site. The weighting used for the study was the product of the share of electricity sales weights and the case weights.

Segment	Large Sector			Small Sector		
	Accounts	Sample	Case Weight	Accounts	Sample	Case Weight
Education	761	5	152	13,727	30	458
Grocery	493	5	99	11,904	15	794
Health	417	7	60	19,288	31	622
Industrial Manufacturing	2,037	24	85	71,784	51	1,408
Institutional/Public Service	758	9	84	51,570	34	1,517
Lodging	107	3	36	7,562	18	420
Miscellaneous/Other	443	3	148	68,973	55	1,254
Office	766	6	128	105,961	49	2,162
Religious	75	0	NA	22,628	5	4,526
Restaurant	51	1	51	16,910	59	287
Retail	726	2	363	62,082	55	1,129
Warehouse	211	3	70	13,851	37	374

OVERVIEW: DEFINITIONS

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

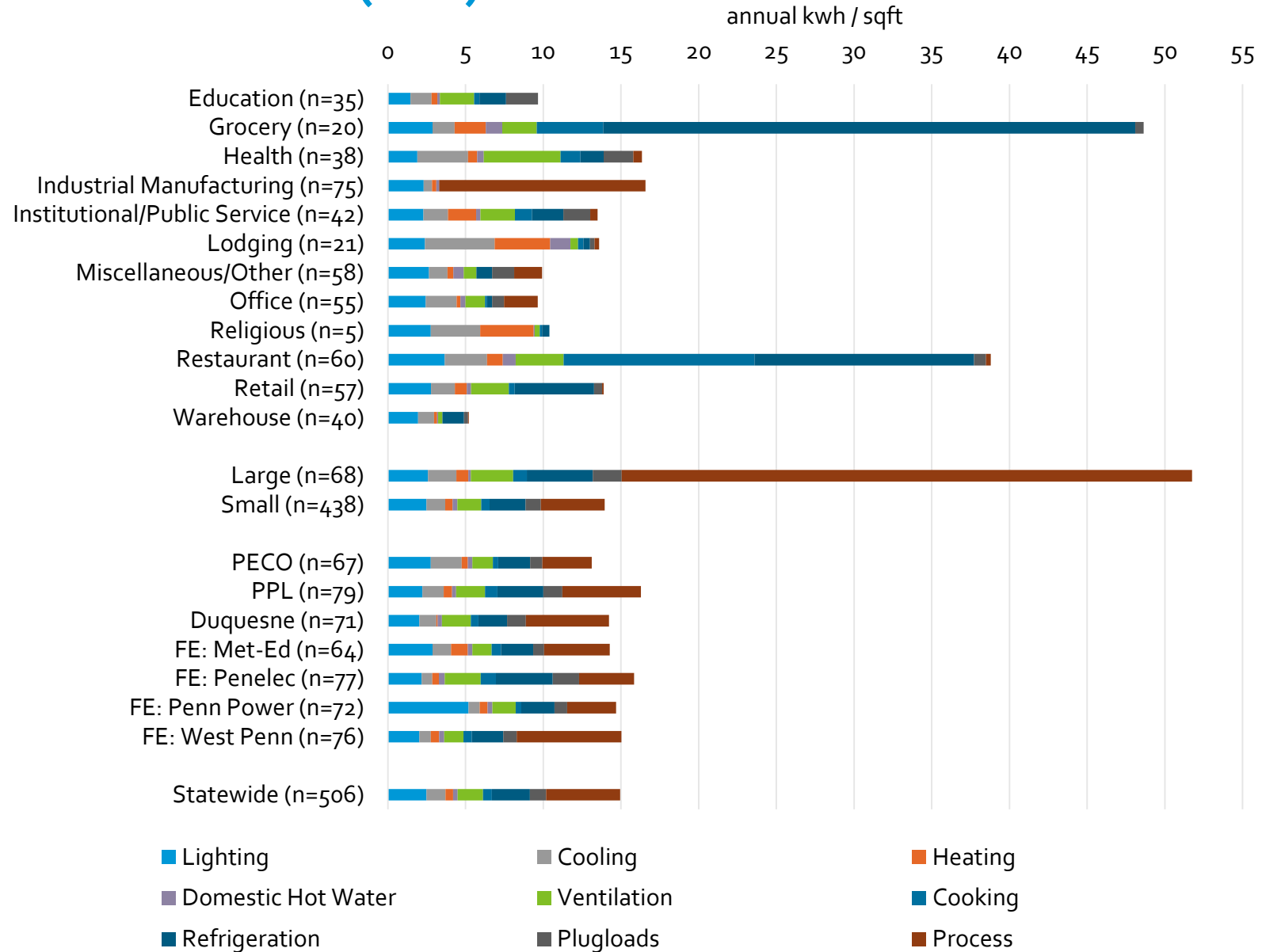
Share of...	N value	Conceptual calculation	Analysis Application
Sites	Sites	$\frac{\text{\# of sites where technology is present}}{\text{total \# of sites}}$	Penetration of end uses or technology at the site level
Units	Items of equipment	$\frac{\text{\# of units with feature or characteristic}}{\text{total \# of units}}$	Saturation of end use technology features or efficiency Distribution of unit sizes Distribution of unit ages
Capacity	Items of equipment	$\frac{\text{capacity (kW, kBTU, gal) with feature or within segment}}{\text{total capacity}}$	Distribution of equipment technology Fuel share

ENERGY USE INTENSITY & END USE PENETRATION

ENERGY USE INTENSITY (EUI)

- 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 field data and segment specific, publicly available data on energy usage and intensity
- Commercial Buildings Energy Consumption Survey (CBECS) scaling used to bridge gap between top-down and bottom-up

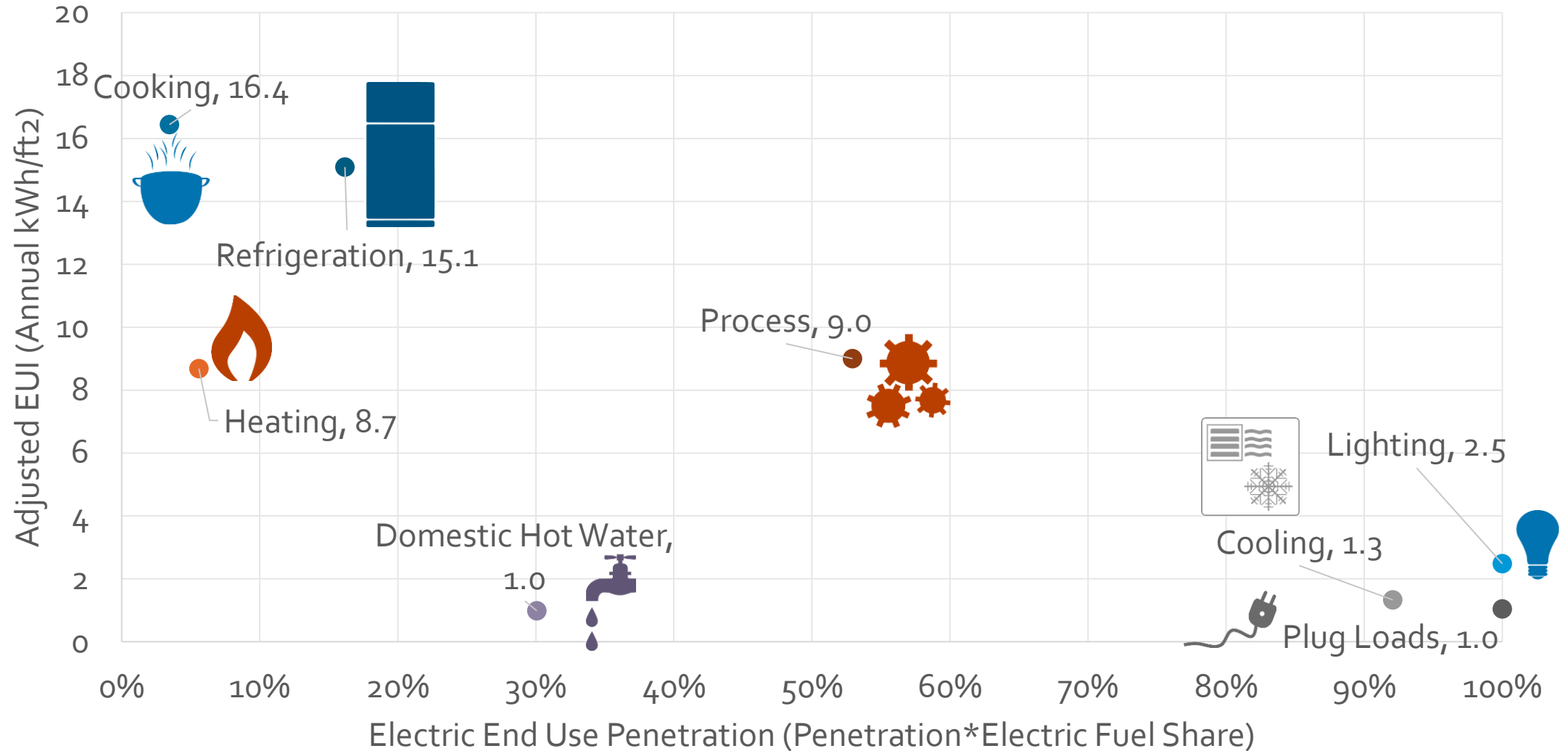
ENERGY USE INTENSITY (EUI)



END USE PENETRATION AND FUEL SHARE

End Use	Penetration	Fuel Share (capacity)				Unit n-values
		Natural Gas	Electric	Propane	Other	
Lighting	100%	0%	100%	0%	0%	
Space Heating	99%	86%	6%	5%	3%	4,276
Space Cooling	92%	0%	100%	0%	0%	
Plug Load	100%	0%	100%	0%	0%	
Refrigeration	16%	0%	100%	0%	0%	
Cooking	10%	60%	35%	5%	0%	1,192
Water Heating	89%	62%	34%	4%	3%	940
Process	58%	9%	91%	0%	0%	5,093

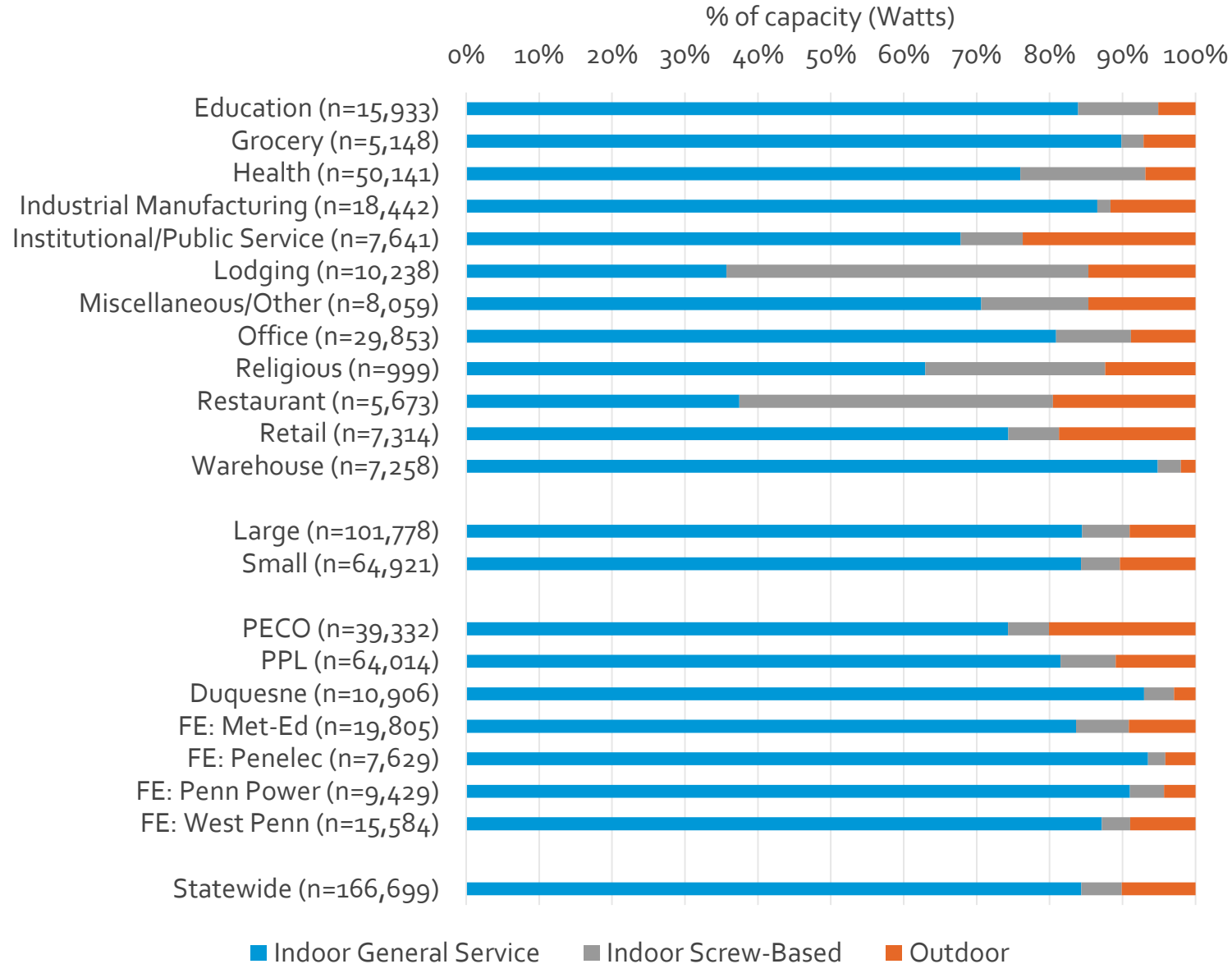
EUI AND ELECTRIC END USE PENETRATION



CATEGORIZATION OF LIGHTING

Category	Equipment	Detail
Technology	LED	
	CFL	
	HID	Induction, Mercury Vapor, Metal Halide, High Pressure Sodium
	Halogen	
	Incandescent	
	Linear Fluorescent	High Bay T12, High Bay T8, High Bay T5, T12, T8, T5
	Neon	
Style	High Bay Linear	High bay fixtures with linear fluorescent or LED tubes
	High Bay Non-Linear	HIDs or non-linear LEDs
	Low Bay Linear	LED, T12, T8, and T5 or U-Tubes
	Area or Wall Pack	Outdoor and parking garage
	Low Bay Non-Linear	CFL, LED, Incandescent, Halogen lights with integral ballasts; pin-based lamps
Application	Indoor General Service	
	Indoor Screw-Based	Aligns with TRM hours-of-use and coincidence factor assumptions
	Outdoor	

