Commercial Building Stock Assessment: Results Webinar

May 11th, 2020

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2019 Commercial Building Stock Assessment

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May 11, 2020

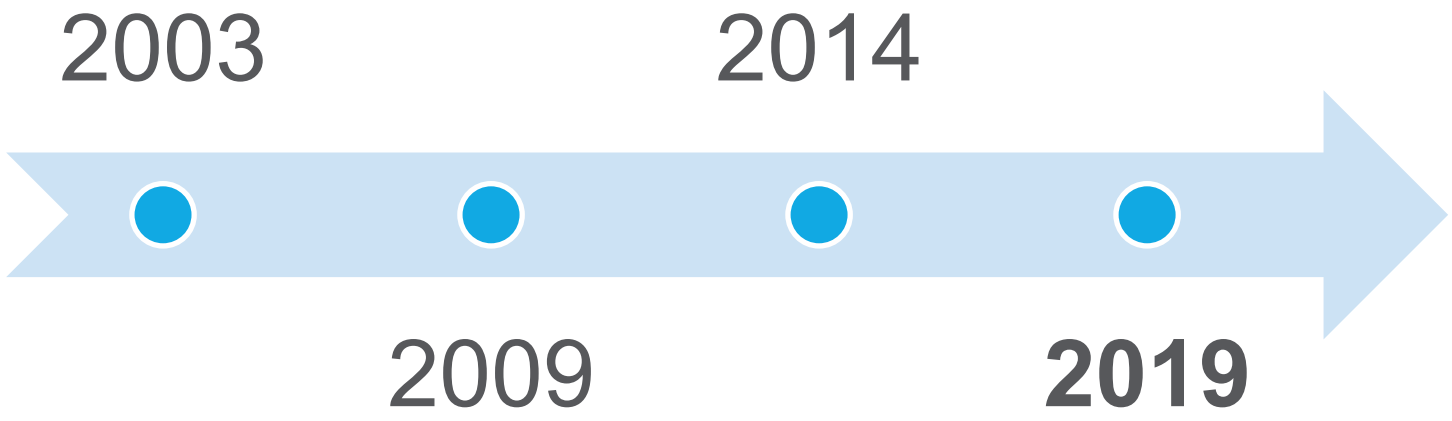
CLASSIFICATION LEVEL: PUBLIC

Agenda

- General Overview of CBSA Study
- Study Methods
- High Level Findings
  - Building Characteristics
  - Space Heating and Cooling
  - Water Heating
  - Lighting
  - Energy Use Intensities
- Conclusions

General Overview

Commercial Building Stock Assessments



- Conducted region-wide
- Provide inputs into regional power plan and utility energy efficiency program design and planning
- Establish baseline of current use
- To the extent possible, observe changes in building stock over time
- Developed through collaborative process with stakeholder working groups

2019 CBSA

- Phase 1 Study (SBW Consulting)
  - Sample Design
  - Data Collection Fields
- Phase 2 Study (Cadmus)
  - Develop Sample Frame
  - Implement Sample Design
  - Data Collection
  - Develop Case Weights
  - Data Analysis
  - Database and Reporting

Cadmus Team

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Major Changes from 2014 to 2019 CBSA

- Sample design
  - Innovative virtual catalog
  - Two-stage sample design
  - Specific definition for sites (one or more buildings in a census block on contiguous parcels with the same property taxpayer)
  - Set 1,000 square feet as minimum site floor area
  - 2014 sampled new construction at higher rate than other vintages

Major Changes from 2014 to 2019 CBSA

- Building types
  - Excluded universities
  - Added “mixed commercial” building type
  - Removed small residential care
  - Excluded exterior parking garages and vacant buildings

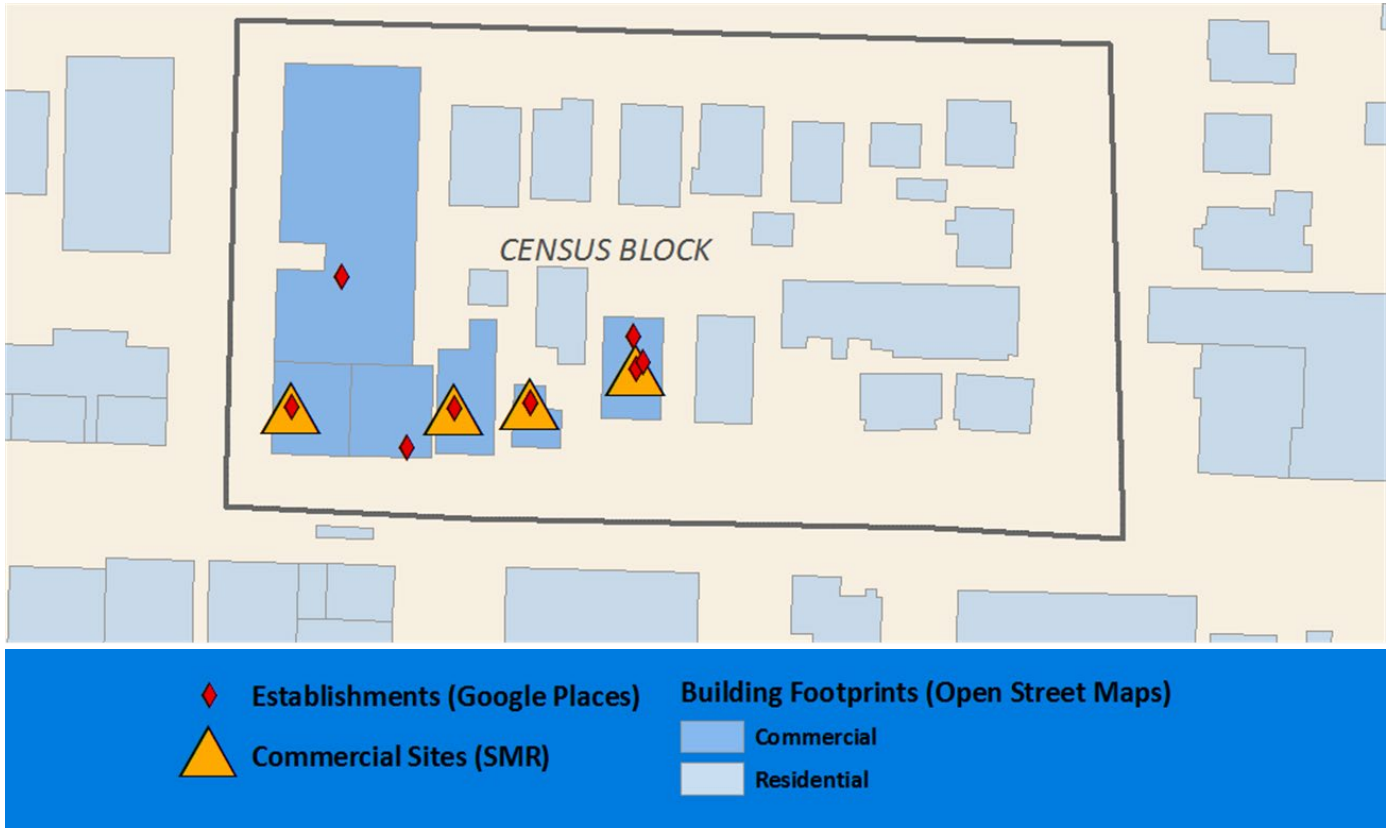
Major Changes from 2014 to 2019 CBSA

- Updated data collection fields
  - Tablet-based data collection
  - Removed or consolidated many fields
  - More extensive detail on pump systems
- Analysis
  - Not clear whether 2014 used sites or buildings for analysis
  - 2019 conducted most analysis on building-level (except EUIs)
  - Updated case weighting method based on two-stage sample

CBSA 2019 Methods

CBSA 2019 Methods: Virtual Catalog

- Innovative Technique Using Geocoded Data
- Combined Data from:
  - Google Places (back-end data for Google Maps)
  - SMR Research (parcel-level tax assessor data)
  - U.S. Census Bureau geospatial and tabular datasets



CBSA 2019 Methods: Two-Stage Sample

- Stage 1 Sample
  - Filtered virtual catalog to remove nonapplicable sites
  - Sampled 5,000 census blocks
  - Stratified on size, region, density, urban/rural, IOU/POU
  - Manual review of census blocks
  - Resulted in ~30,000 sites
- Stage 2 Sample
  - Stratified by building type
  - Sampled in waves
  - No more than two sites per block
  - Soft targets by floor area and region to ensure reasonable representation

CBSA 2019 Methods: Sample Targets

- Targeted Size Strata
  - Small: 1,000 to 10,000 ft^2 (51%)
  - Medium: 10,000 to 100,000 ft^2 (34%)
  - Large: greater than 100,000 ft^2 (15%)
- Regional strata
  - Idaho/Montana: 17%
  - Oregon: 27%
  - Washington: 55%

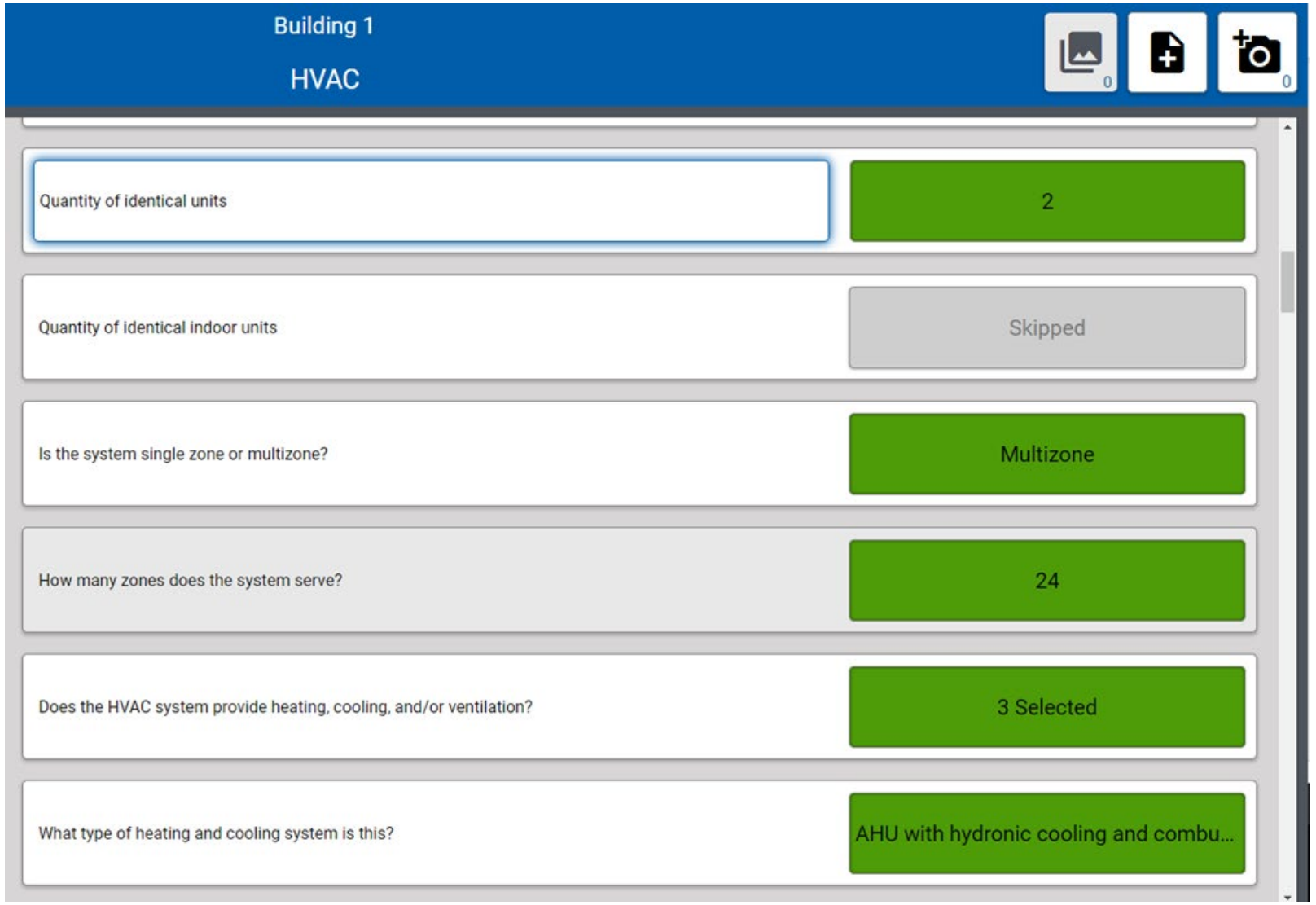
Building Type	Stage 1 Sites	Sample Targets
Assembly	20,663	56
Grocery	11,162	68
Hospital	922	45
Lodging	5,809	71
Mixed Commercial	40,157	83
Office	58,612	116
Other	5,745	21
Residential Care	6,042	80*
Restaurant	19,188	51
Retail/Service	58,416	89
School	8,669	45
Warehouse	26,194	83
Total	**261,579**	**808***