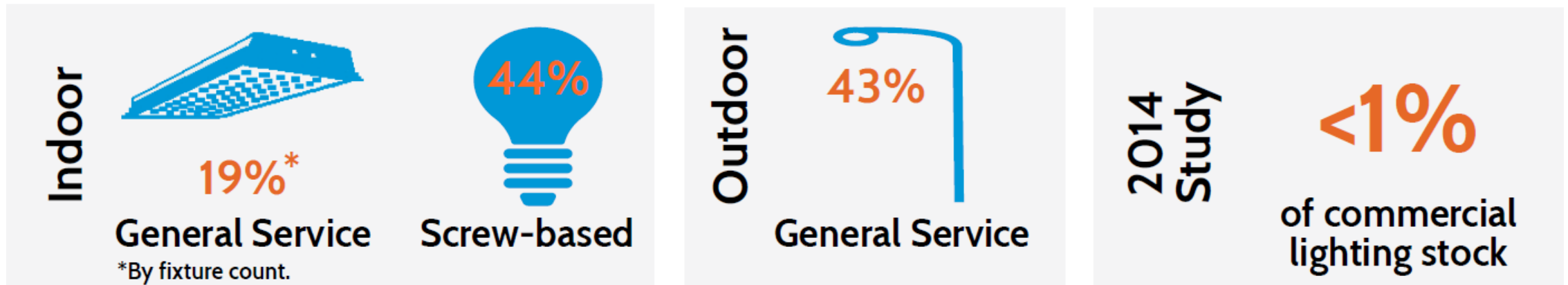
LIGHTING – DISTRIBUTION OF CONNECTED LOAD ACROSS APPLICATIONS



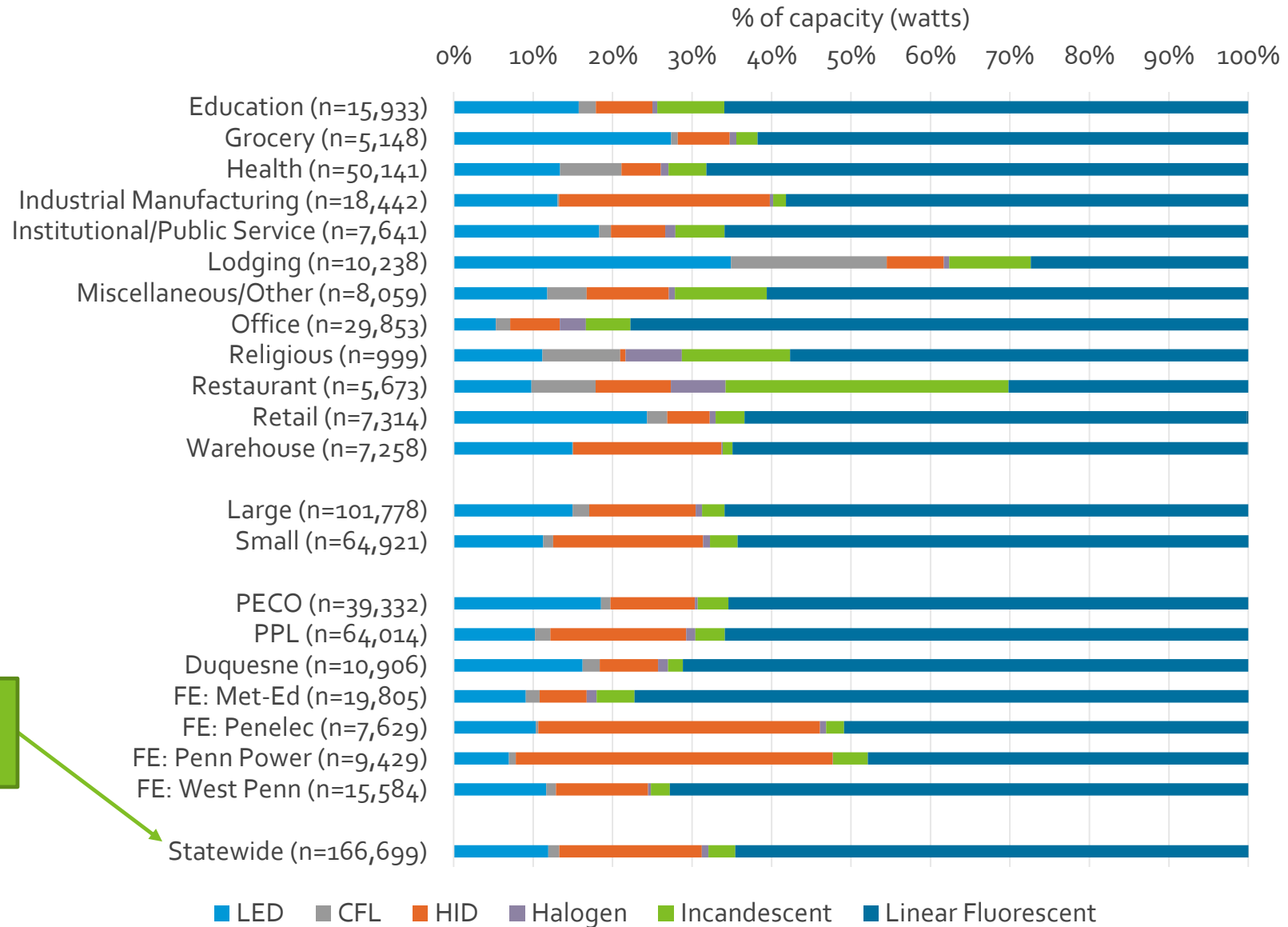
LED SATURATION BY APPLICATION

- Indoor General Service is the dominant application
 - 85% of non-residential lighting connected load
 - 19% LED in summer/fall 2018
- LED saturation is higher for indoor screw-based and outdoor lighting applications
 - These applications only account for ~ 15% of lighting connected load combined

LED Saturation

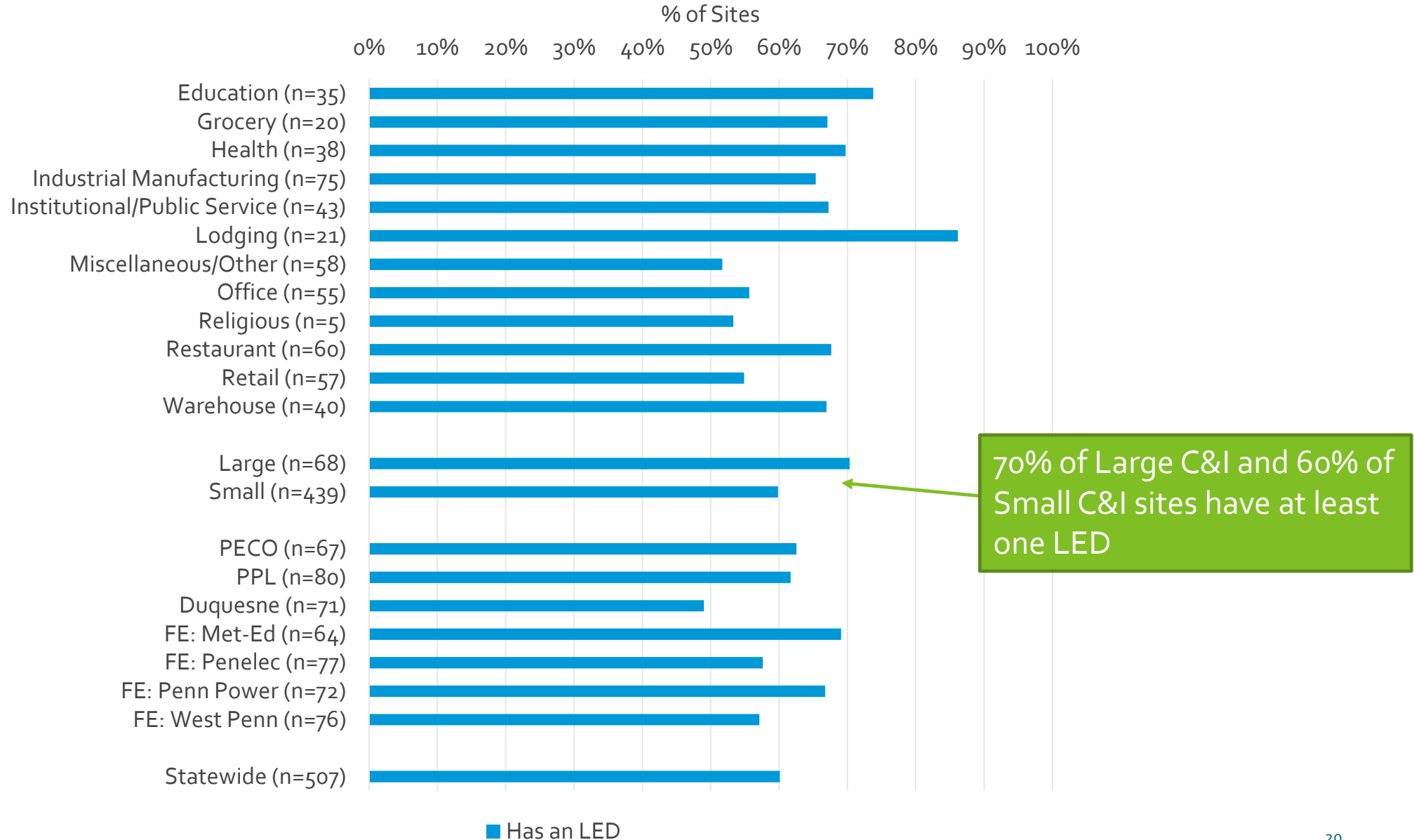


LIGHTING – DISTRIBUTION OF CONNECTED LOAD ACROSS TECHNOLOGY

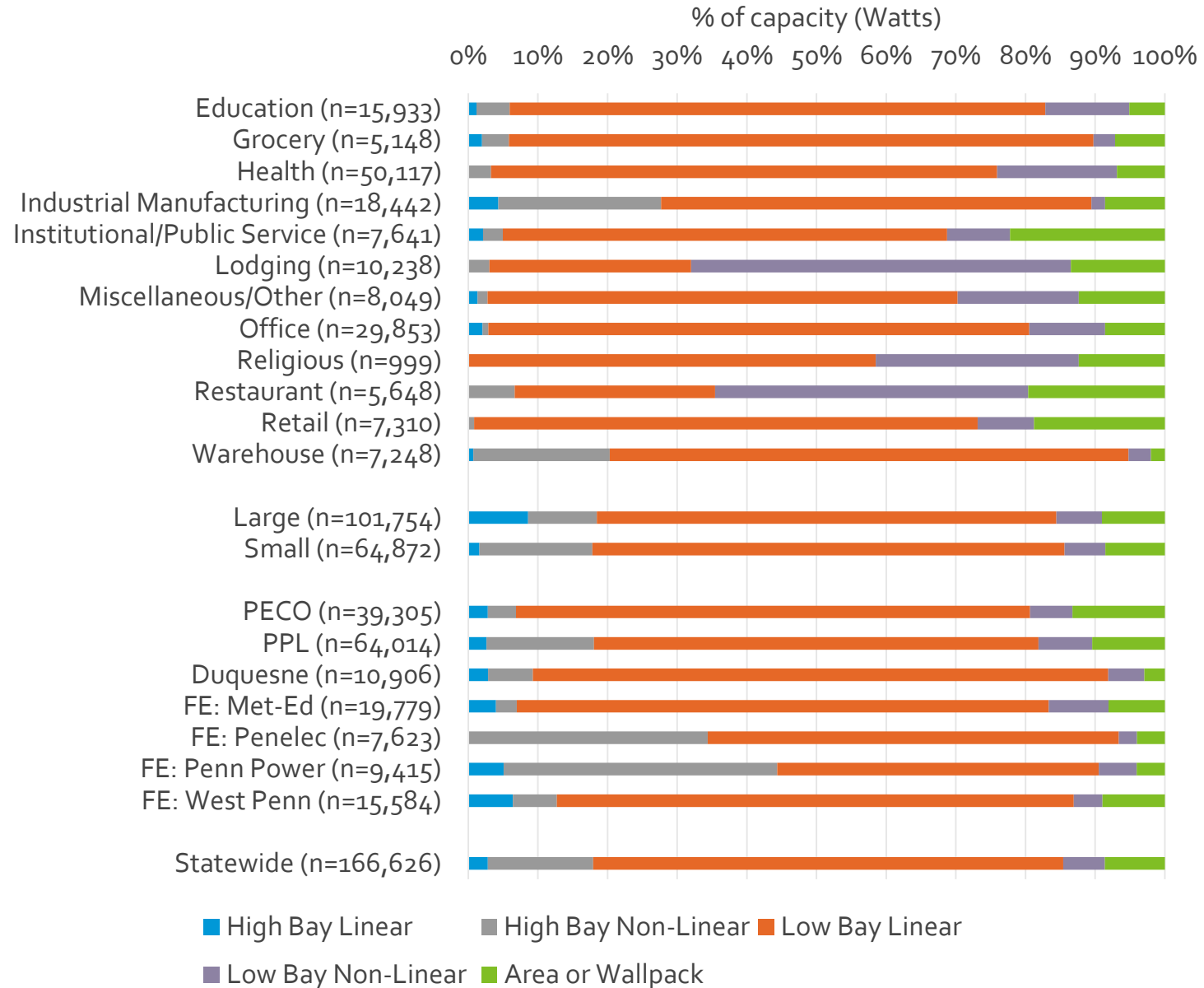


11.9% of all lighting
Wattage is LED

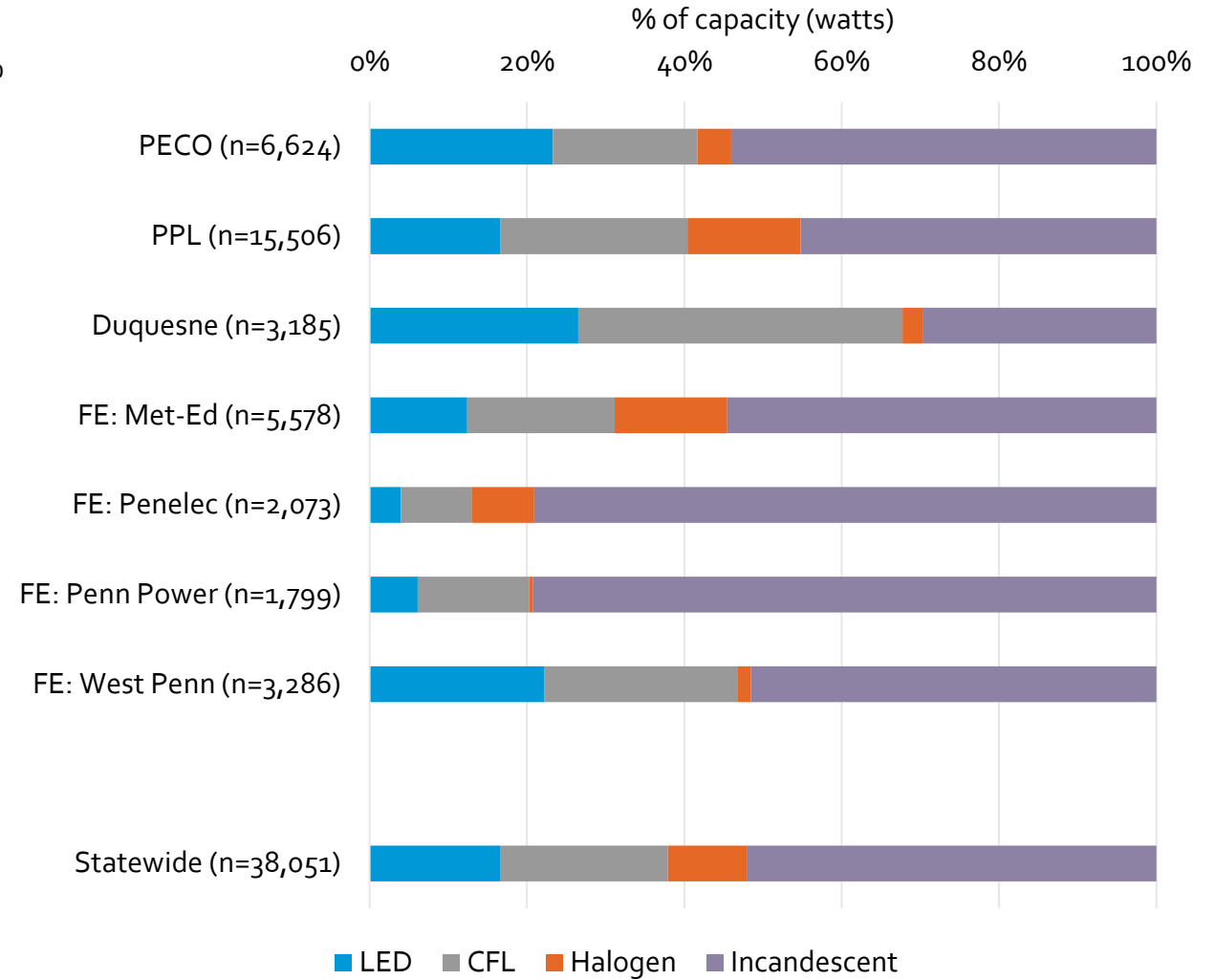
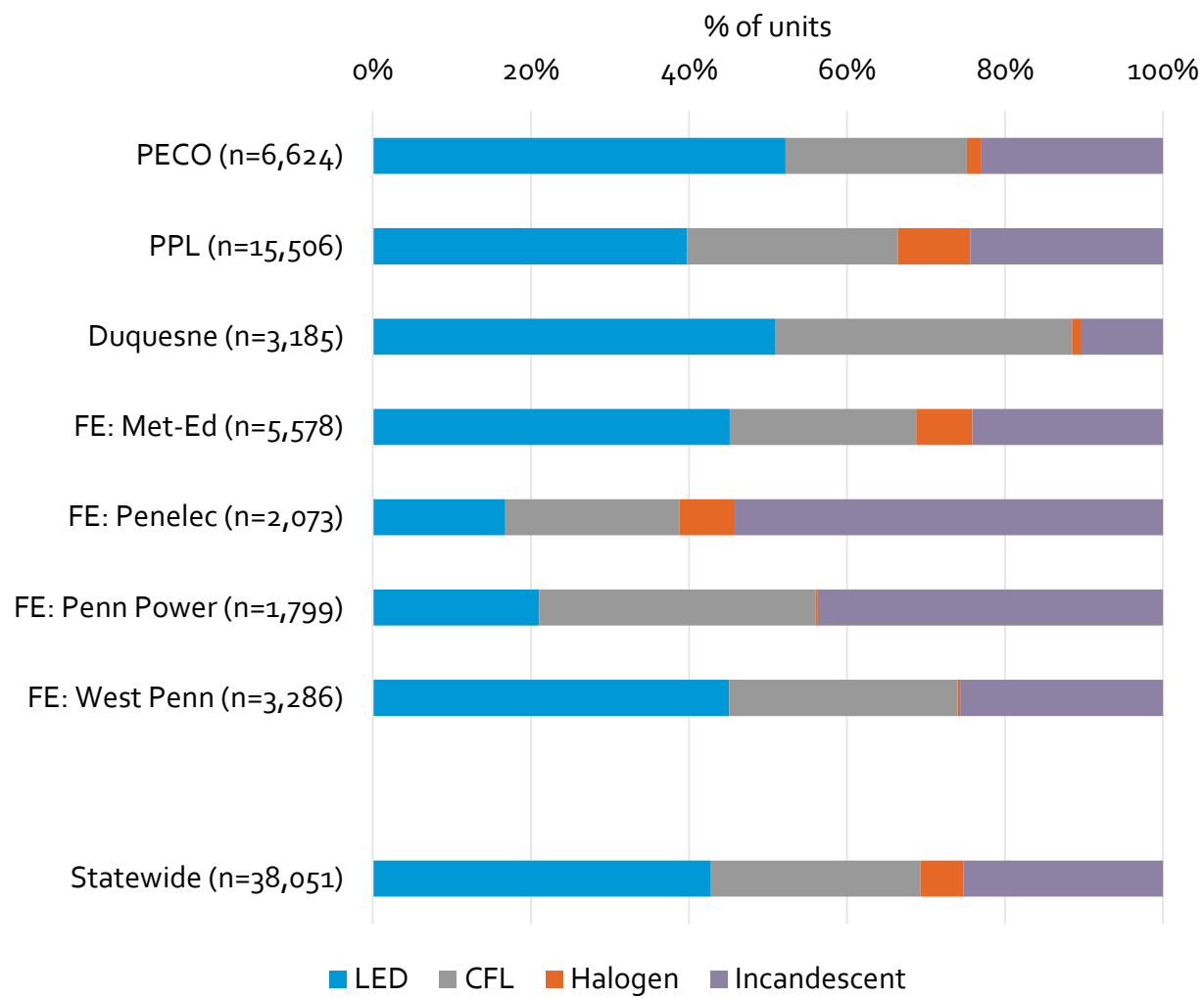
LIGHTING – LED PENETRATION



LIGHTING – DISTRIBUTION OF CONNECTED LOAD ACROSS STYLES



LIGHTING – DISTRIBUTION OF LOW BAY NON-LINEAR TECHNOLOGY TYPE



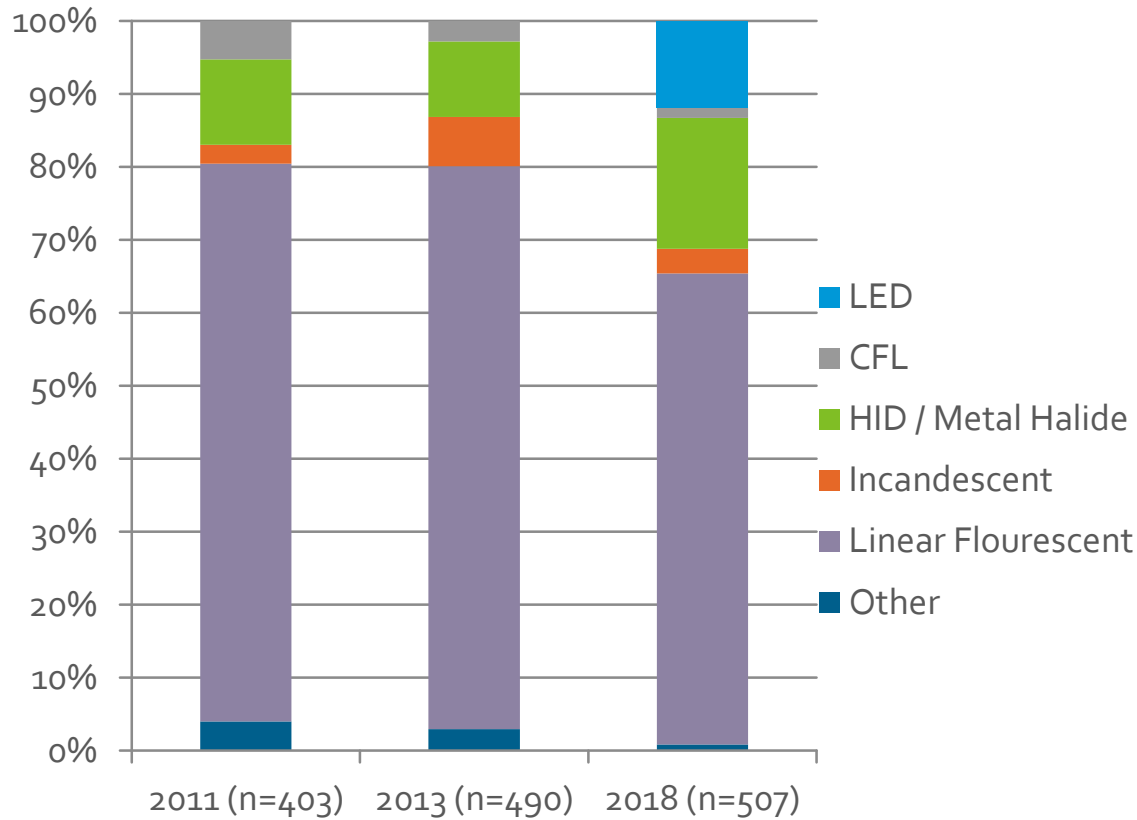
LIGHTING POWER DENSITY

Surveyed	
Segment (n = sites)	Mean LPD
Education (n=35)	0.95
Grocery (n=20)	1.01
Health (n=38)	0.96
Industrial Manufacturing (n=74)	0.83
Institutional/Public Service (n=43)	0.89
Lodging (n=21)	0.43
Miscellaneous/Other (n=58)	1.16
Office (n=55)	1.06
Religious (n=5)	0.99
Restaurant (n=60)	1.00
Retail (n=56)	0.95
Warehouse (n=40)	0.65
Sector	
Large (n=68)	0.72
Small (n=437)	0.96
Statewide (n=505)	0.95

International Energy Conservation Code (IECC) 2015			
Building Type	LPD	Building Type	LPD
Automotive facility	0.80	Multifamily	0.51
Convention center	1.01	Museum	1.02
Courthouse	1.01	Office	0.82
Dining: bar lounge/leisure	1.01	Parking garage	0.21
Dining: cafeteria/fast food	0.90	Penitentiary	0.81
Dining: family	0.95	Performing arts theater	1.39
Dormitory	0.57	Police station	0.87
Exercise center	0.84	Post office	0.87
Fire Station	0.67	Religious building	1.00
Gymnasium	0.94	Retail	1.26
Health-care clinic	0.90	School/university	0.87
Hospital	1.05	Sports arena	0.91
Hotel / Motel	0.87	Town hall	0.89
Library	1.19	Transportation	0.70
Manufacturing	1.17	Warehouse	0.66
Motion picture theater	0.76	Workshop	1.19

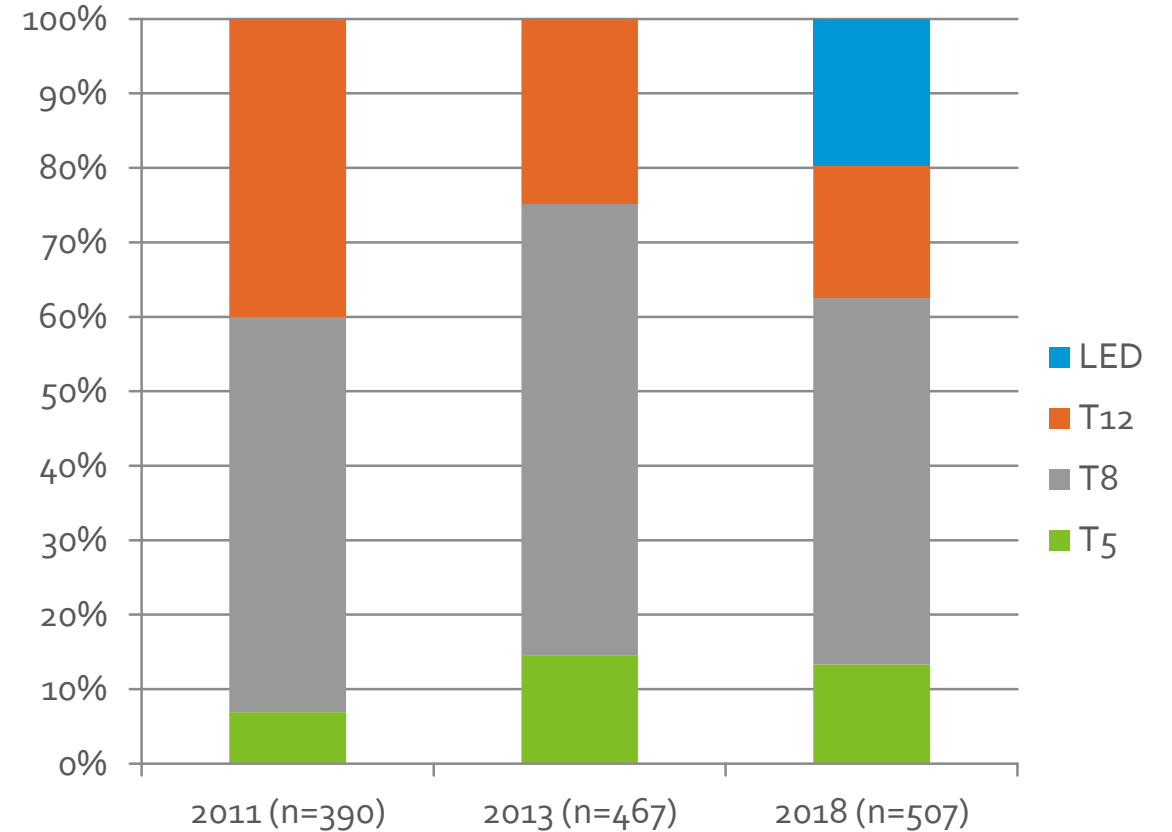
LIGHTING – COMPARISON ACROSS STUDIES

Comparison of Lighting Technologies (by Connected Load)



*2011 based on sq. ft., 2013 and 2018 based on connected load

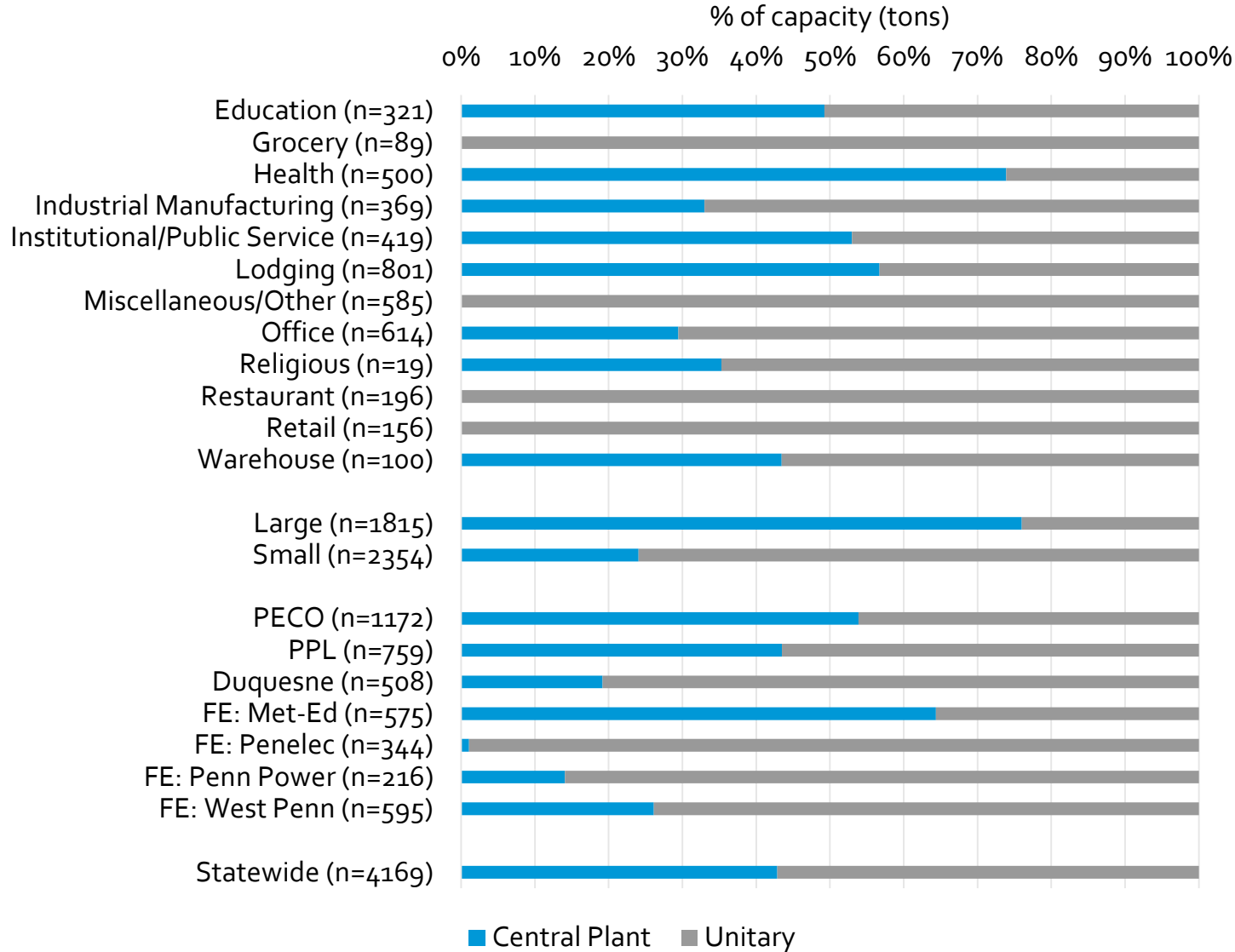
Comparison of Linear Fluorescent Lamp Type Distribution (by Fixture Count)