CBSA 2019 Methods: Recruitment

- Cadmus Asked Utilities, BPA, and Energy Trust to First Review Sites
- Varied Recruitment Methods
  - Utility, BPA, Energy Trust Outreach
  - Professional Relationships
  - Call Center
  - Trade Organizations
  - Door-to-Door Outreach
- Incentives
  - Gift Card Ranging from $50-$250 (depending on site size)
  - Site-Specific Energy Report

CBSA 2019 Methods: Data Collection

- Tablet-Based Data Collection
- Tool Linked Photos Directly to Data Entries
- Approx. 550 Data Fields
- Field Assessors Had to Prioritize Based on Time Available On-Site



CBSA 2019 Methods: Within-Site Sampling

- Three Levels Possible Within-Site
  - Building Sampling
  - Business Sampling
  - Room Sampling
- Conditional on Approval from Site Contacts
- Frequent Constraints from Site Contacts and Tenants

CBSA 2019 Methods: Case Weights

- Determined as Function of Inclusion Probability
- Logistic Regression Variables
  - Stage 1 census block selection probability
  - Stage 2 site floor area as fraction of total strata floor area
  - Stage 2 recruitment eligibility rates
- Trimmed Weights for Sites with Weighted Floor or Room Area Greater than 10% of Total
- Calibrated Weights so Resulting Floor Area Equal to Total in Stage 1 Sample Frame within Each Type

CBSA 2019 Methods: Data Analysis

- Equipment and Capacities Analyzed at Building Level
- Applied Within-Site Sampling Weights
- Lighting Power Density
- Energy Use Intensities
- Applied Case Weights to Calculate Region-Level Results

CBSA 2019 Methods: Database and Tables

- Final data stored as SQL relational database
- Extensive dataset – 96 tables with 1,241 unique columns
- 62 analysis tables in public Excel workbook
- Public flat file tables
  - Building summary
  - HVAC summary
  - Lighting summary

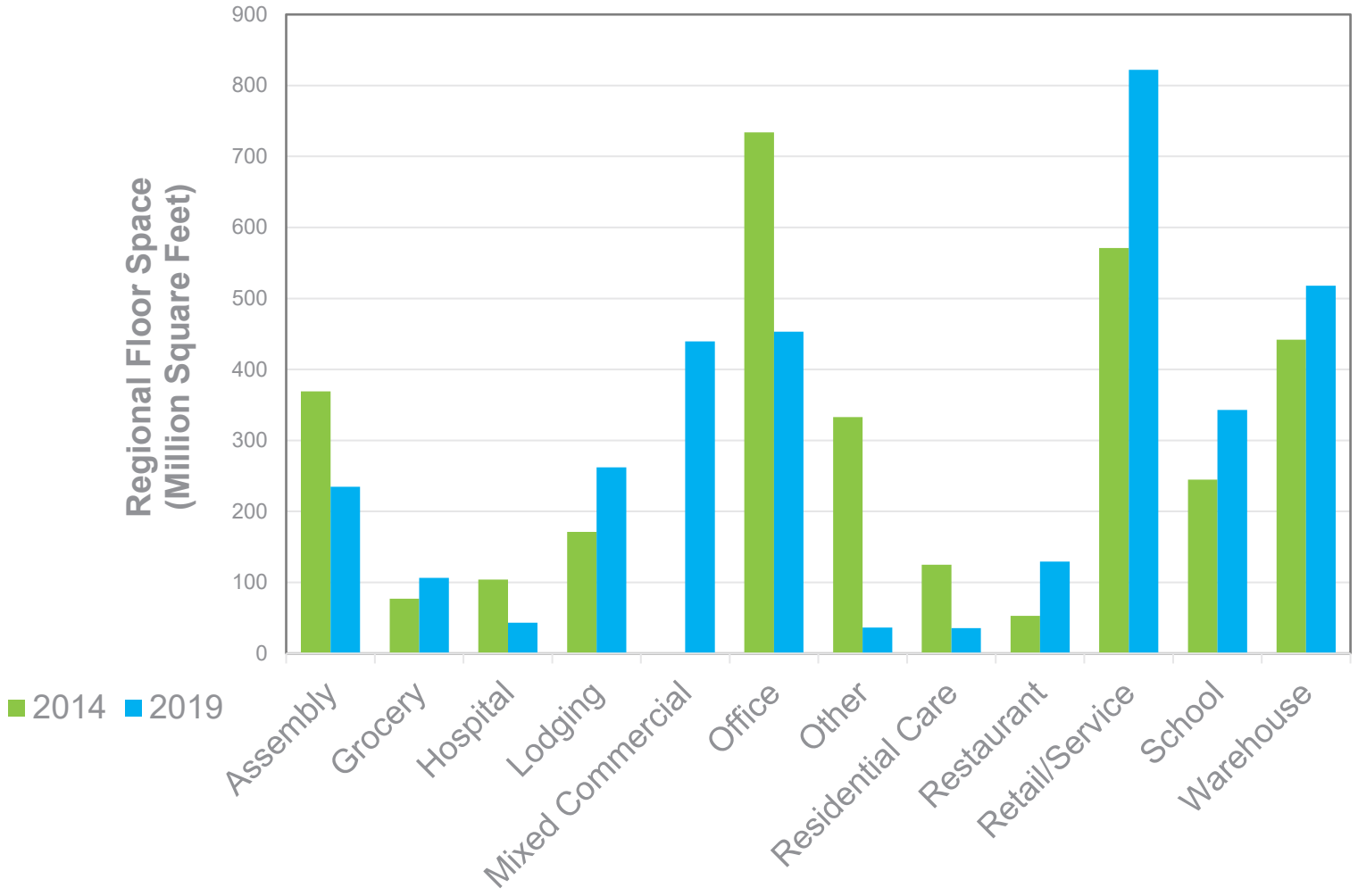
Key Findings

Final Assessment Results

Building Type	Sample Targets	Sites Assessed	Buildings Assessed
Assembly	56	60	72
Grocery	68	59	60
Hospital	45	43	53
Lodging	71	66	83
Mixed Commercial	83	99	73
Office	116	108	153
Other	21	13	24
Residential Care	38	40	51
Restaurant	51	46	53
Retail / Service	89	105	133
School	45	44	68
Warehouse	83	66	109
Total	**766**	**749**	**932**

Building Characteristics

- Total Floor Space
  - 3,424 million square feet
  - 6% increase over 2014
  - Variance in building type floor area from 2014
  - Updated type definitions
  - Added mixed commercial
  - Buildings reclassified based on assessments

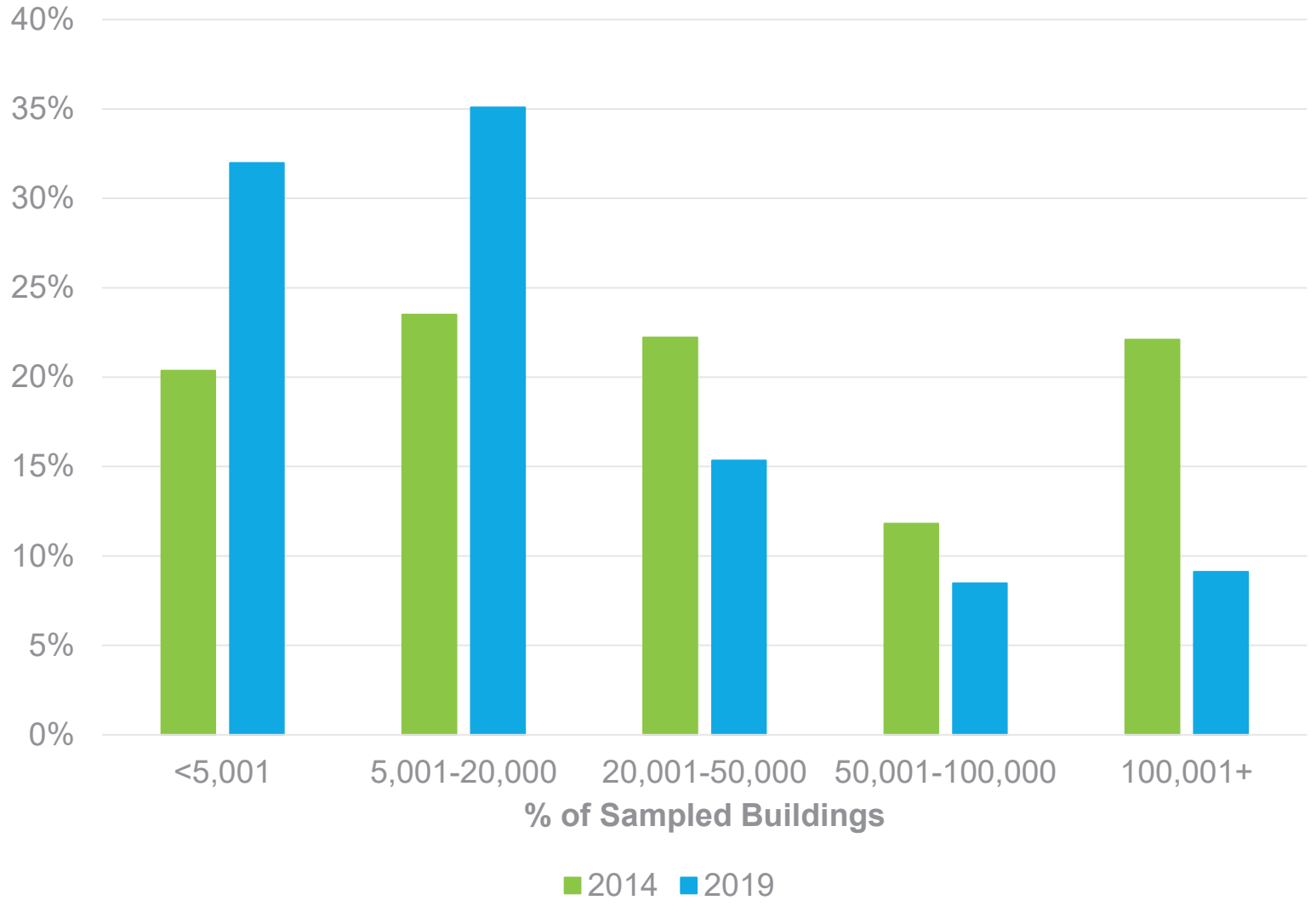


Building Types Updated Based on Site Assessments

	Assembly	Grocery	Hospital	Lodging	Mixed Commercial	Office	Other	Residential Care	Restaurant	Retail / Service	School	Warehouse
Assembly	47			1	5	3				1	1	
Grocery		56			4				1	8		
Hospital			41			2		1				
Lodging				62	1					1		
Mixed Commercial	6	3	1	2	39	12		1	3	8	1	1
Office	4		1	1	12	82	2	1		9		3
Other	1				7	6	6					
Residential Care	2							37				
Restaurant					6				42	3		
Retail/Service					11	1	1			67		3
School						1	1				42	1
Warehouse					14	1	3			8		58