*2011 based on sq. ft., 2013 and 2018 based on fixture count

AIR CONDITIONING

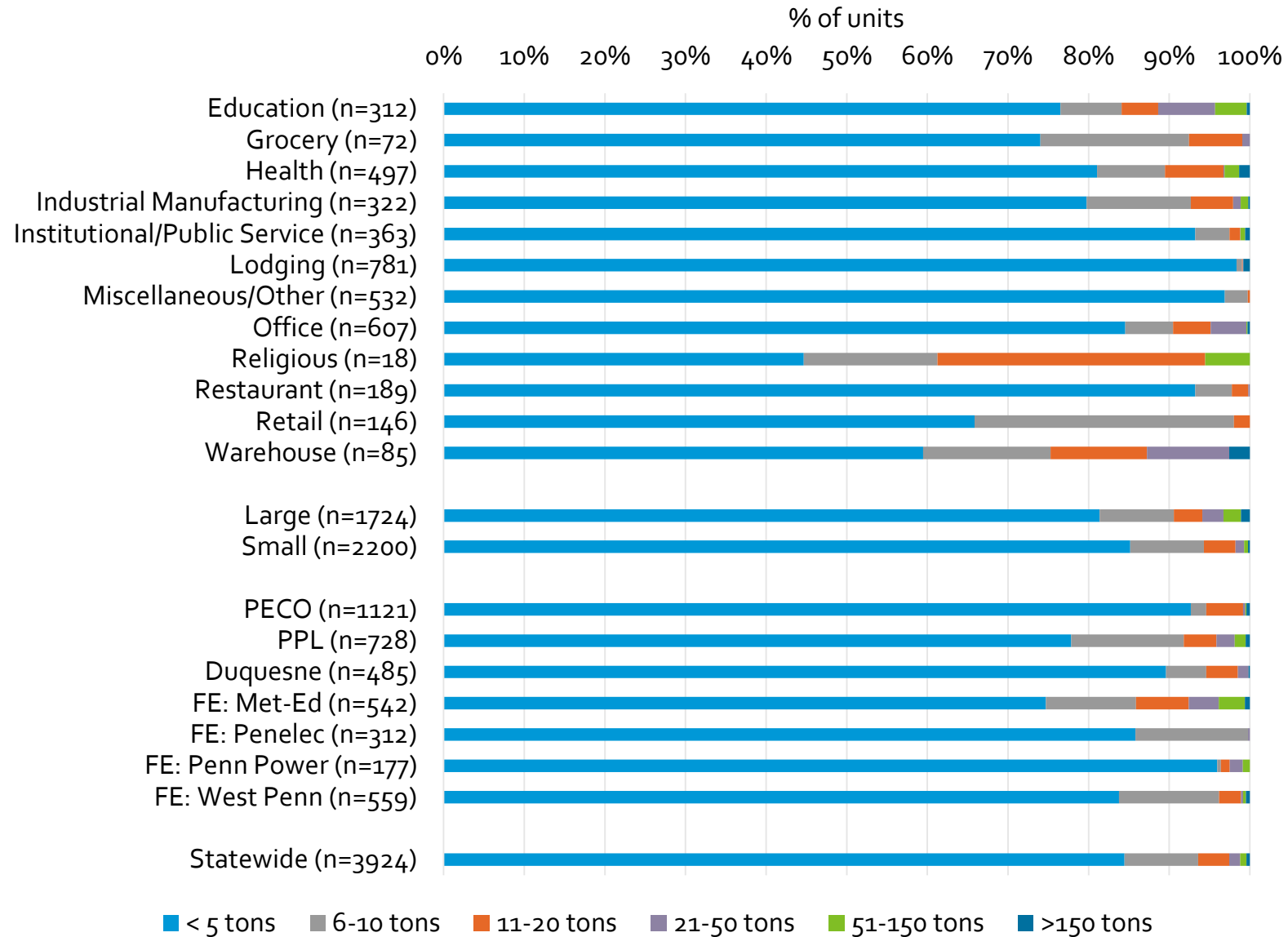
COOLING EQUIPMENT TYPE



Or



COOLING UNIT SIZE DISTRIBUTION – ALL COOLING TYPES



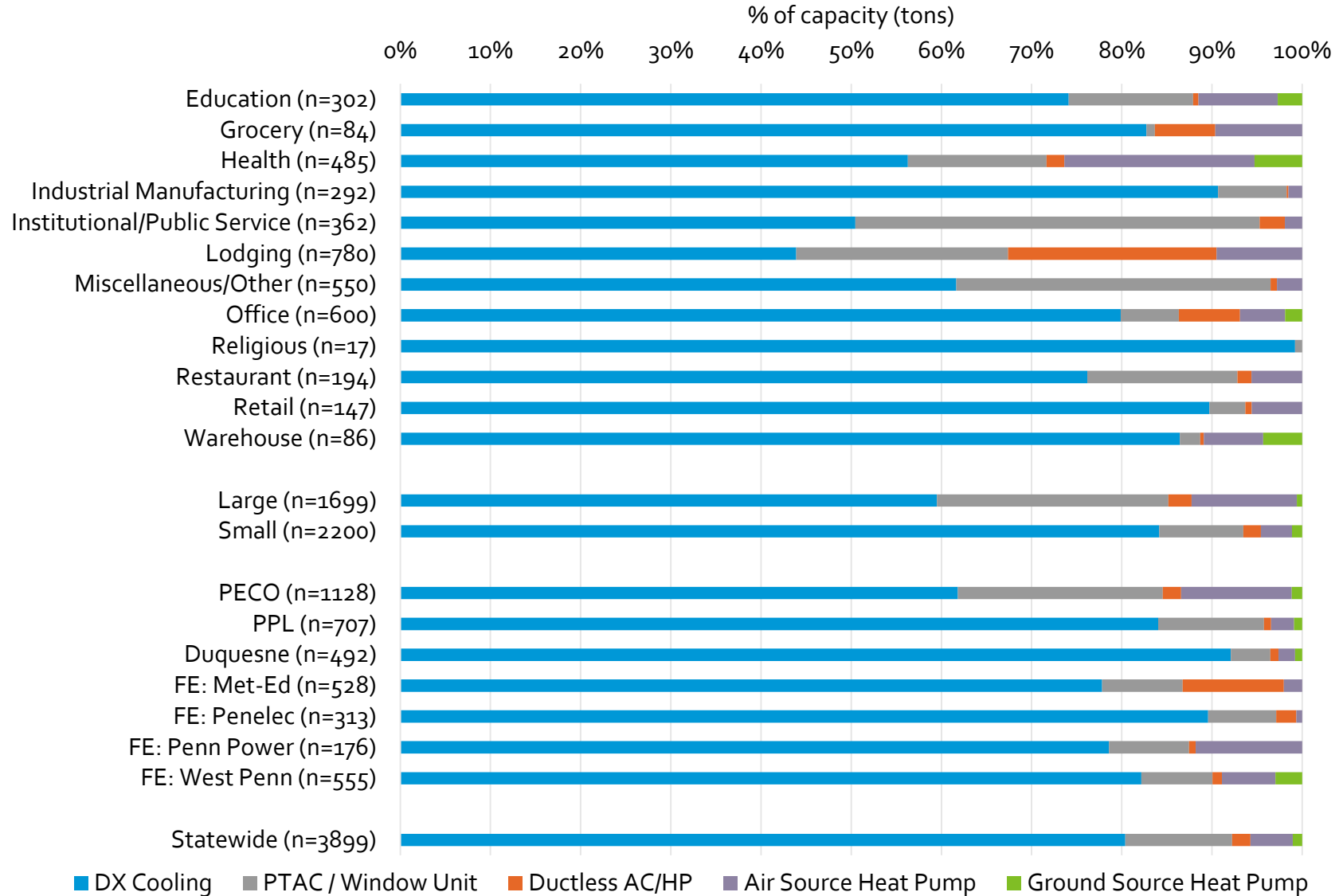
AC – CENTRAL PLANT PARAMETERS

Parameter	Share of Tonnage
Condenser Type	
Air Cooled Condenser	21%
Cooling Tower	79%
Capacity Control	
Fixed Temp	41%
Floating Temp	59%
Fan Control	
2 Speed	10%
Constant	5%
Variable Frequency	85%

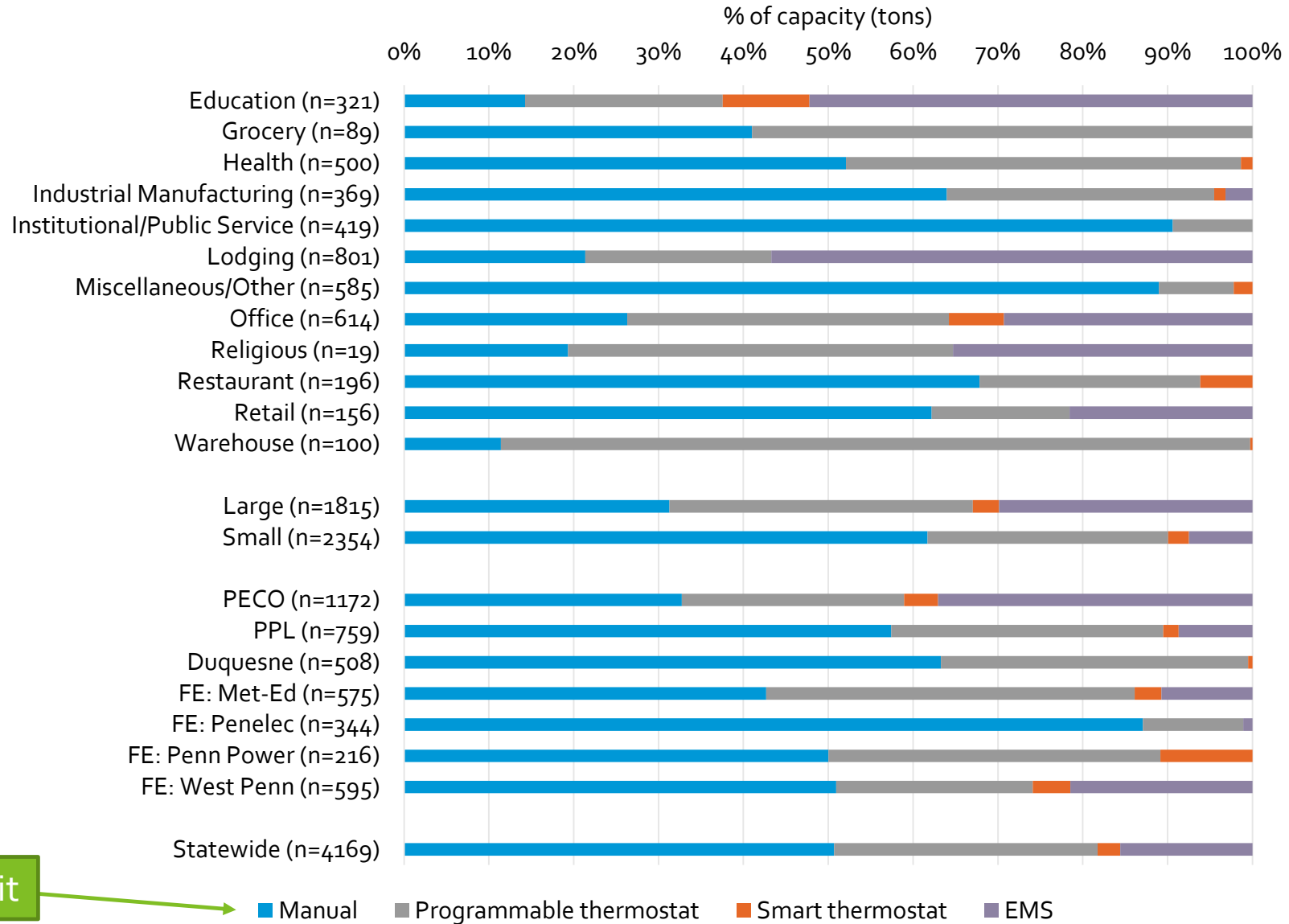
AC – PENETRATION OF UNITARY COOLING ENERGY EFFICIENCY OPTIONS

Parameter	Large (n=623)	Small (n=1,037)	Statewide (n=1,676)
Share of capacity			
Variable Frequency Drive (VFD)	23%	6%	8%
Insulated Ducts	51%	26%	30%
Air-to-Air Recovery	0%	3%	3%
Economizer	16%	18%	18%
Demand Control Ventilation	0%	1%	1%