Building Characteristics

- Regional Floor Space by Building Size
  - Majority of buildings in range of 5,000 to 50,000 ft^2
  - 2019 found more floor area in smallest buildings
  - Variance may result from 2014 using sites rather than buildings for analysis



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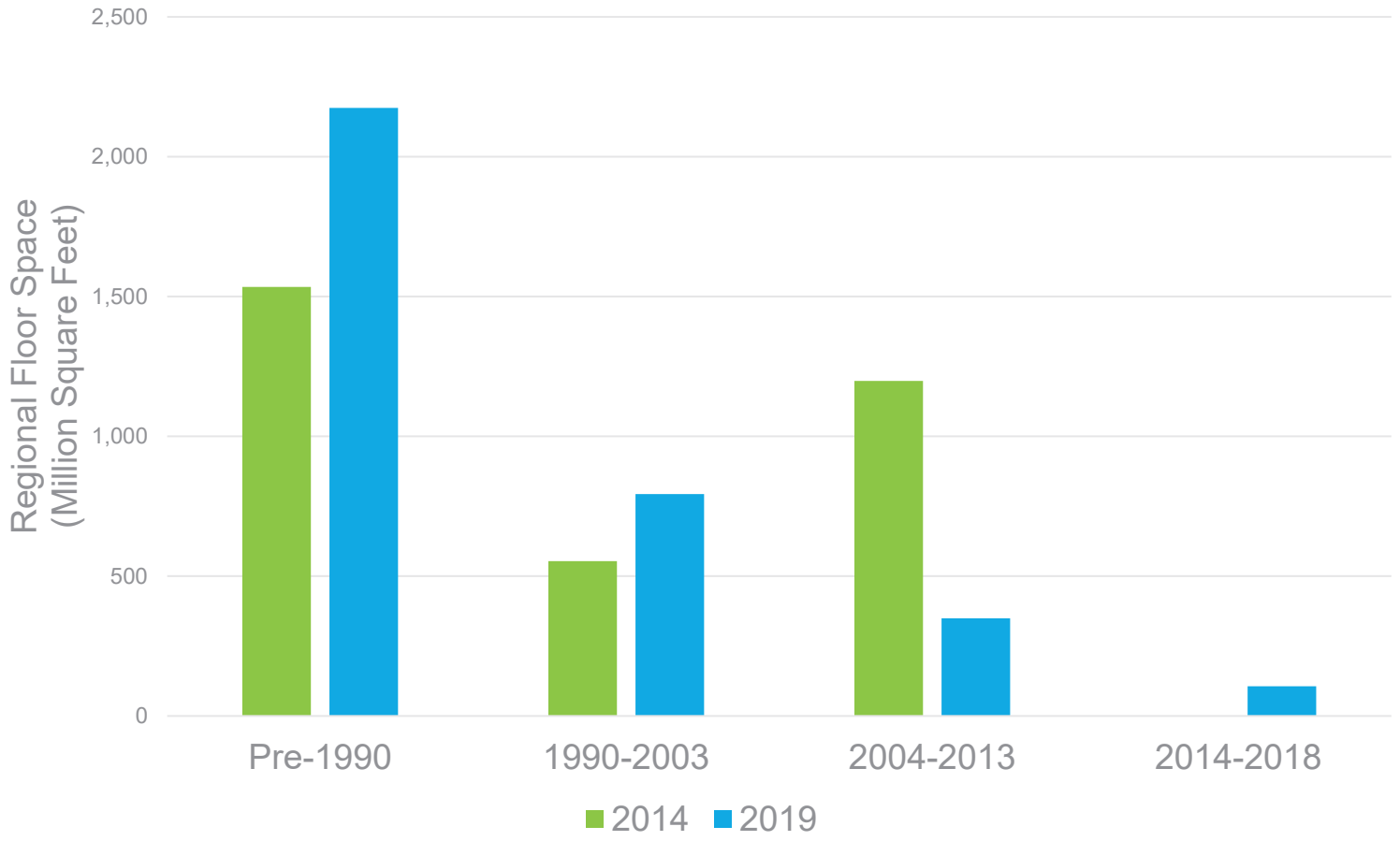
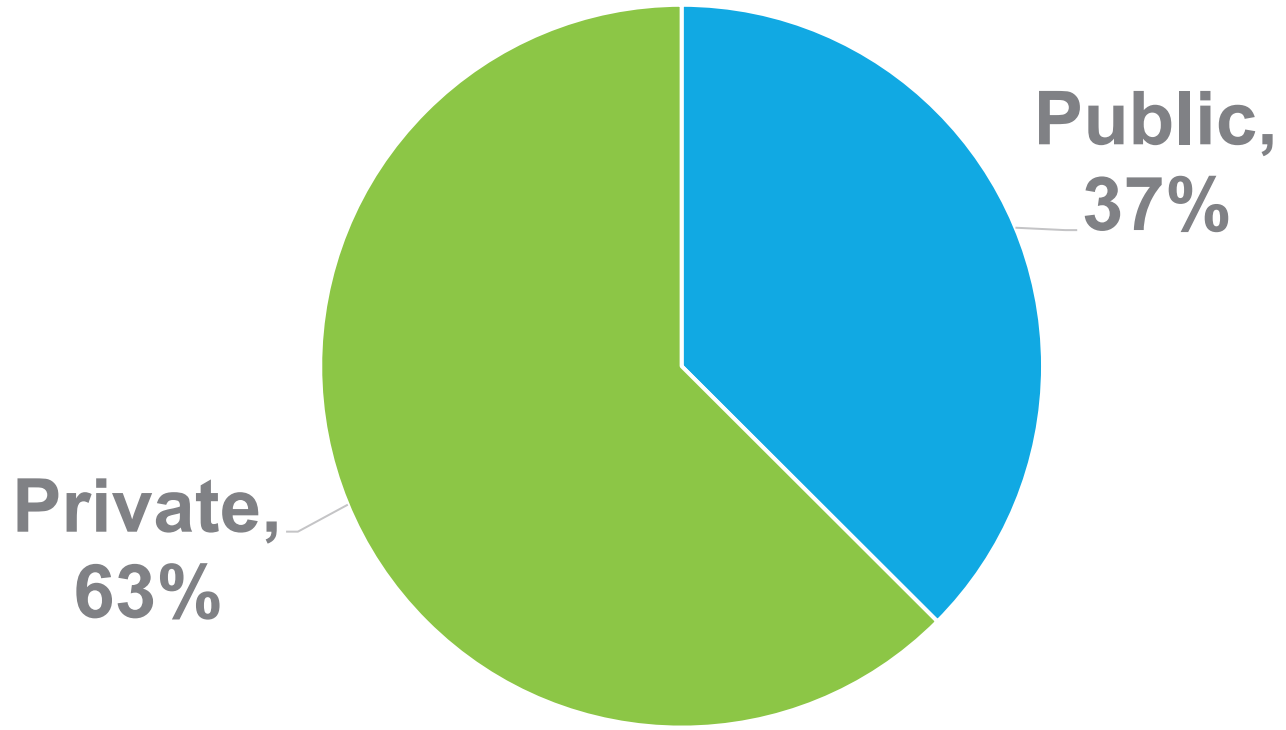
Building Characteristics

- Building Vintage
  - 2019 study better aligned floor area with construction era
  - 2014 oversampled most recent construction decade



Building Characteristics

- Portion of Regional Floor Area by Electric Utility Ownership
  - Nearly 2/3 of buildings in investor-owned utility service territory



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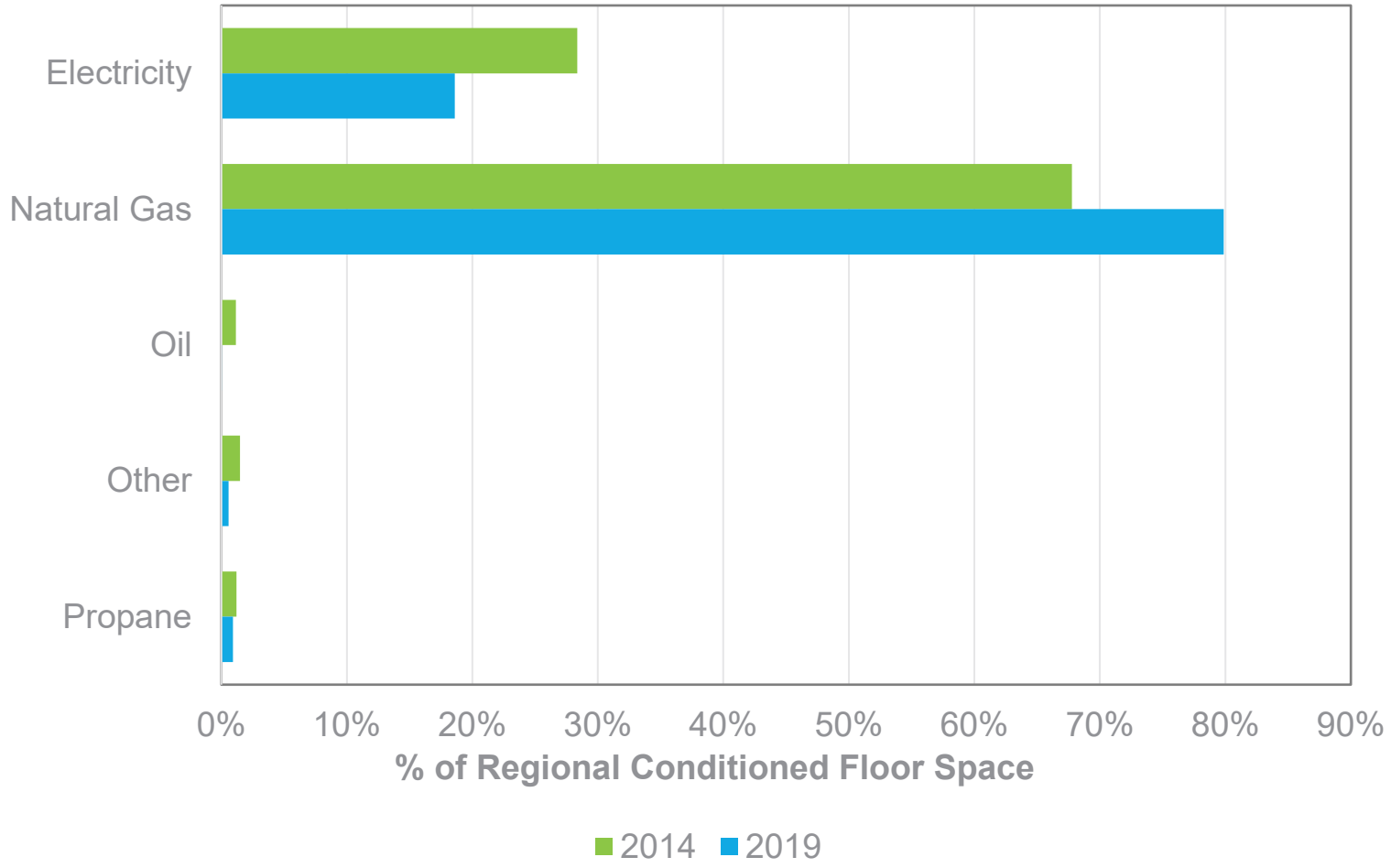
Space Heating and Cooling

- Heating Fuel
  - 80% Natural Gas
  - 19% Electricity
- New construction showed even split of heating fuels
  - 18 buildings with electric
  - 18 buildings with gas



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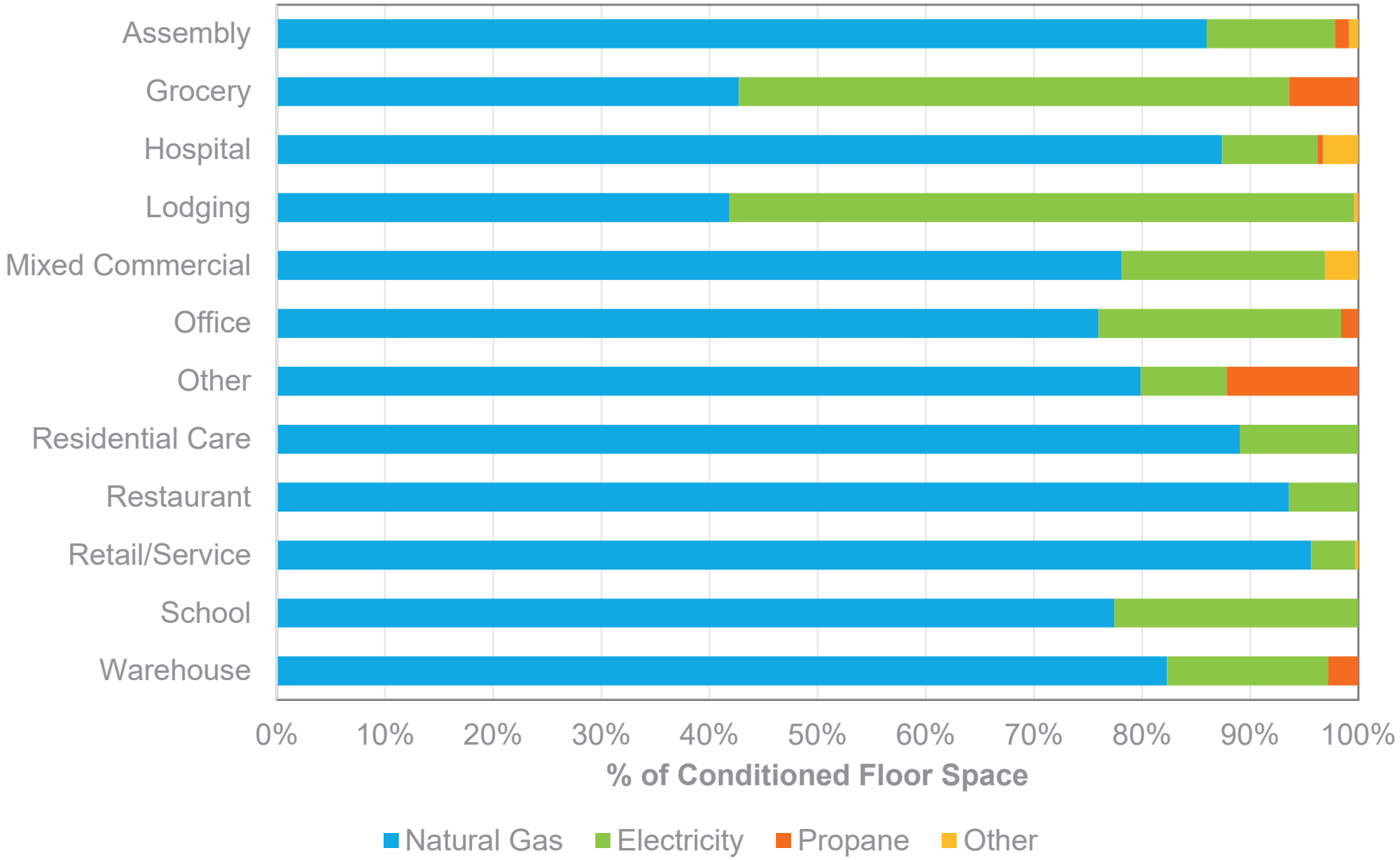
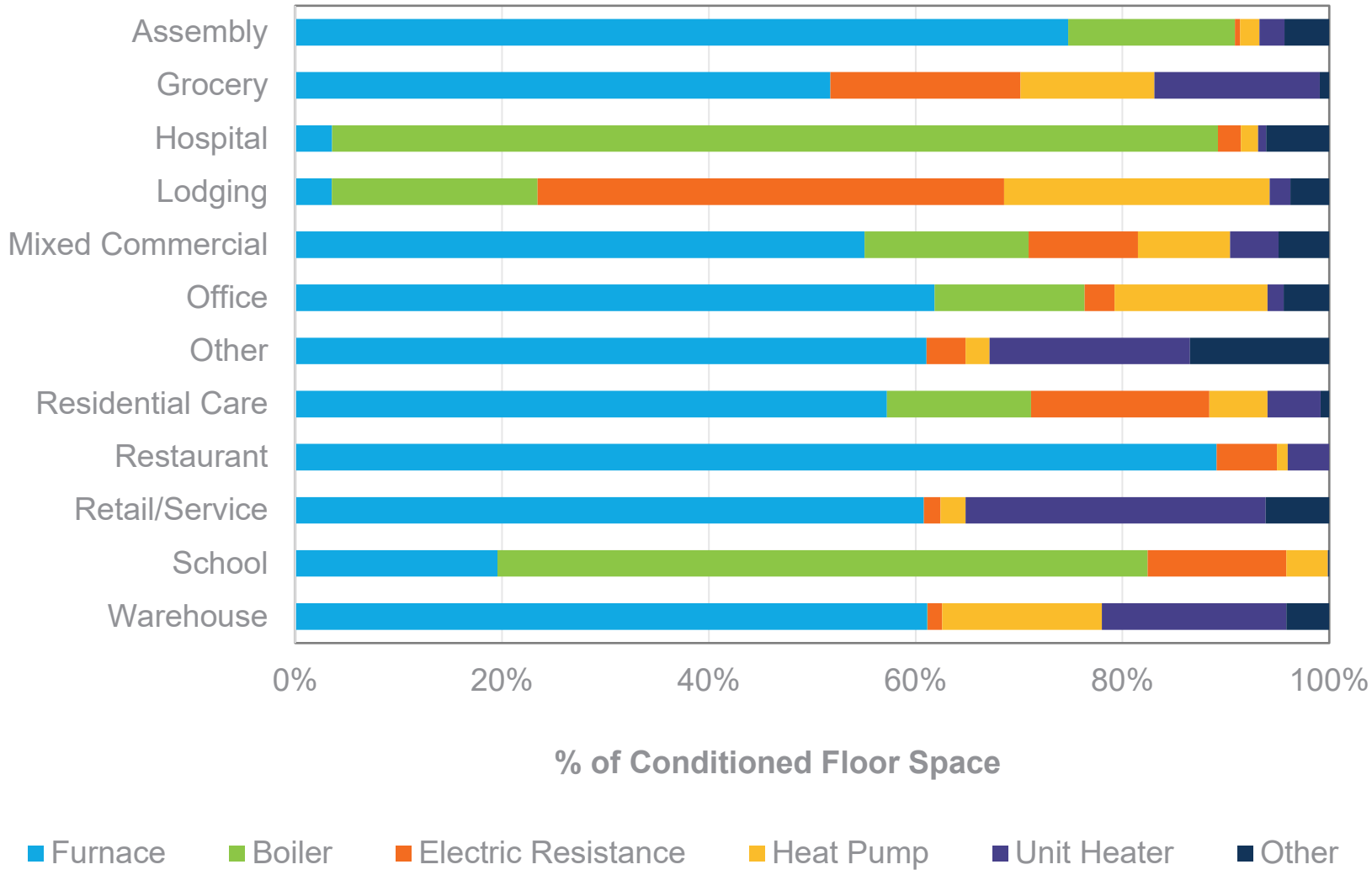
Space Heating and Cooling

- Heated Floor Area by Building Type and Fuel
  - Most rely almost entirely on gas



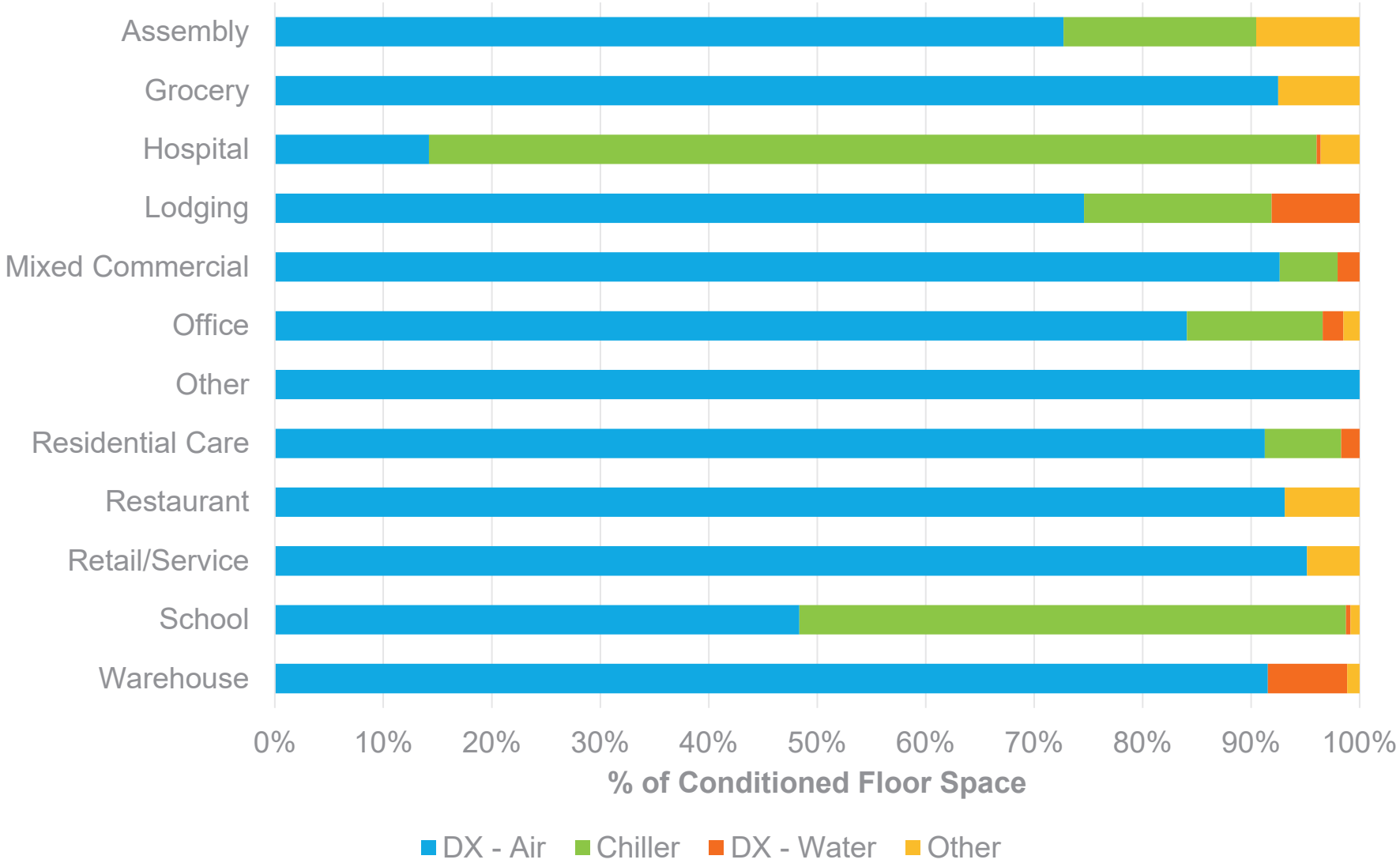
Space Heating and Cooling

- Primary Heating System
  - Furnaces dominate space heating equipment
  - Hospitals and schools have distributed systems that rely on boilers



Space Heating and Cooling

- Primary Cooling System
  - Most buildings rely on DX for cooling
  - Hospitals and schools have distributed systems that rely on chillers