DETAILED UNITARY COOLING EQUIPMENT TYPE

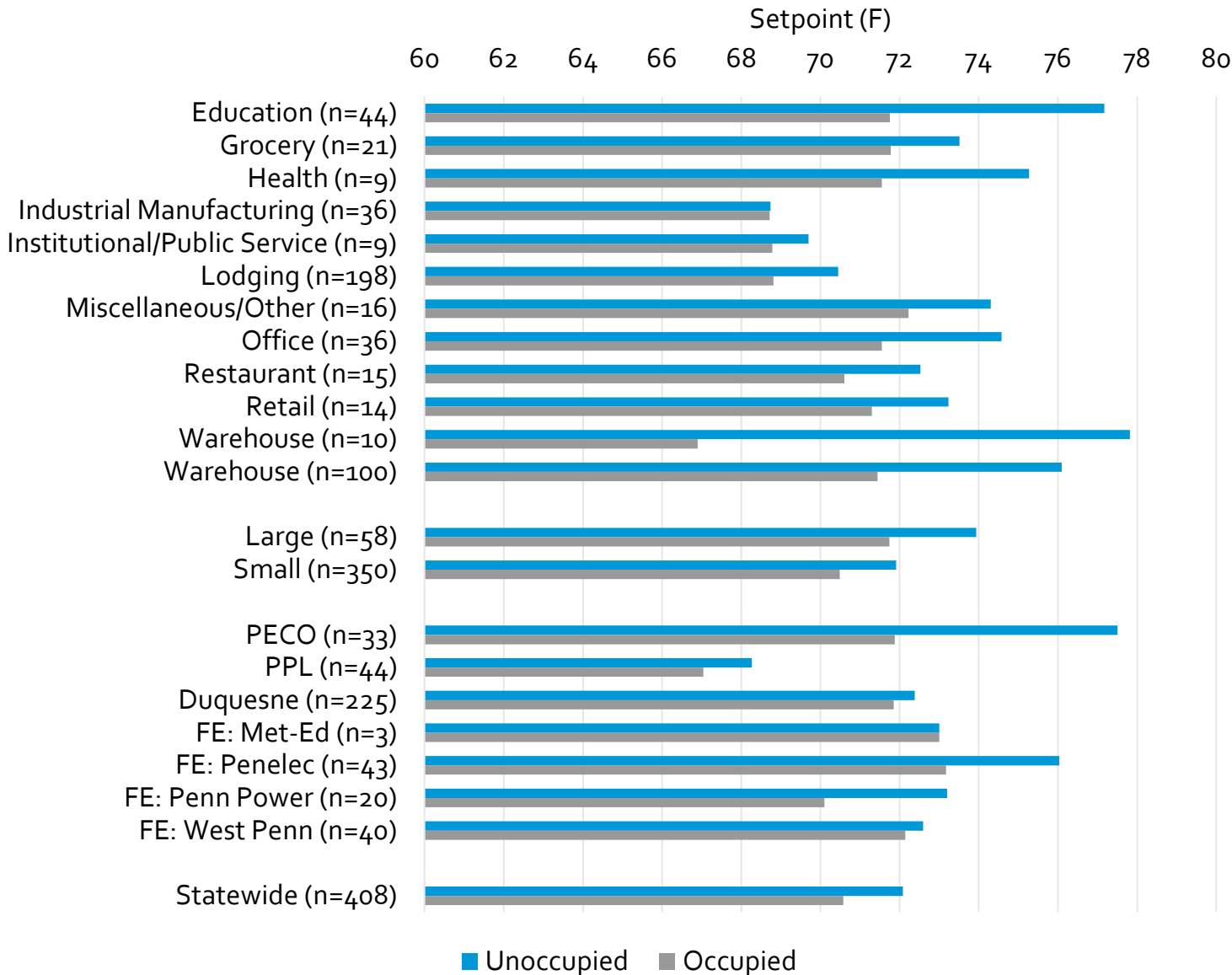


COOLING TEMPERATURE CONTROLS



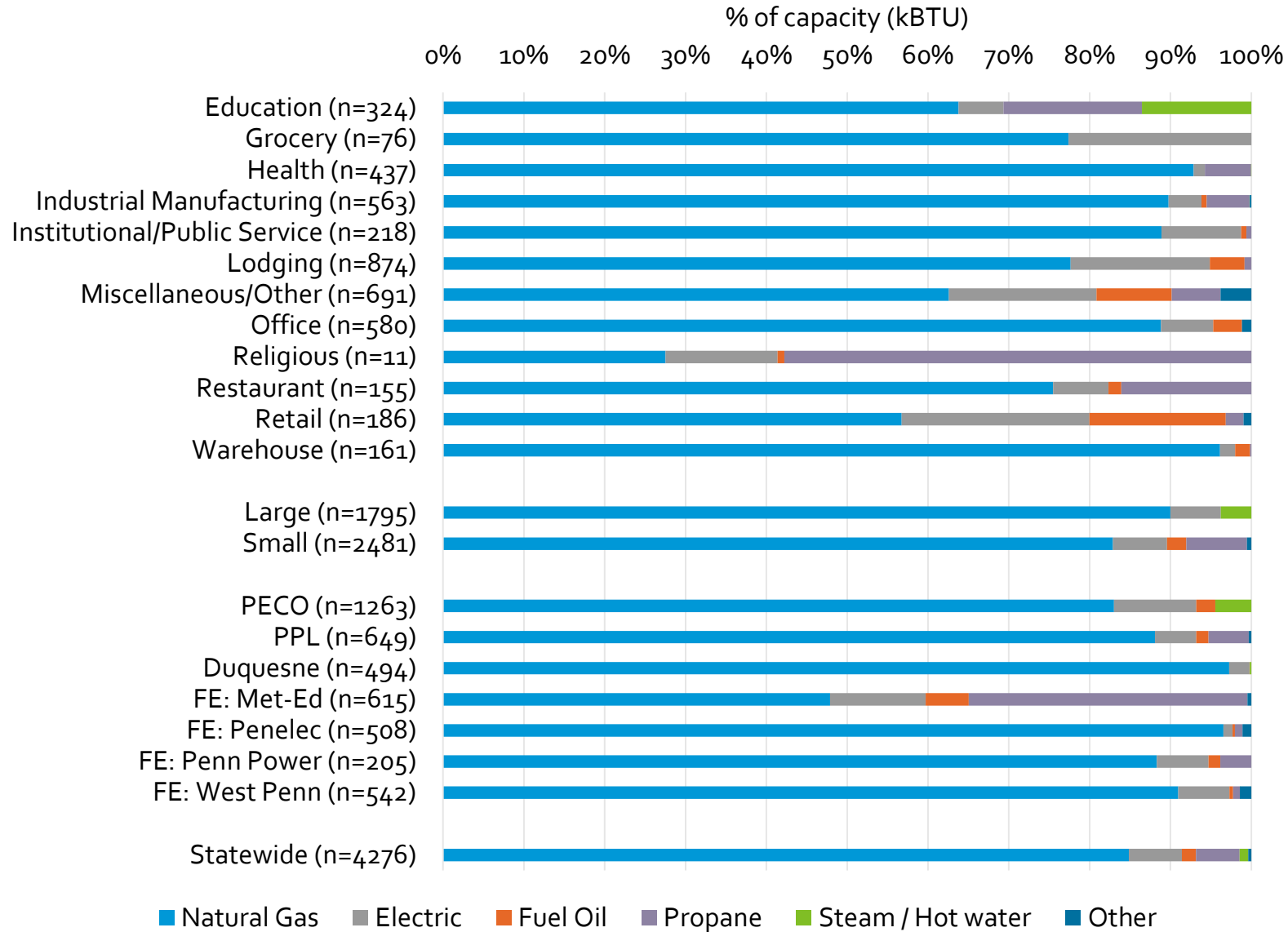
Low-hanging fruit

MEAN COOLING SETPOINTS BY OCCUPANCY AND CONTROL TYPE

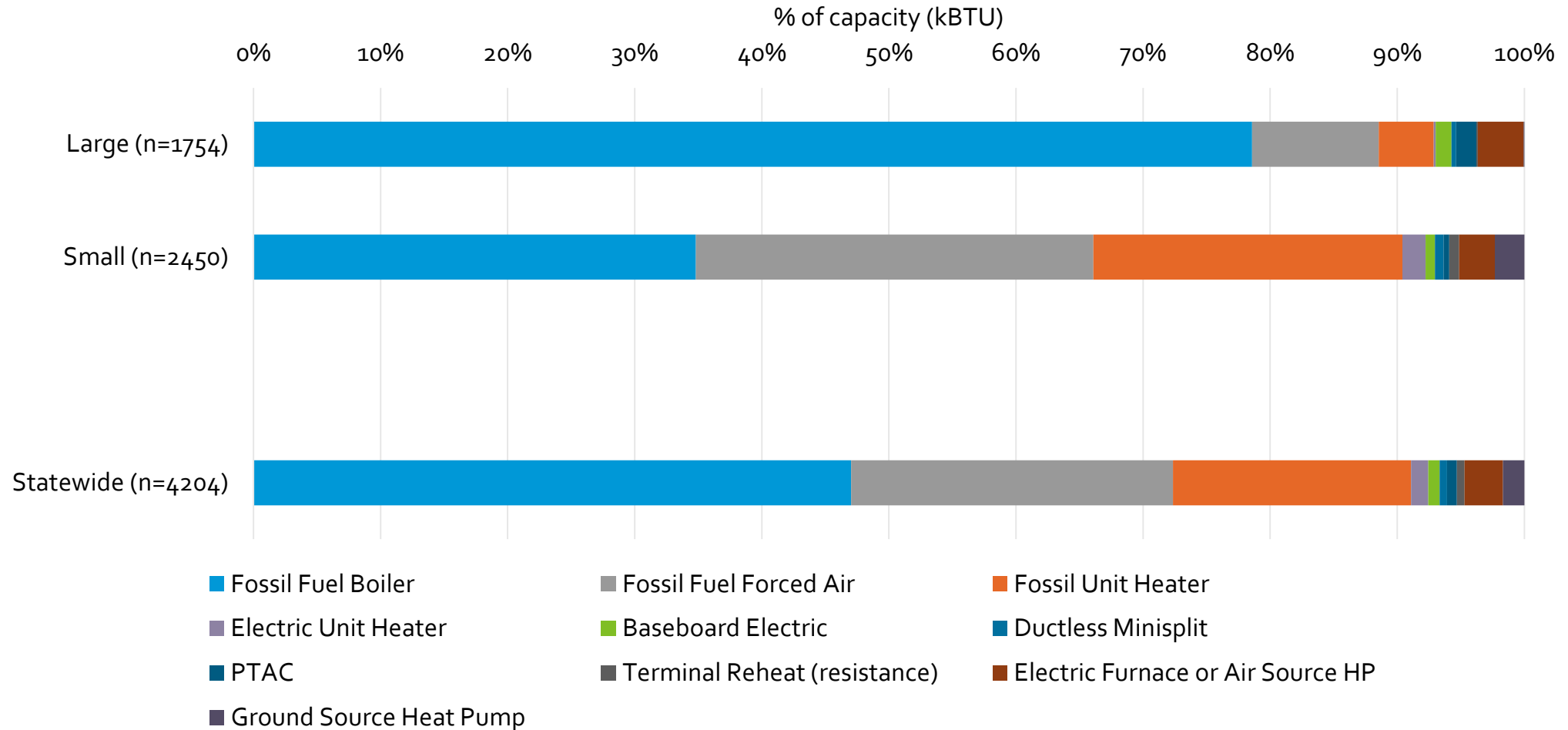


AC Control Type	Unoccupied	Occupied	Difference
Manual (n=199)	68.5	68.2	+0.3
Programmable (n=166)	74.9	72.5	+2.4
Smart (n=23)	77.6	70.9	+6.6
EMS (n=72)	75.7	70.8	+4.9

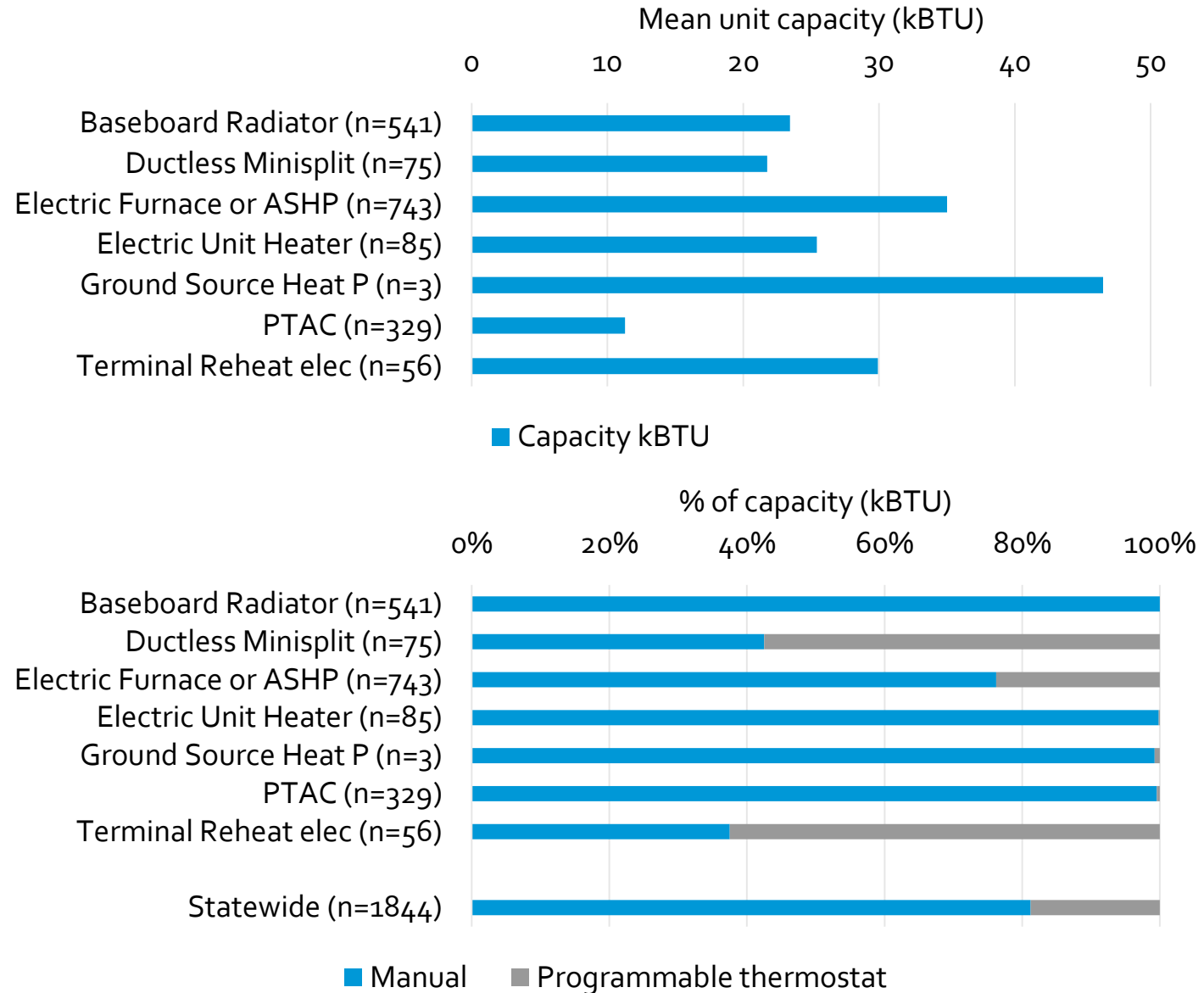
HEATING FUEL SHARES



DETAILED HEATING EQUIPMENT TYPE



ELECTRIC HEATING SYSTEM CAPACITY AND CONTROLS

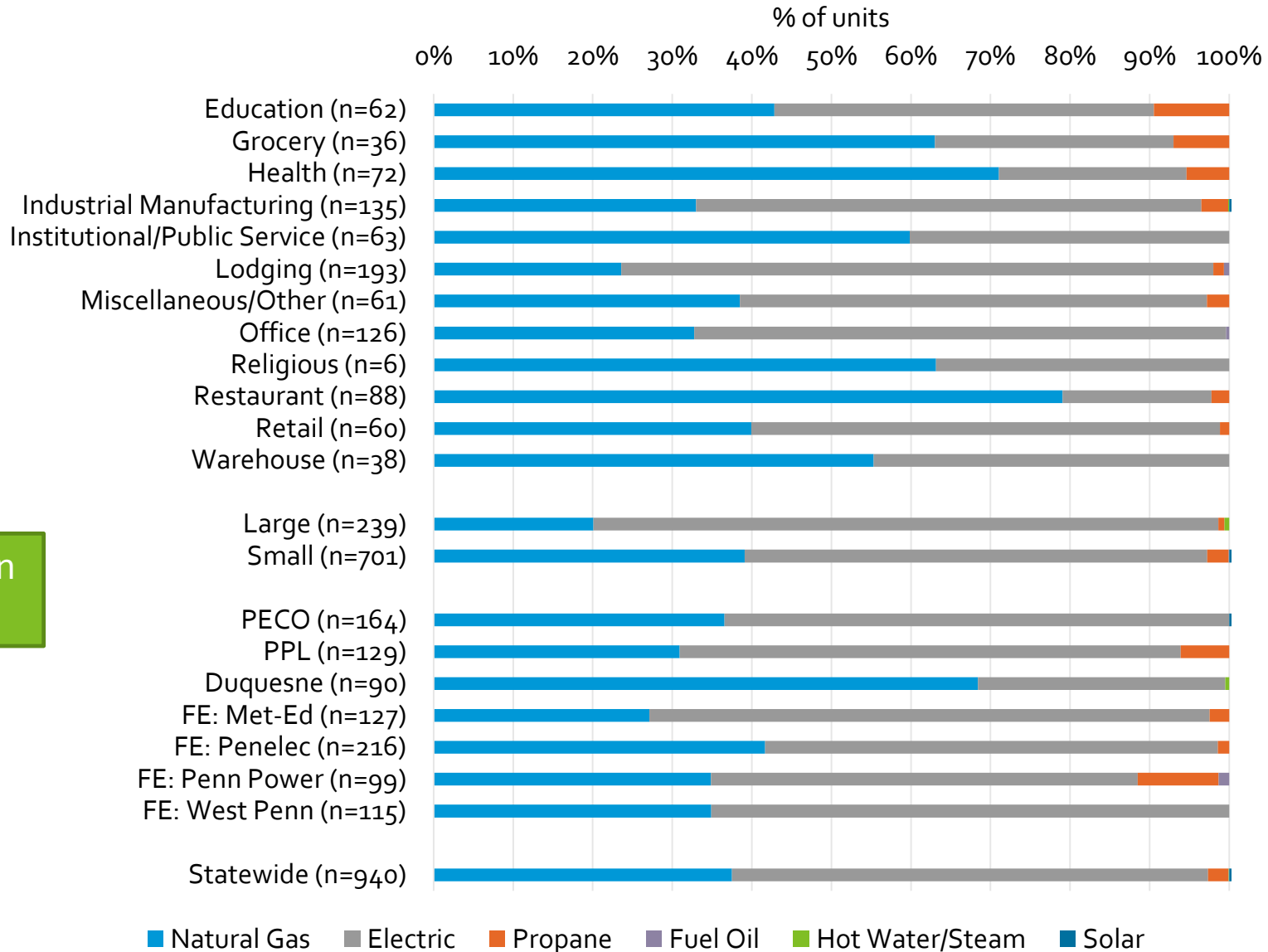


HEATING SETPOINTS BY CONTROL TYPE

Heating Control Type	Unoccupied	Occupied	Difference
Manual (n=224)	65.8	66.9	-1.1
Programmable (n=137)	63.9	69.9	-6.0
Smart (n=5)	61.8	69.8	-8.0
EMS (n=64)	72.7	73.7	-1.0