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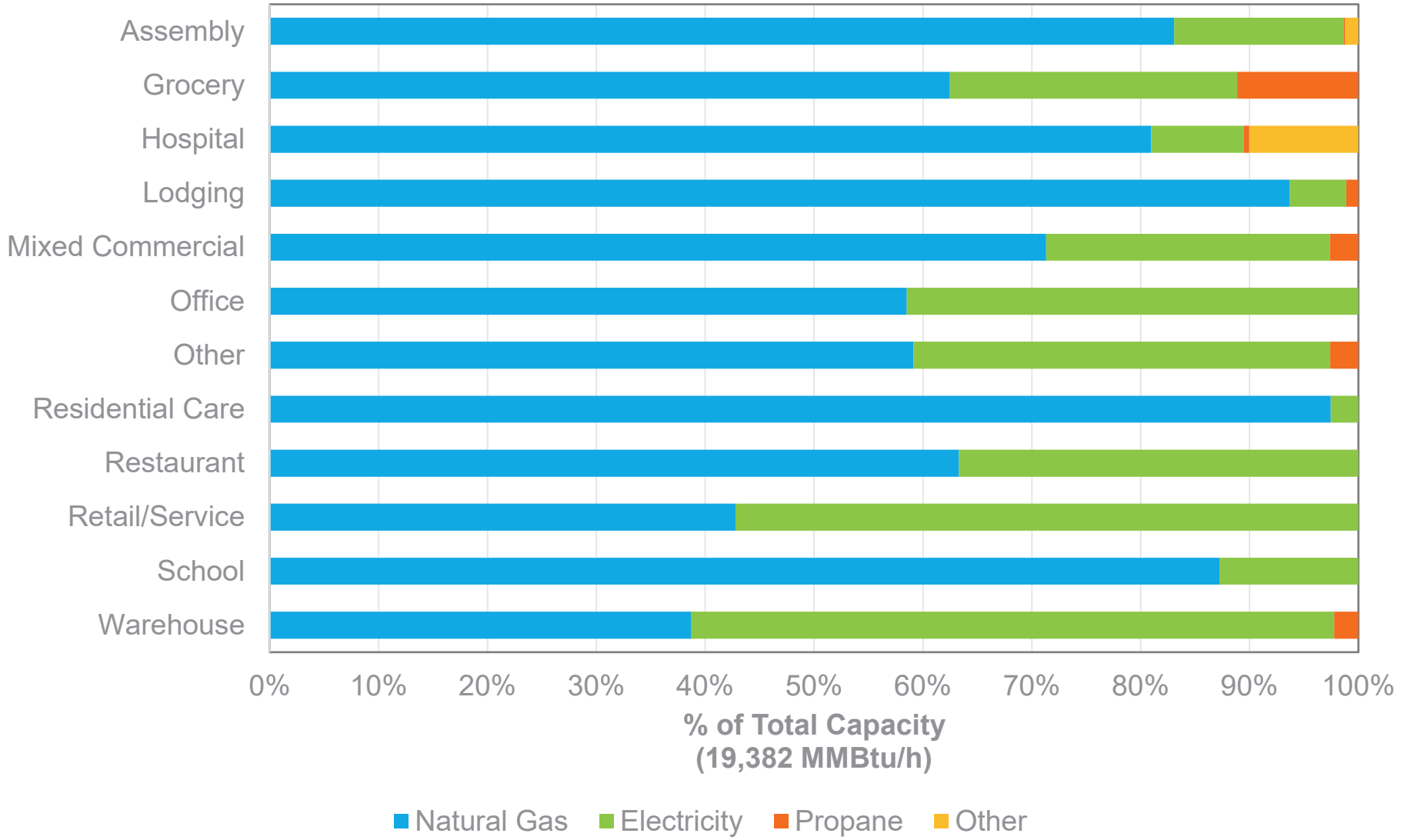
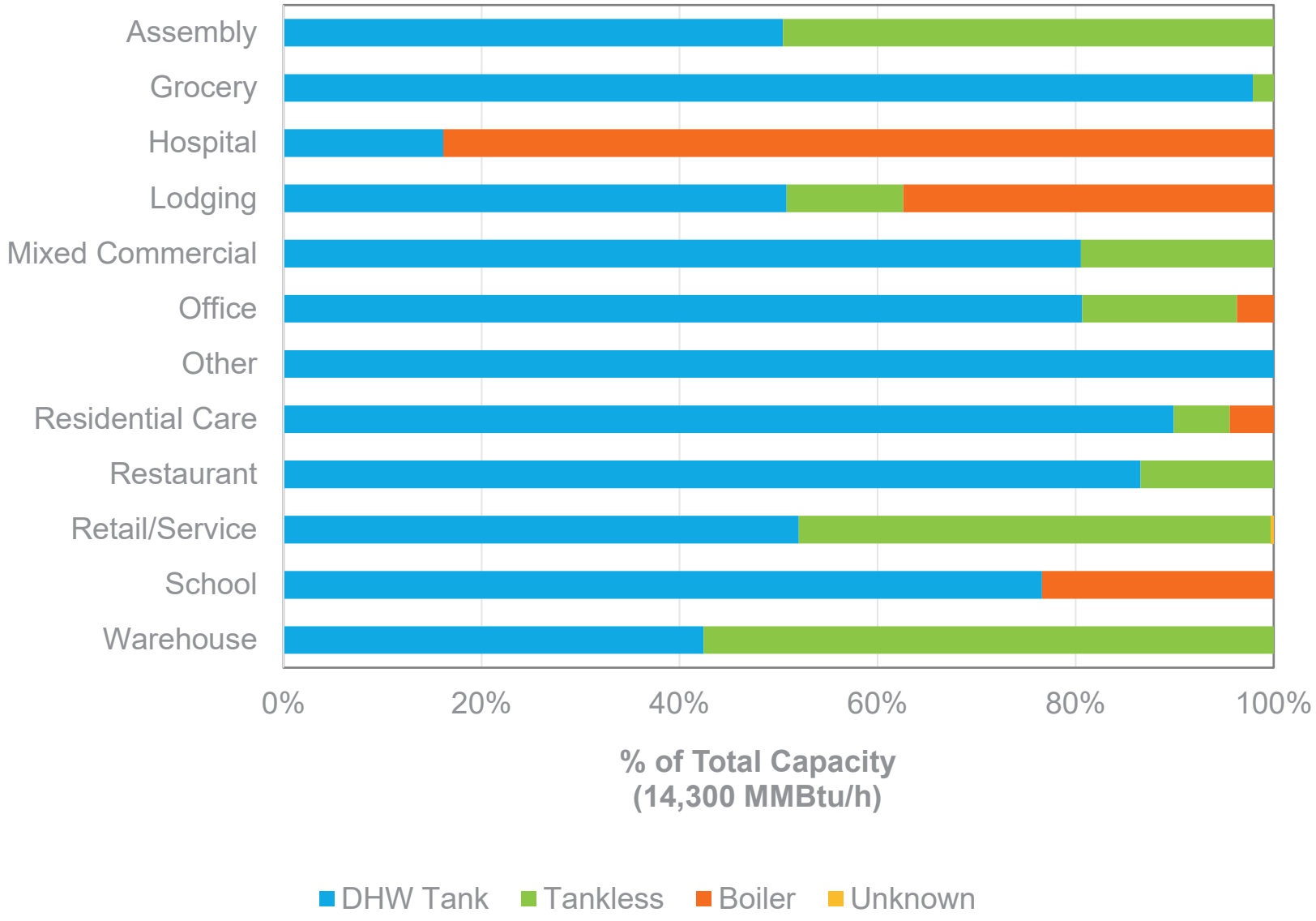
Water Heating

- Water Heating Fuel
  - Natural gas water heating most common



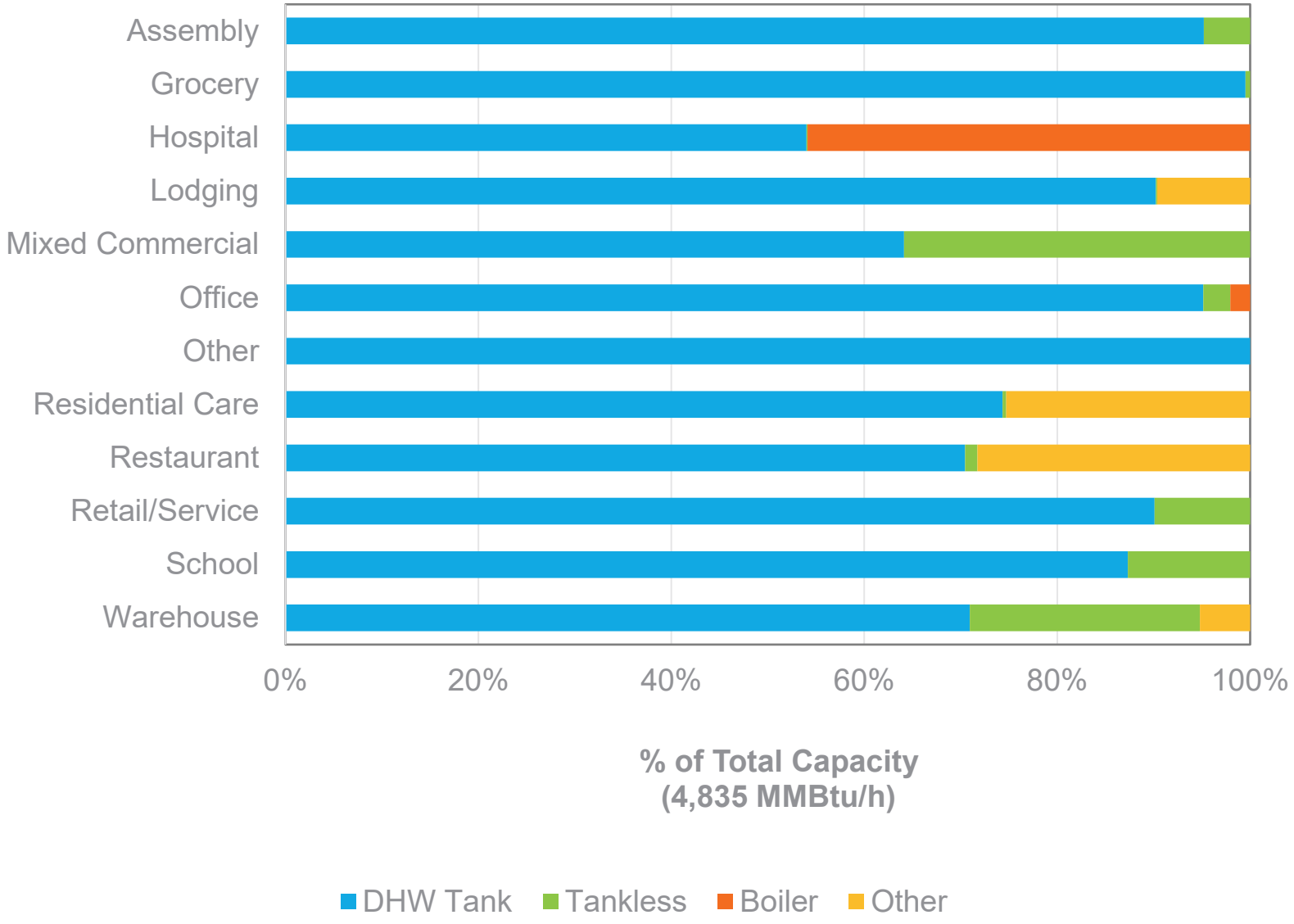
Water Heating

- Gas Water Heating System
  - DHW tanks most frequent gas heating equipment
  - Tankless increased from 5% to 19% since 2014



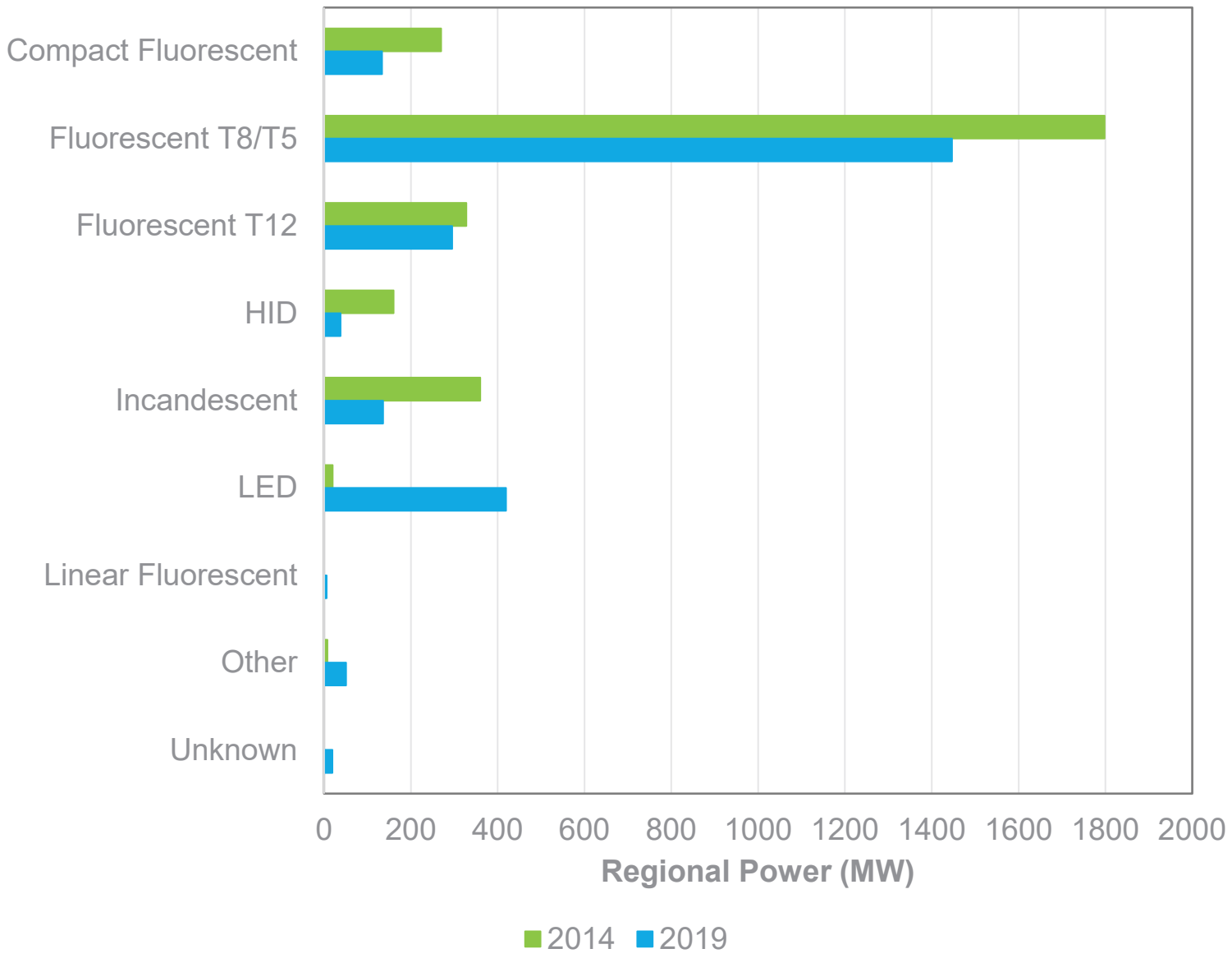
Water Heating

- Electric Water Heating System
  - 25% of commercial water heating capacity is electric
  - Almost no commercial penetration from heat pump water heaters



Lighting

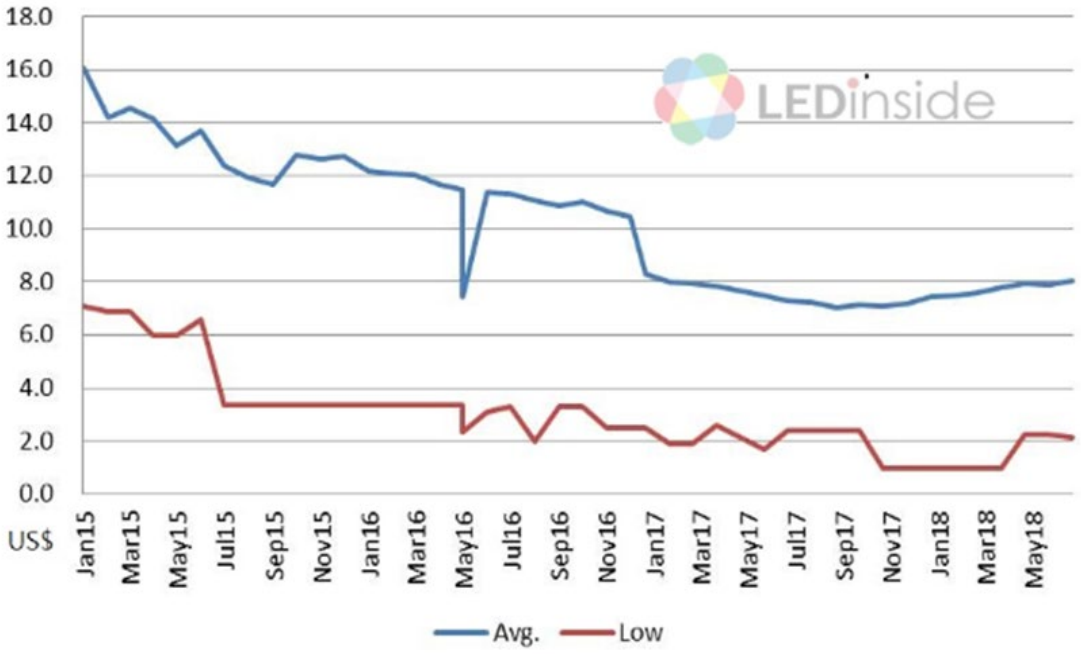
- Indoor Lighting Wattage
  - LED power increased from 20 MW to 419 MW
  - All other less-efficient lighting declined
  - T12s declined only slightly



Lighting

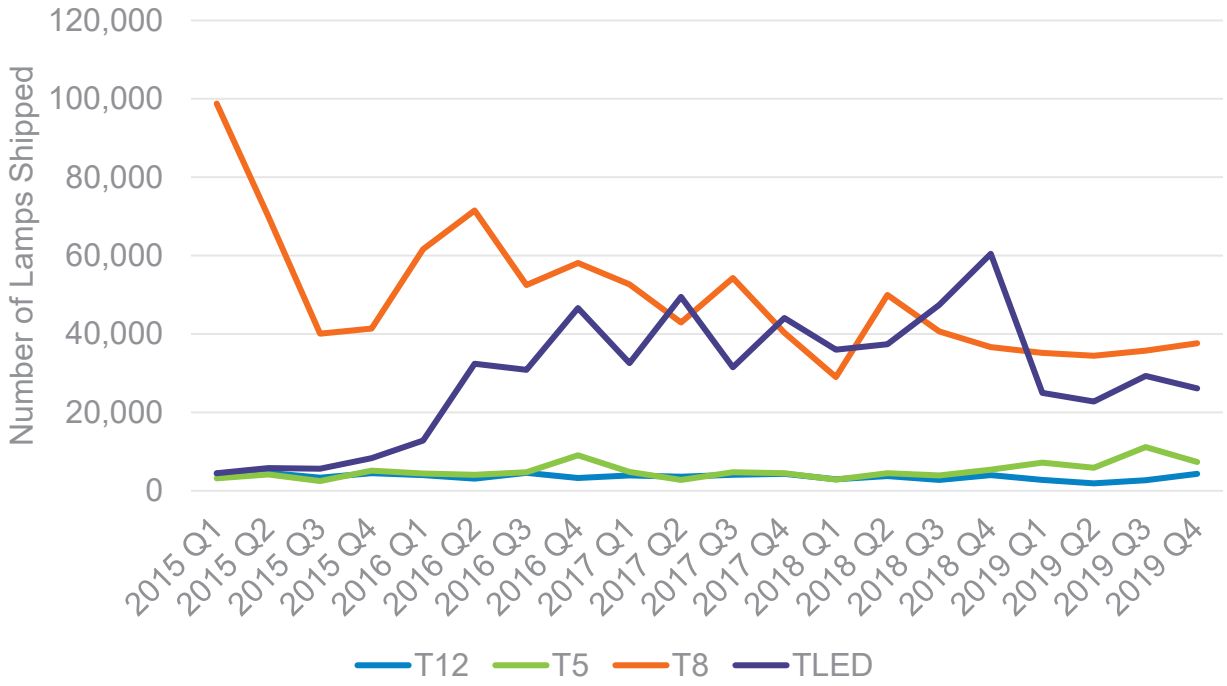
- Trends show lower LED costs and rising distribution volume

60W Equivalent Lamp Retail Price (2015-2018)



Source: LEDinside:
https://www.ledinside.com/news/2018/8/global_led_lighting_products_price_trend

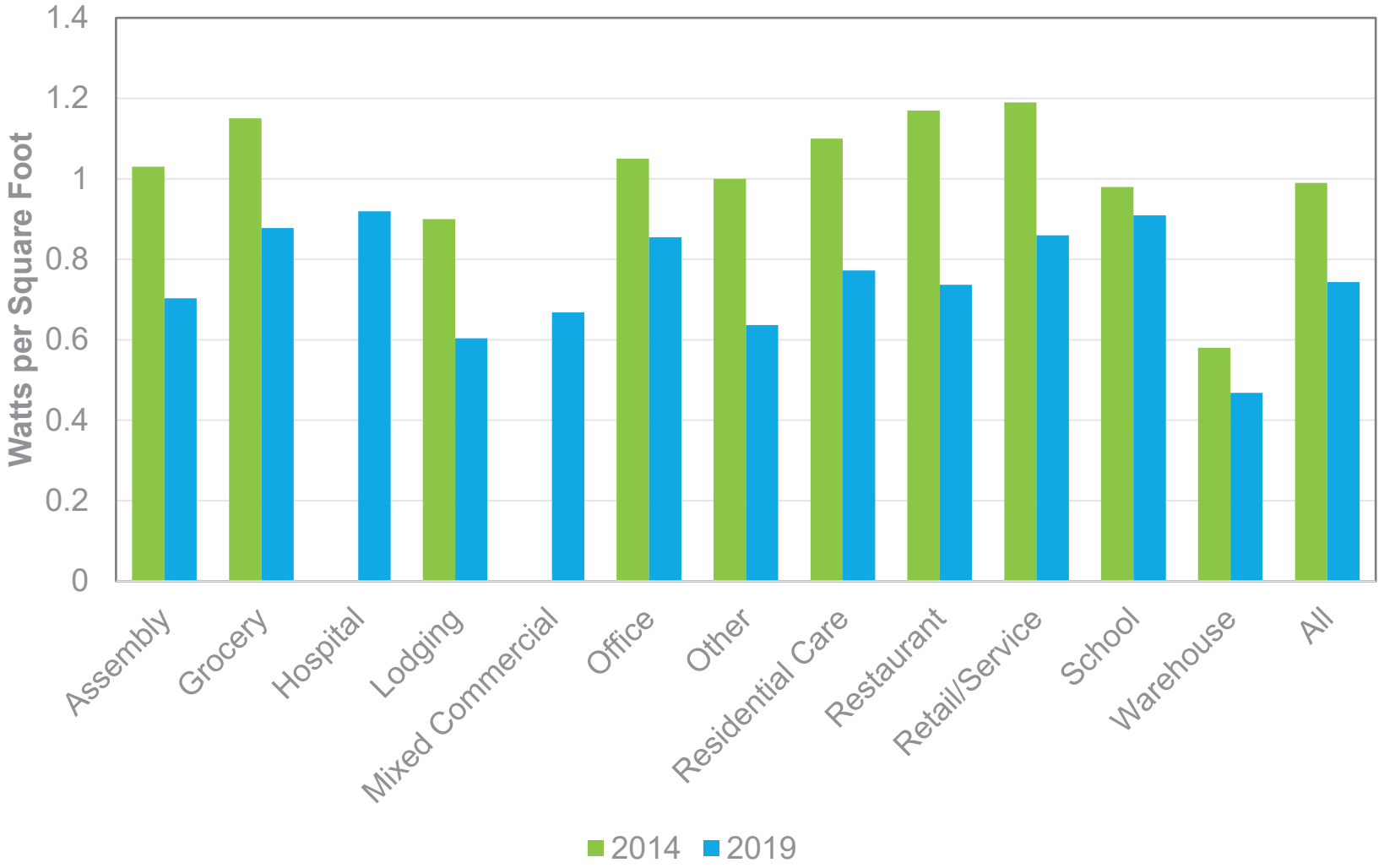
Regional 4-foot Lamp Distribution (2015-2019)