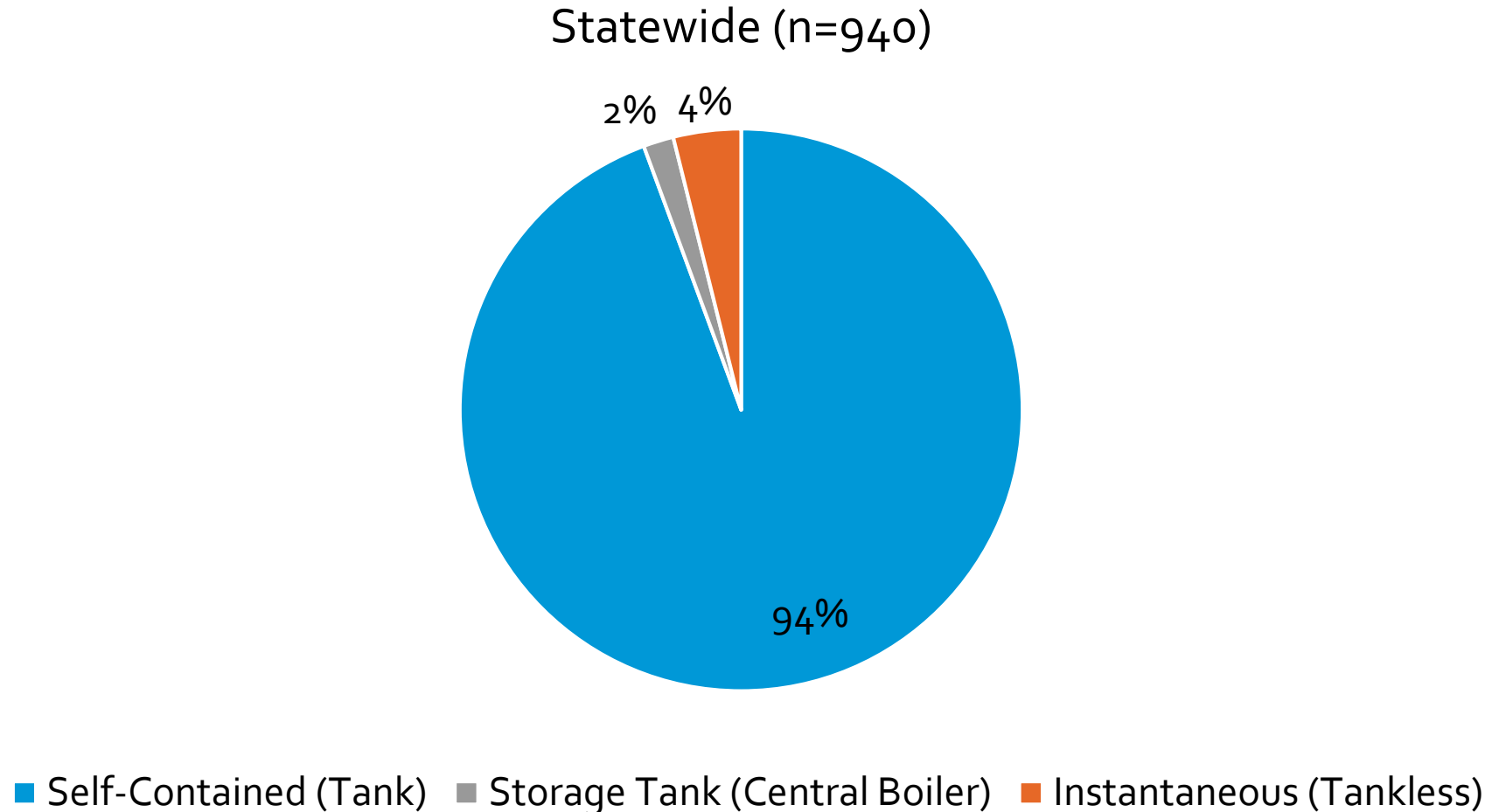
Only includes units where setpoints were verified onsite

WATER HEATING – DISTRIBUTION OF FUEL SHARE (BY DEVICE COUNT)



Slightly more gas in the urban EDCs

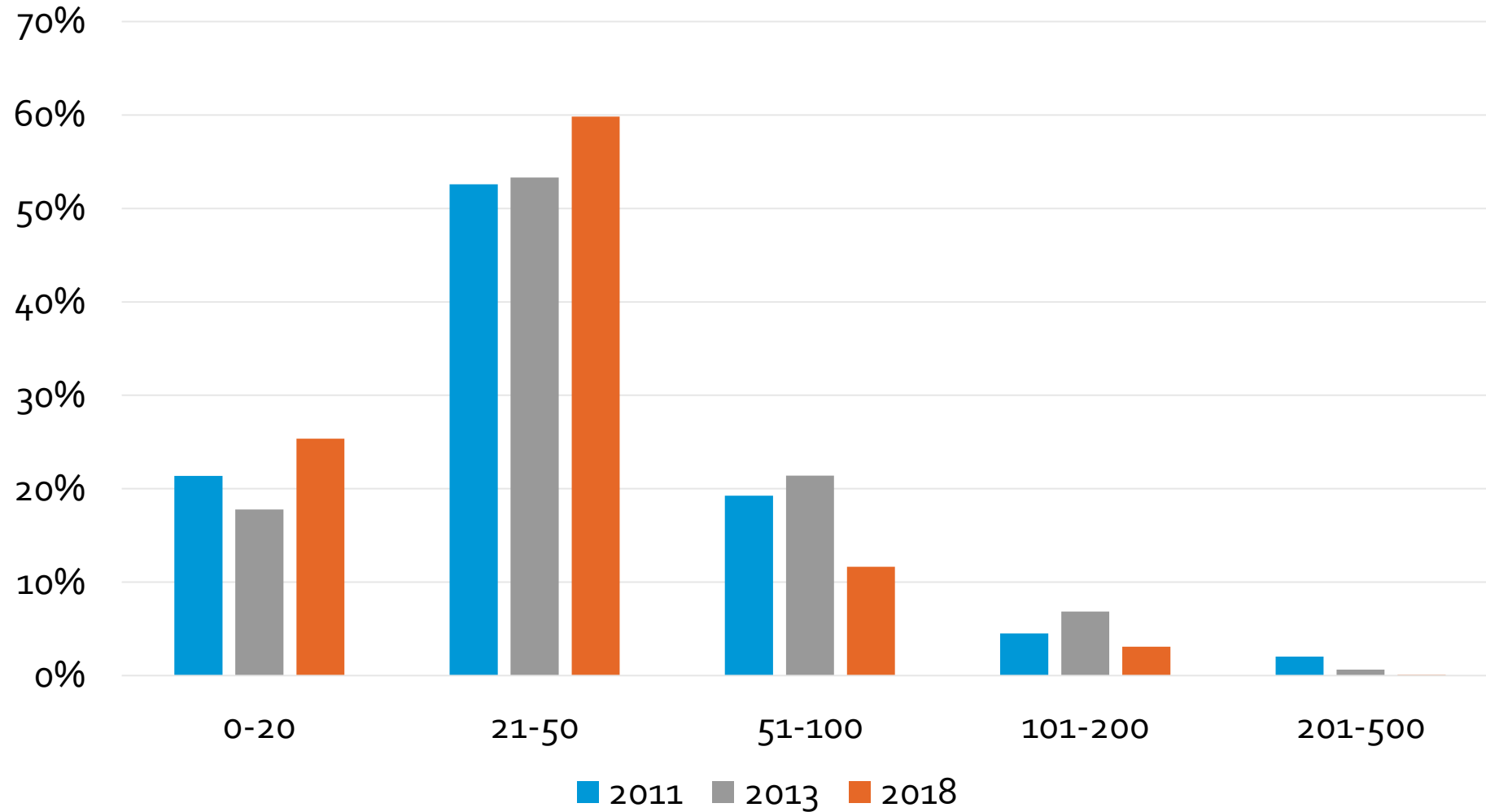
WATER HEATING – DISTRIBUTION OF TANK TYPE (BY DEVICE COUNT)



WATER HEATING – UNIT CHARACTERISTICS

Segment	Avg. Age	Avg. Tank Capacity	Avg. Input Capacity (BTU/h)	Avg. Efficiency of Electric Units	Avg. Efficiency of Fossil Fuel Units
Education (n=62)	7.8	61.8	148,658	94	86
Grocery (n=34)	5.6	46.7	61,448	90	82
Health (n=72)	11.4	618.6	209,870	77	84
Industrial Manufacturing (n=135)	10.5	44.7	58,202	92	81
Institutional/Public Service (n=64)	9.7	54.9	48,057	97	80
Lodging (n=192)	18.9	51.1	157,080	88	87
Miscellaneous/Other (n=61)	8.8	42.3	59,015	95	80
Office (n=126)	8.6	34.7	27,752	92	82
Religious (n=6)	11.0	42.8	33,100	92	80
Restaurant (n=89)	7.7	53.3	71,302	90	78
Retail (n=61)	9.2	42.7	60,211	97	79
Warehouse (n=38)	5.2	45.1	30,410	98	78
Statewide (n=940)	9.5	61.4	58,014	92	81

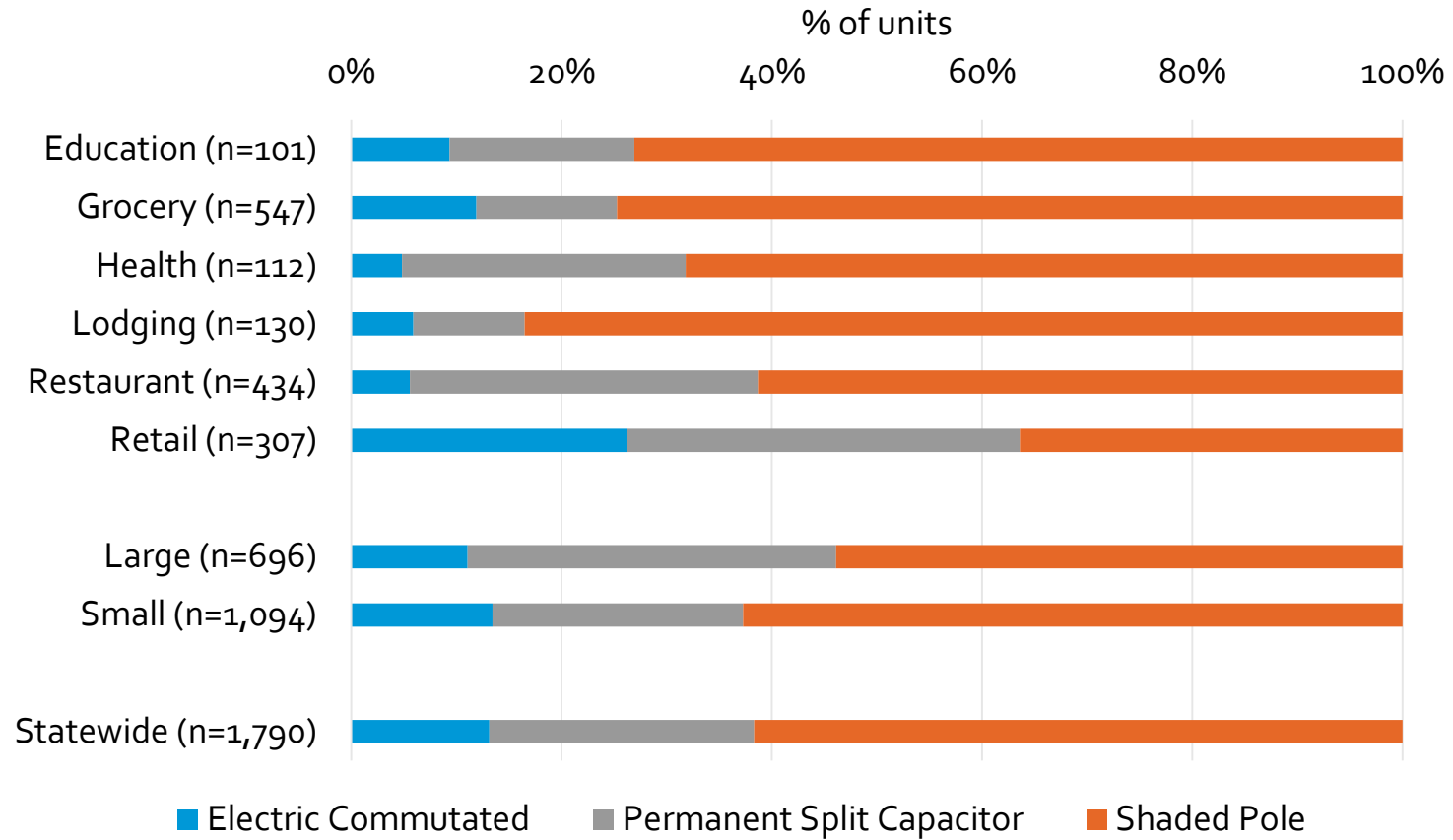
COMPARISON WITH PRIOR STUDIES – WATER HEATING TANK CAPACITY



REFRIGERATION – PENETRATION

Segment	n	Any Refrigeration	Walk-In Refrigeration	Reach-In Refrigeration
Education	35	39%	17%	39%
Grocery	20	100%	59%	96%
Health	38	50%	20%	44%
Industrial Manufacturing	75	11%	6%	9%
Institutional/Public Service	43	15%	3%	15%
Lodging	21	48%	30%	48%
Miscellaneous/Other	58	16%	10%	15%
Office	55	5%	4%	1%
Religious	5	69%	0%	69%
Restaurant	60	100%	69%	93%
Retail	57	38%	12%	38%
Warehouse	40	30%	19%	26%
Sector				
Large	68	28%	19%	23%
Small	439	16%	7%	14%
EDC				
PECO	67	19%	9%	18%
PPL	80	17%	4%	15%
Duquesne	71	19%	16%	14%
FE: Met-Ed	64	12%	5%	12%
FE: Penelec	77	14%	3%	14%
FE: Penn Power	72	18%	13%	6%
FE: West Penn	76	12%	6%	12%
Statewide				
	507	16%	7%	14%