Source: NEEA Lighting Distribution Data

Lighting

- Lighting Power Density
  - LPD declined across all building types



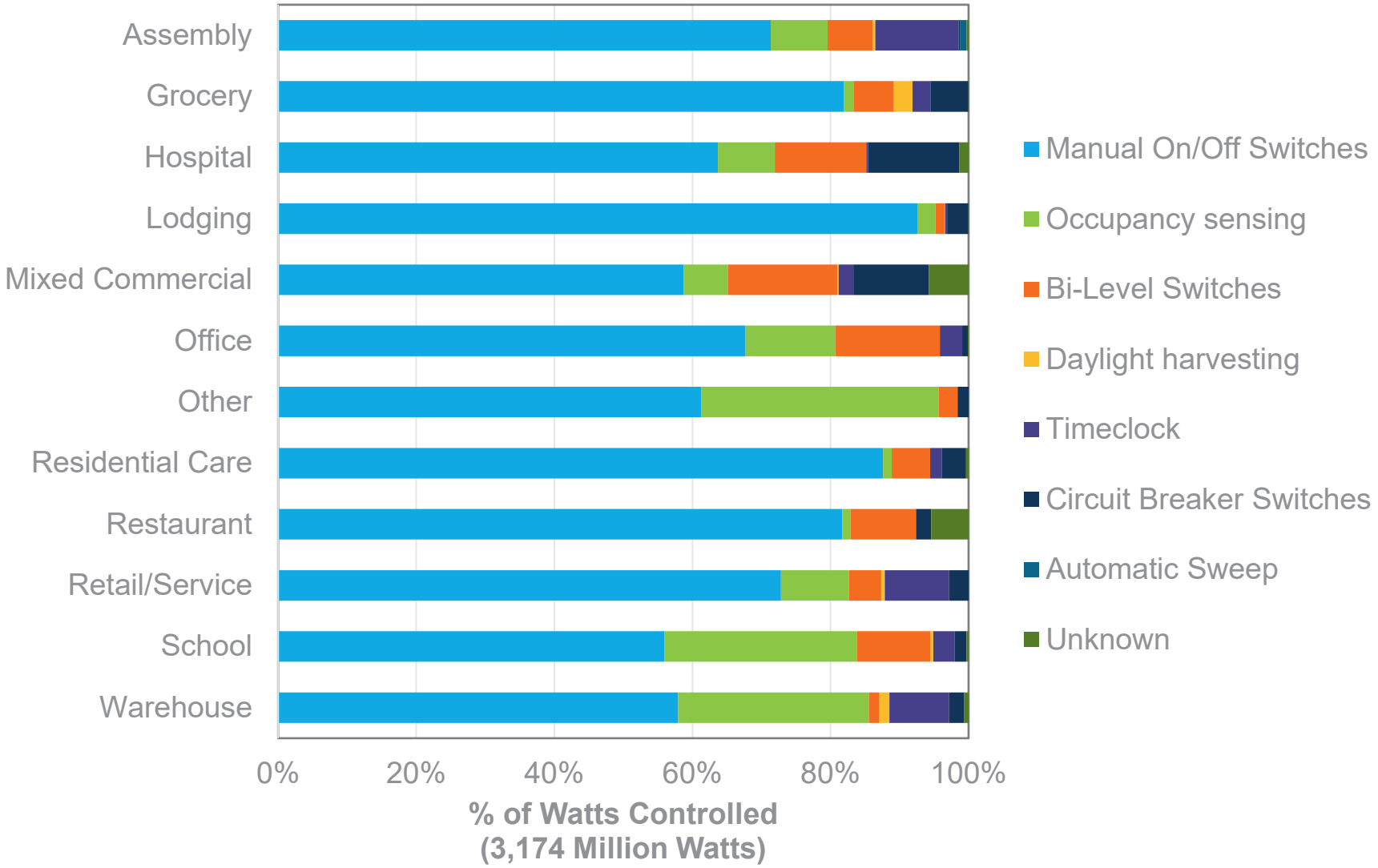
Key Findings: Lighting

- CBSA LPD vs. State Codes
  - Current LPDs below code across most building types (green cells)
  - Data shows office buildings have same or higher lighting LPD than code (white and orange cells)
  - Washington code most stringent

Building Type	Idaho	Montana	Oregon	Washington
Assembly				
Grocery				
Hospital				
Lodging				
Office				
Restaurant				
Retail/Service				
School				
Warehouse				

Lighting

- Lighting Controls
  - Manual controls still dominate
  - Occupancy sensors now control 13% of lighting power
  - Daylight harvesting controls less than 1% of lighting power



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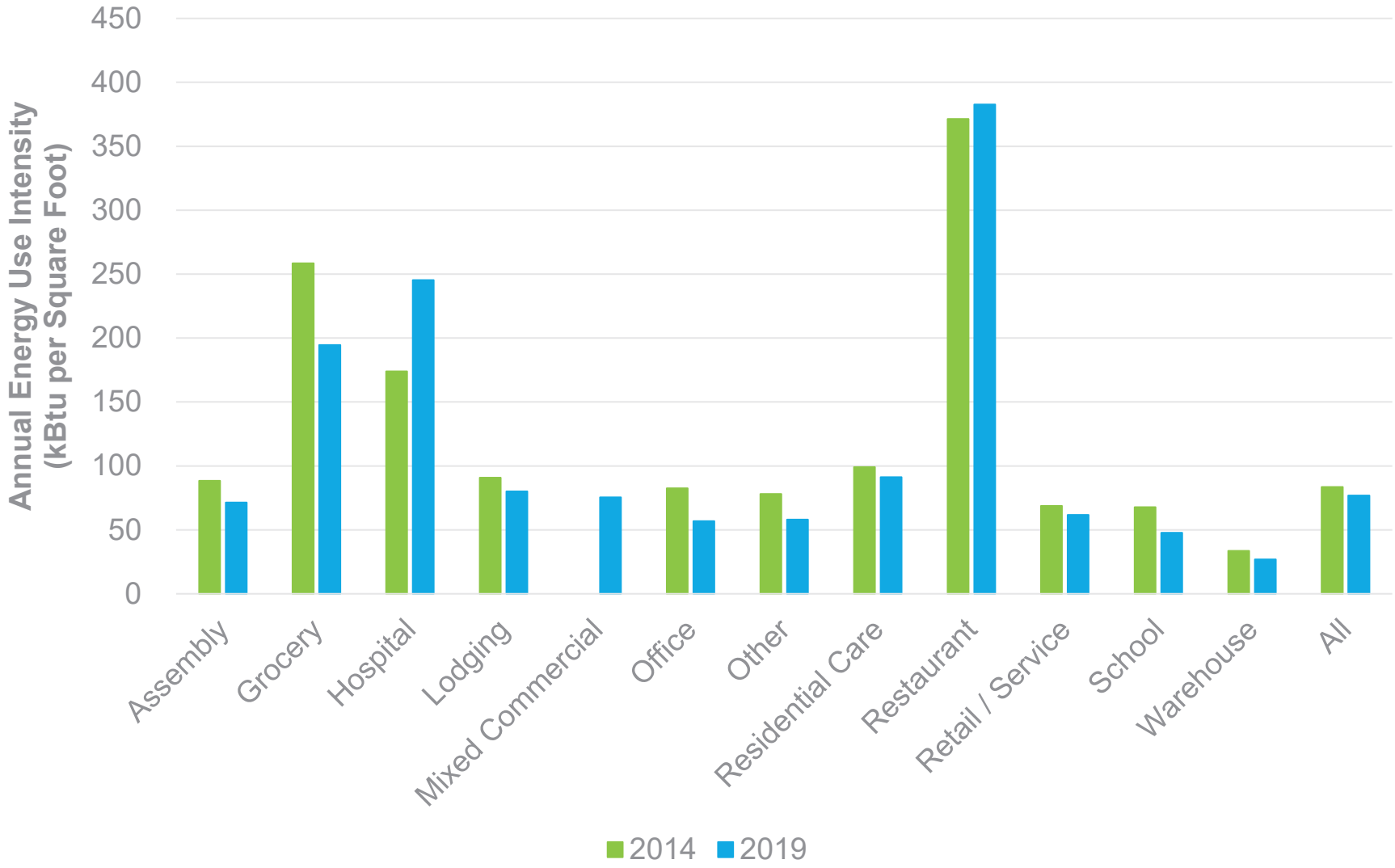
Energy Use Intensities

- Combined Fuel EUI
  - Decreased from 2014 for most building types
  - Provides context with heating fuel changes from 2014
  - Hospital EUI now aligns better with 2012 CBECS



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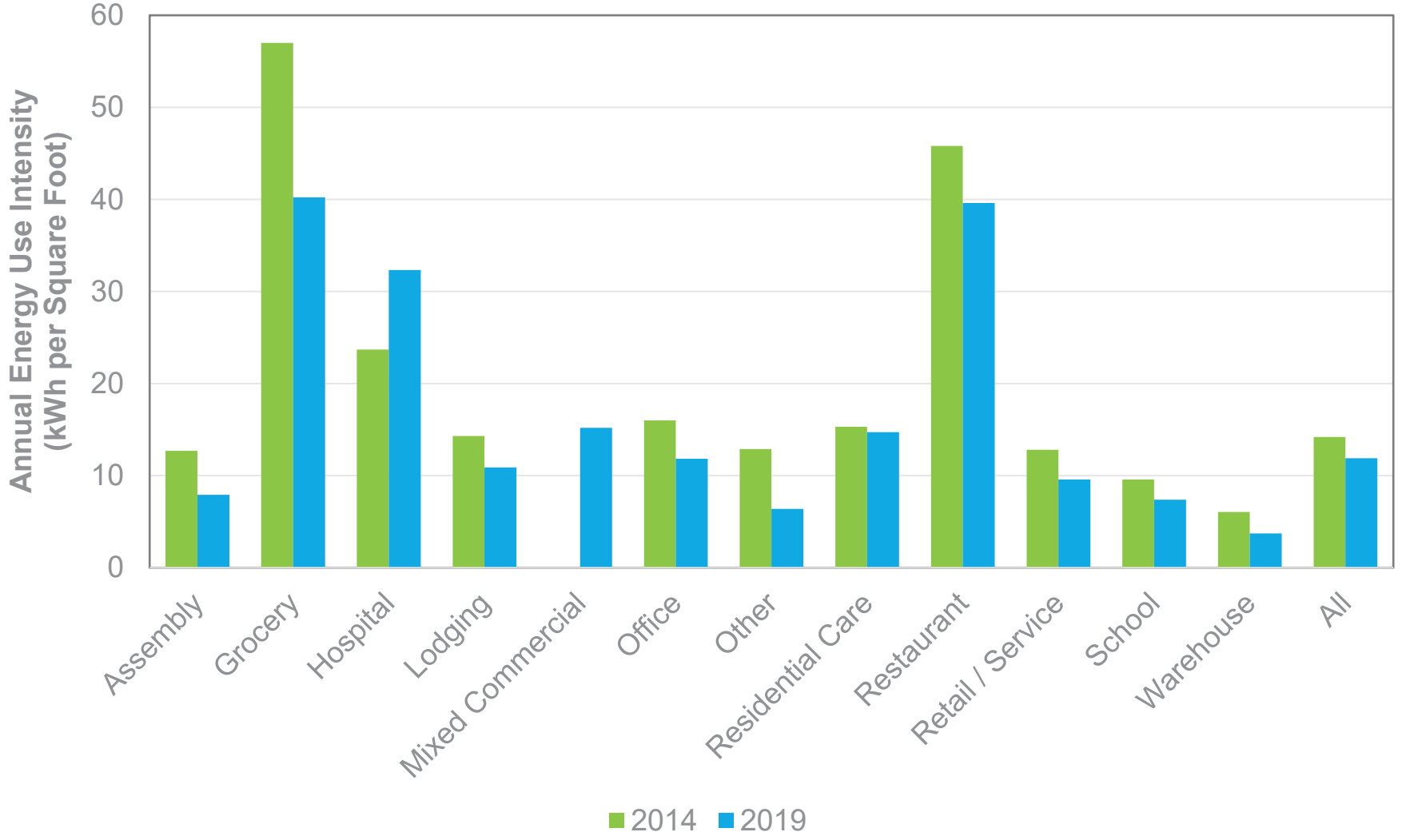
Energy Use Intensities