REFRIGERATION – MOTOR TYPE



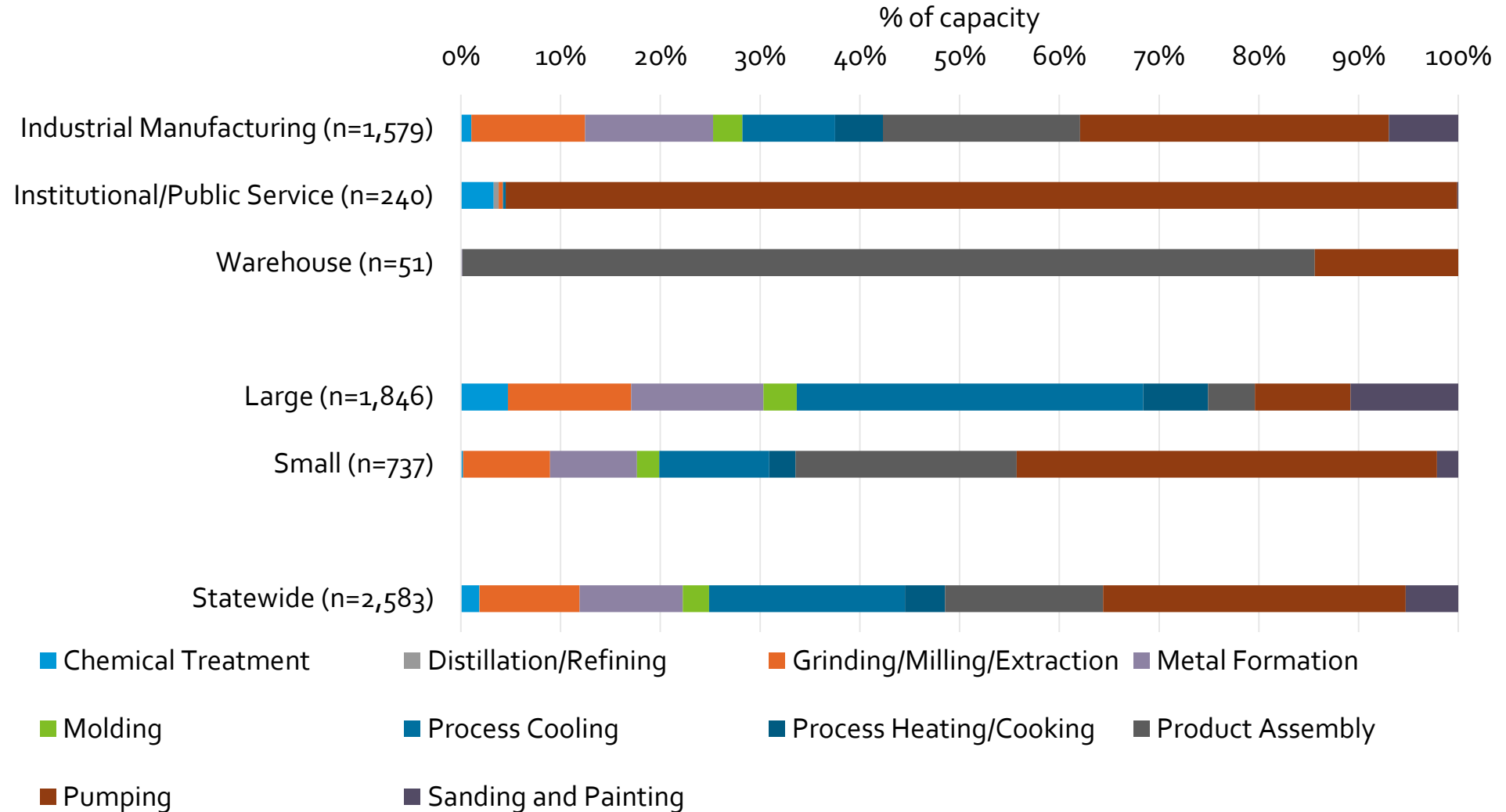
REFRIGERATION – UNIT CHARACTERISTICS

	Walk-In		Reach-In	
	Large C&I	Small C&I	Large C&I	Small C&I
n (sites)	21	88	22	147
Anti-Sweat Heating Control	N/A	N/A	14%	5%
Special Doors	N/A	N/A	42%	15%
LED Lights	66%	18%	39%	45%
Motion Sensors	13%	0%	11%	1%
VFDs on Compressors	30%	11%	N/A	N/A
VFDs on Condensers	30%	10%	N/A	N/A
Demand Defrost Controls	35%	19%	22%	9%
Floating Head Pressure	32%	8%	N/A	N/A
System Commissioned	44%	12%	N/A	N/A
Heat Recovery	7%	0%	N/A	N/A

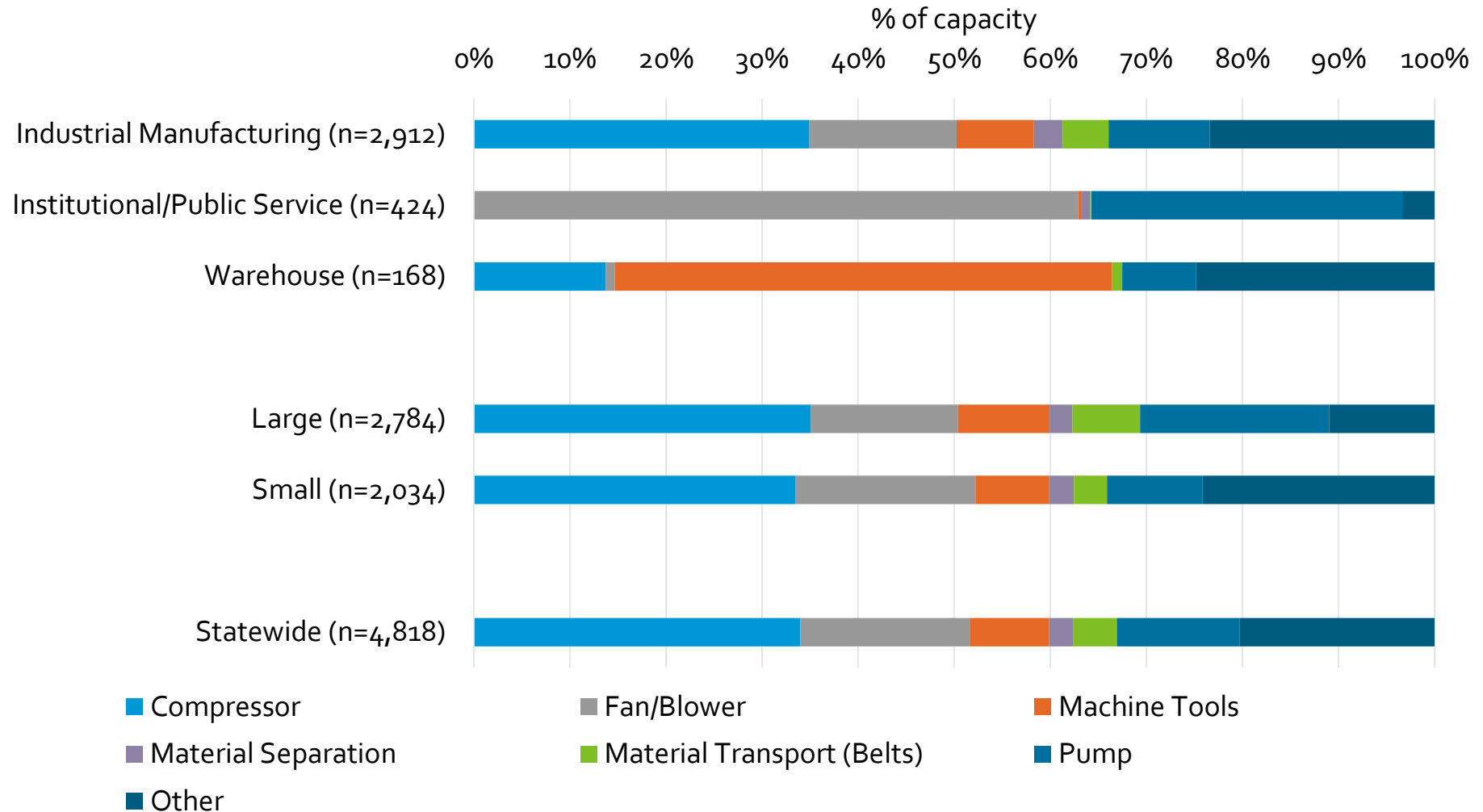
PROCESS

- Survey data includes information on the overall process and the corresponding motors
 - Process categories include:
 - Chemical Treatment
 - Distillation/Refining
 - Grinding/Milling/Extraction
 - Metal Formation
 - Molding
 - Process Cooling
 - Process Heating/Cooking
 - Product Assembly
 - Pumping
 - Sanding and Painting
 - Motor categories include:
 - Compressor
 - Fan/Blower
 - Machine Tools
 - Material Separation
 - Material Transport (Belts)
 - Pump
- $\# \text{ Units} = \# \text{ Identical Processes} * \# \text{ Motors per Process}$

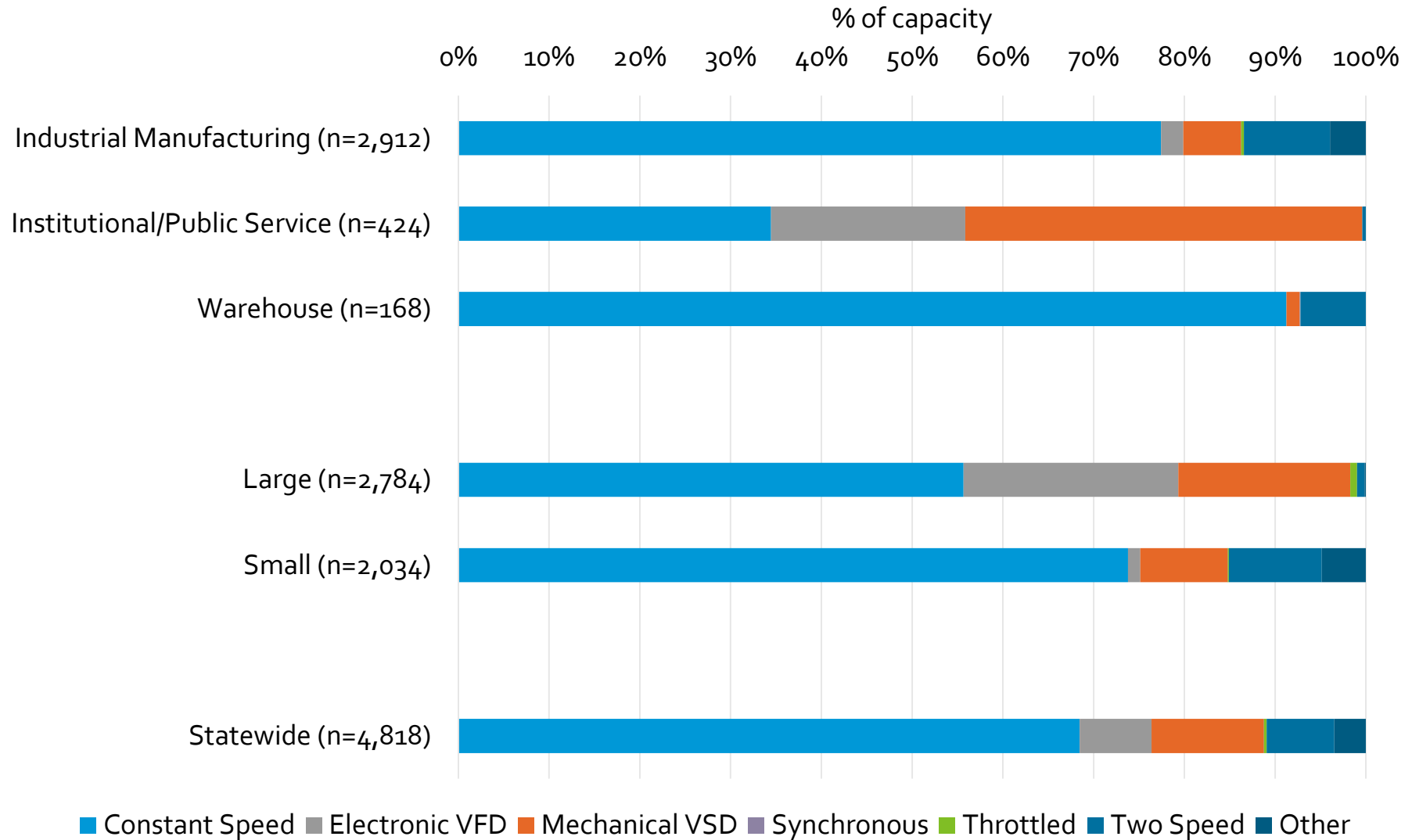
DISTRIBUTION OF PROCESS TYPE FOR ELECTRIC PROCESSES



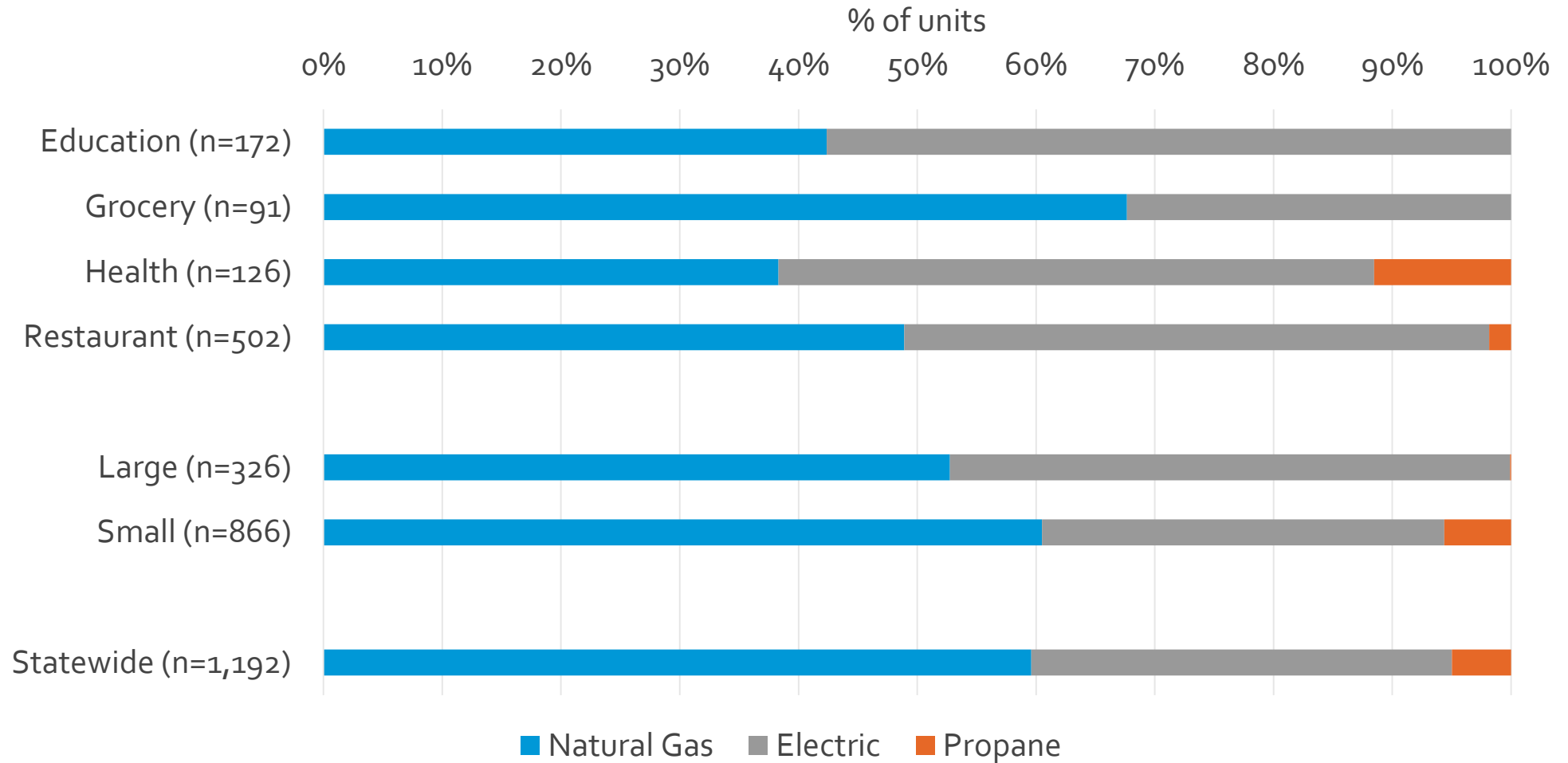
PROCESS – DISTRIBUTION OF SERVICE TYPE



PROCESS – DISTRIBUTION OF MOTOR CONTROL TYPE

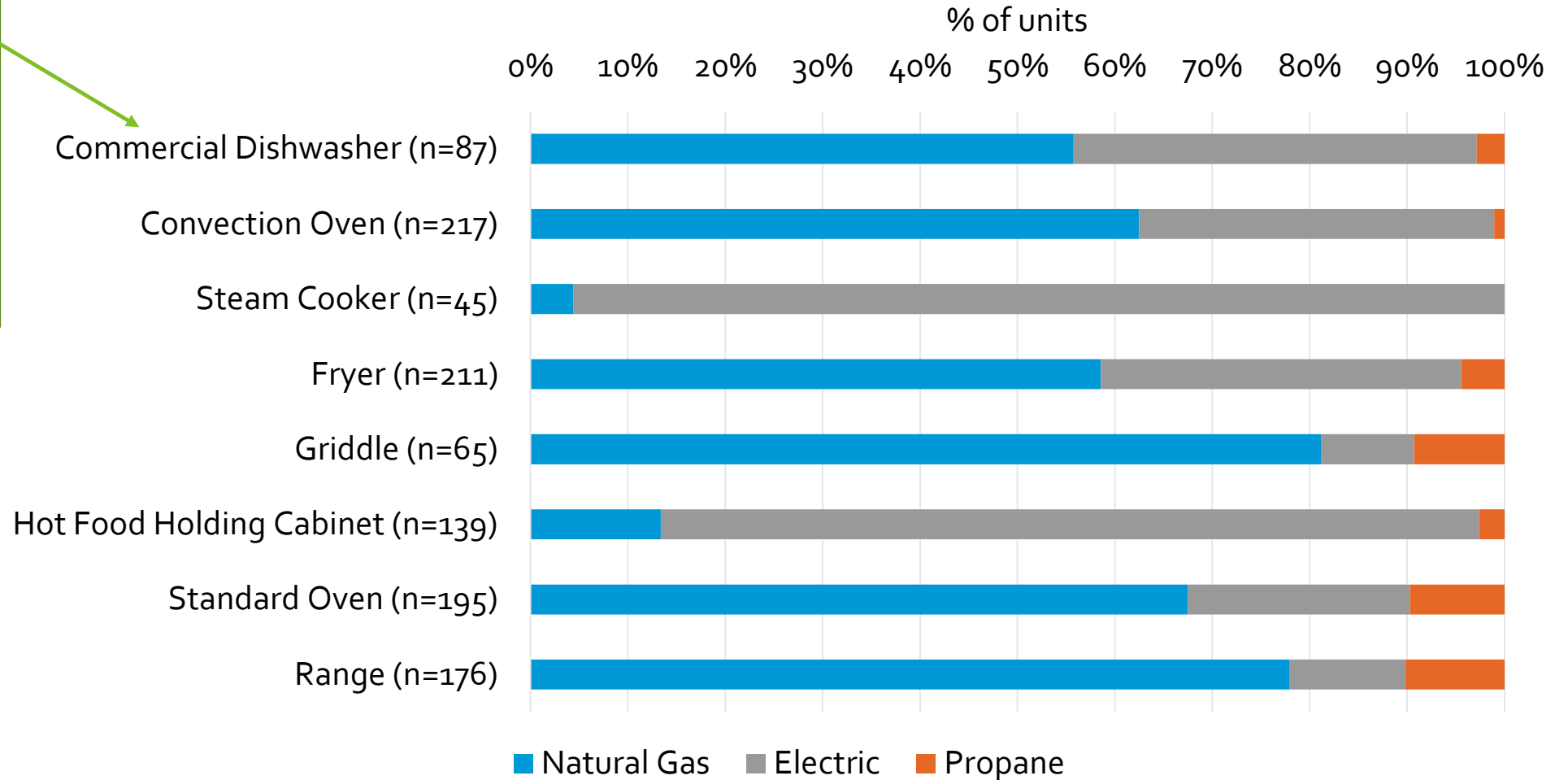


COOKING – FUEL SHARE



COOKING – FUEL SHARE BY EQUIPMENT TYPE

Fuel share for commercial dishwashers indicates the type of fuel used for the water heating component of the dishwasher.



COOKING – PERCENT OF EQUIPMENT WITH ENERGY STAR RATING

Kitchen Equipment Type (n=unit)	% ENERGY STAR
Commercial Dishwasher (n=59)	6.8
Convection Oven (n=142)	9.3
Fryer (n=89)	8.2
Griddle (n=44)	16.5
Hot Food Holding Cabinet (n=70)	4.3
Range (n=130)	4.3
Standard Oven (n=139)	7.1
Steam Cooker (n=28)	10.7

Clearly identifiable
only

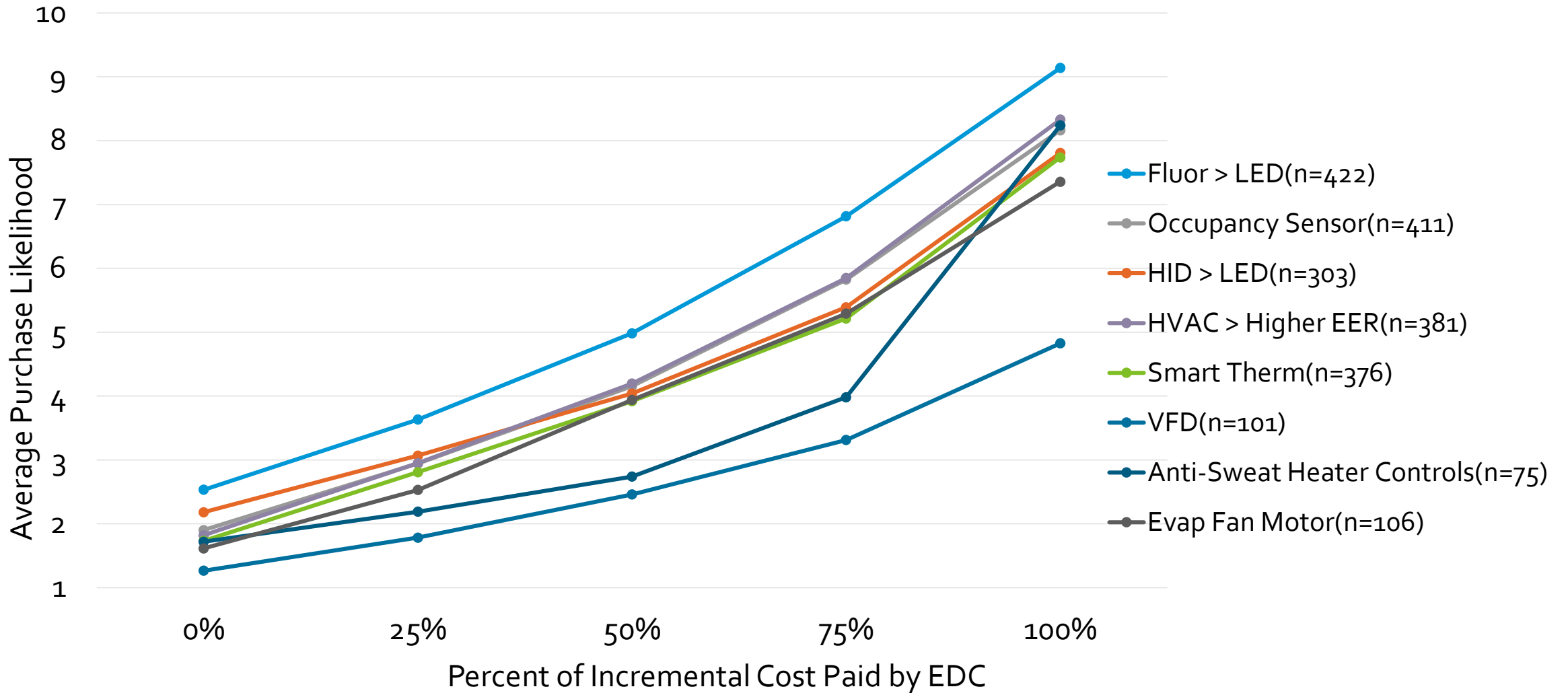
PLUG LOAD – EQUIPMENT PENETRATION

Equipment Type	Large (n = 64)	Small (n = 413)	Statewide (n = 477)	% ENERGY STAR
All-in-One Imaging	85%	55%	56%	44.5
Servers	58%	34%	35%	19.4
Laptops	47%	31%	32%	44.8
Personal Computers	90%	89%	89%	25.3
Monitors	94%	83%	84%	38.9
Paper Shredders	42%	27%	27%	14.3
Standalone Fax Machine	15%	8%	8%	21.5
Standalone Photocopiers	8%	7%	7%	36.1
Standalone Printers	70%	62%	62%	28.8
Standalone Scanners	0%	3%	3%	39.4
Televisions	53%	38%	38%	29.6
Uninterruptable Power Supply	2%	1%	1%	2.8
Water Coolers	51%	36%	36%	15.2
Refrigerated Vending Machines	50%	18%	19%	12.2
Non-Refrigerated Vending Machines	35%	17%	17%	7.7
Residential Style Refrigerators	68%	81%	81%	25.4
Ice Makers	8%	3%	3%	11.5

WILLINGNESS TO PAY

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Purchase Likelihood (1 = Not at All Likely, 10 = Extremely Likely)



EQUIPMENT PURCHASE POLICIES AND PROGRAM AWARENESS

% "Yes"

Survey Question	Large (n=63)	Small (n=418)	Statewide (n=481)
Does your company have any procurement policies or guidelines to purchase high efficiency options when they are available and would provide a lower life cycle cost?	51%	24%	24%
Do you do capital planning for major equipment replacements and proactively replace equipment when it is toward the end of its useful life (as opposed to waiting until something fails to replace it)?	85%	29%	30%
For significant energy-using equipment purchases, does your company routinely analyze the different efficiency and cost options to assess life cycle costs?	91%	47%	48%
Are you aware of your utility's energy efficiency rebate program?	87%	37%	39%
Have you participated in the program before?	71%	17%	18%

MOTIVATING FACTORS FOR ENERGY EFFICIENT INVESTMENTS

1 = Not Important
5 = Very Important

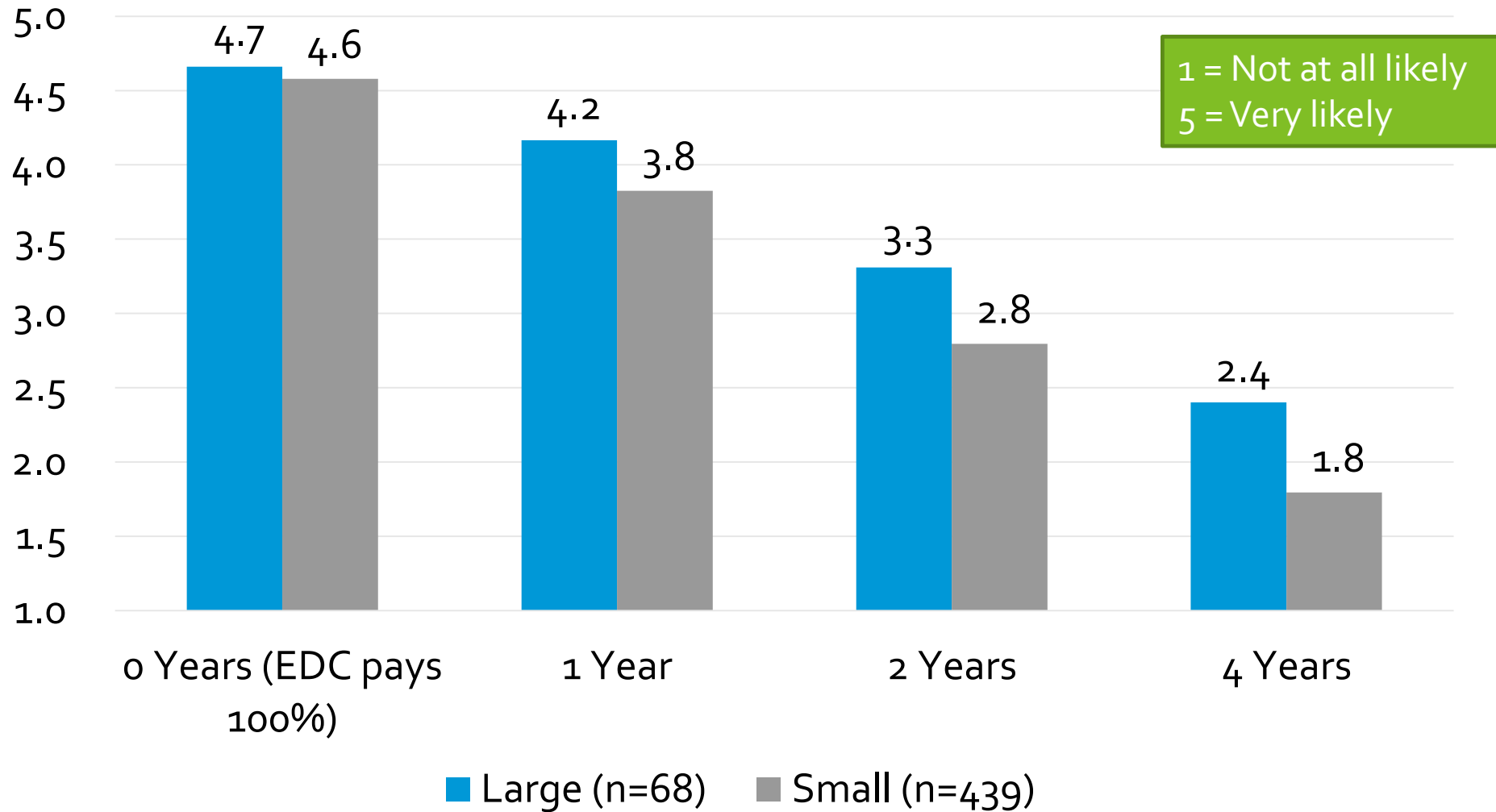
Motivation of Interest	Mean Response (1-5)
Availability to Utility Rebate (n=481)	3.5
Environmental Concerns (n=483)	3.2
Health Benefits (n=483)	3.4
Higher Rent for Tenants (n=483)	1.3
Improved Cash Flow (n=483)	4.4
Interest in Advanced Technologies (n=483)	3.1
Lower Energy Bills (n=483)	4.2

BARRIERS TO ENERGY EFFICIENT INVESTMENTS

1 = Never
5 = Often

Barrier of Interest	Mean Response (1-5)
Access to Financing (n=483)	2.6
Awareness of Efficient Technology (n=483)	2.3
Company Branding Restrictions (n=483)	1.2
Concerns for Tenant Comfort (n=483)	1.8
Disruptions to Service (n=483)	2.9
Return on Investment (n=483)	3.0

LIKELIHOOD OF INVESTING BASED ON TIMING OF RETURN



QUESTIONS?