- Electric EUI
  - Decreased from 2014 for almost all building types
  - Lower LPD reduced electric EUIs
  - Hospital EUI now aligns better with 2012 CBECS



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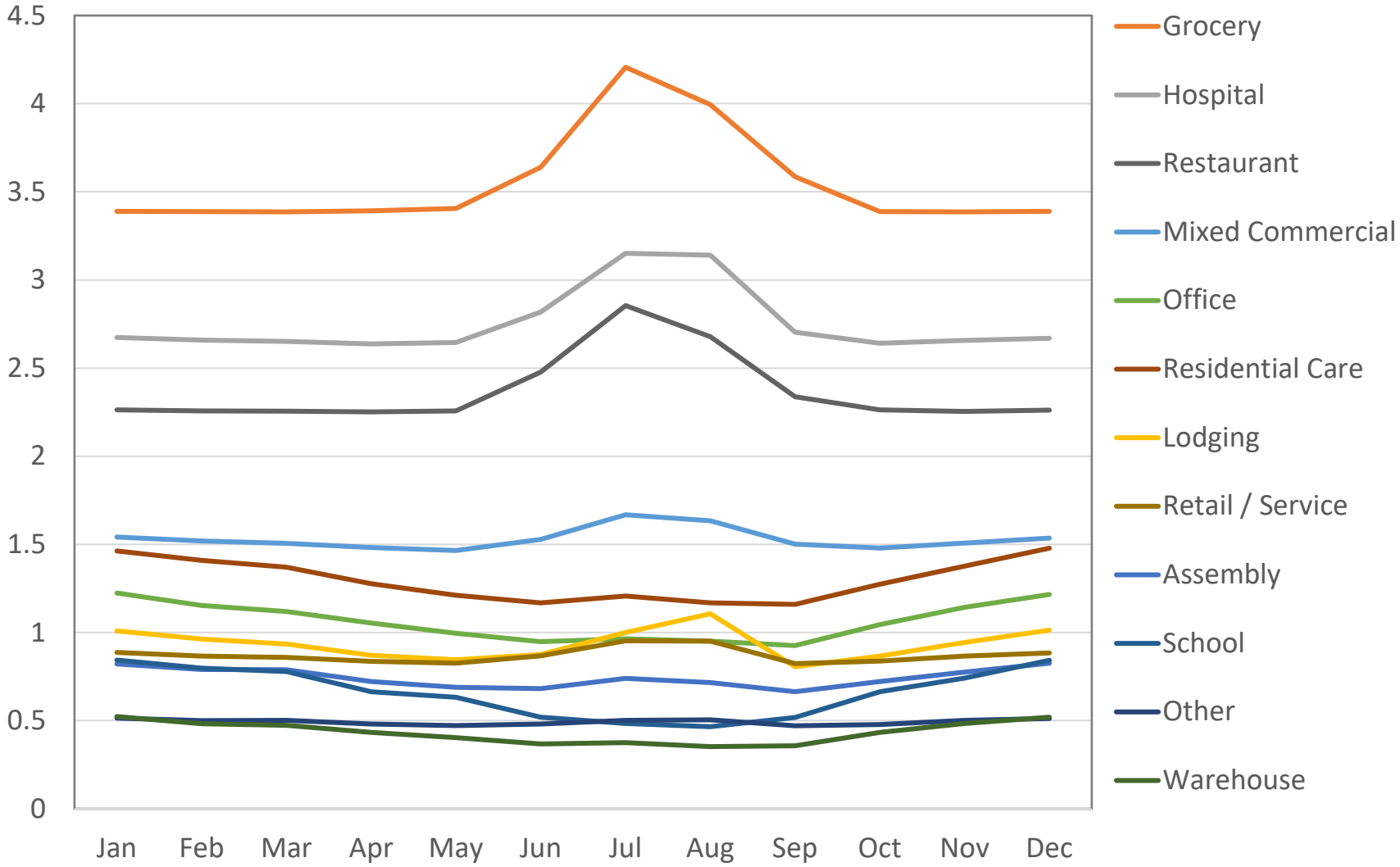
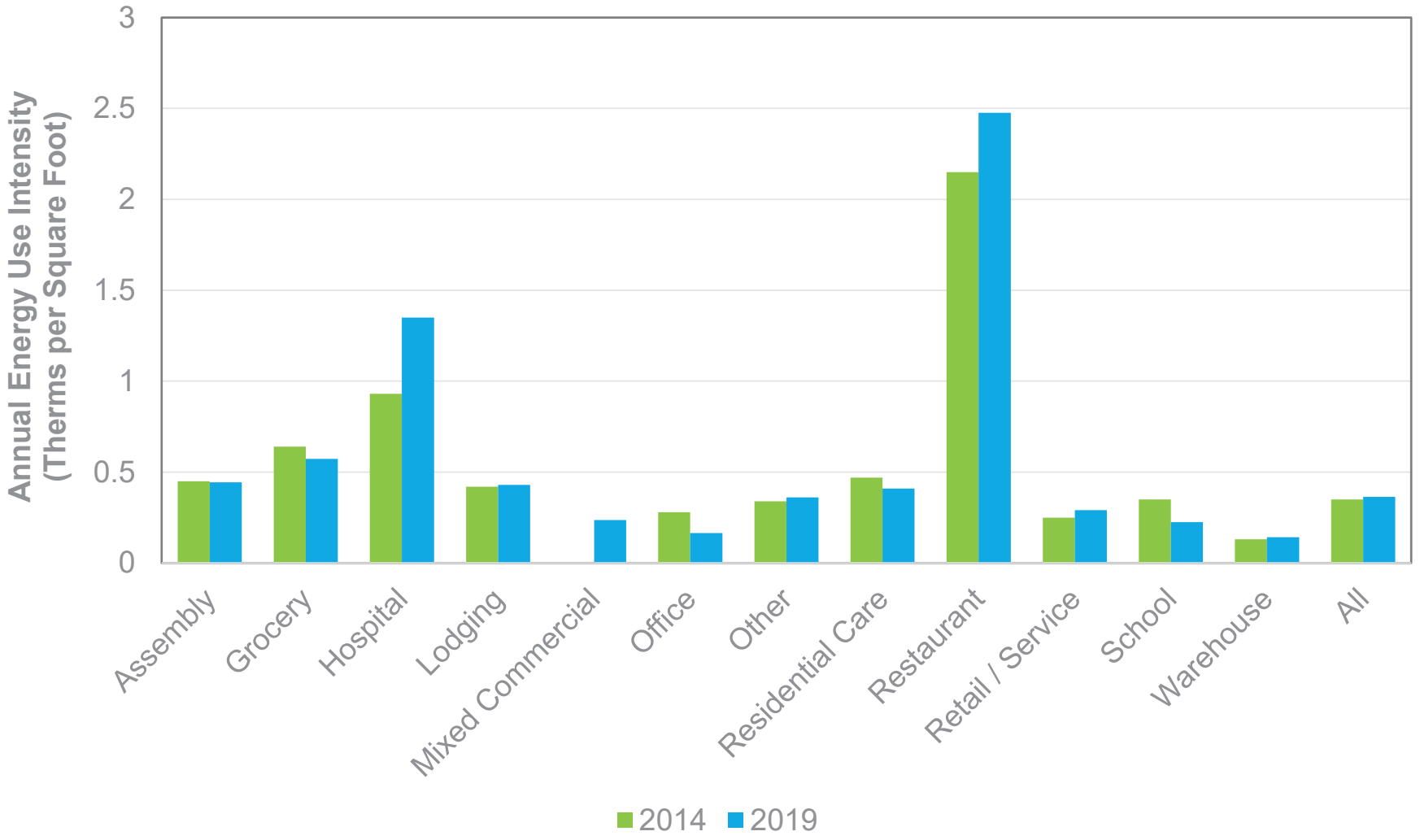
Energy Use Intensities

- Monthly Electric EUI
  - More than half of building types show electric peak in summer
  - Remainder have winter peak



Energy Use Intensities

- Natural Gas EUI
  - Little change since 2014 for most
  - Hospital now aligns better with CBECS
  - 2019 data found higher restaurant natural gas EUIs in sample



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Conclusions

Conclusions

- Virtual Catalog Provides Option for More Robust Sample Frames
  - Google Places data helps fill in gaps in tax assessor data (e.g., government buildings, schools)
  - More recently updated data
  - Challenges with multiple listings at the same location
  - Does not filter out home-based businesses
  - Manual review of data can be budget-intensive

Conclusions

- New Commercial Buildings Rely More on Electric Heating
  - Overall sample found 80% of regional floor area with gas heating
  - 36 buildings in sample constructed since 2014
  - Split in half on space heating fuel
  - Total floor area for electric heated buildings was 20% higher than gas heated buildings

Conclusions

- LED Adoption Increased Dramatically
  - Energy efficiency programs and education pushed LEDs
  - LED prices also dropped dramatically
  - LED portion of regional lighting power increased from 1% to 17%
  - Primarily displacing HIDs, incandescent bulbs, and CFLs
  - Overall decrease in regional lighting power from 2,944 MW to 2,531 MW (-14%)

Conclusions

- Significant Regional Energy Efficiency Opportunities Remain
  - Linear Fluorescent Lamps to LEDs
    - Linear fluorescents still represent 1,737 MW (69% of lighting power)
  - Lighting Controls
    - Two-thirds of lighting power controlled by manual on/off switches
    - Occupancy sensors only control 13%, daylight harvesting < 1%
  - Conventional Tank Water Heating Replacement
    - DHW tanks represent most of water heating capacity
    - Tankless tripled to 19% of gas water heating capacity
    - Heat pump water heaters are small portion of overall capacity

Conclusions

- LEDs Reduced Indoor Lighting Power Density
  - Overall average LPD declined by 25% from 2014
  - Almost all building types show reduction of 19% to 37%
  - Review of lighting power data shows reduction driven mostly by LED retrofits

Conclusions

- LEDs Reduced Electric Energy Use Intensity
  - Regional electric EUI declined by 17% from 2014
  - Most building types reduced electric EUI by 20% to 40%
  - Decrease in LPD through LEDs drove much of reduction
  - 2019 CBSA distribution of heating fuels contributed to lower electric EUIs
  - Assume regional energy efficiency programs also contributed to EUI reduction

Questions

NEXT STEPS

- Send out presentation and address unanswered questions (if any) 5/12
- Final adjustments to report and database – 5/15
- Report and Database Available on NEEA Website by 5/22

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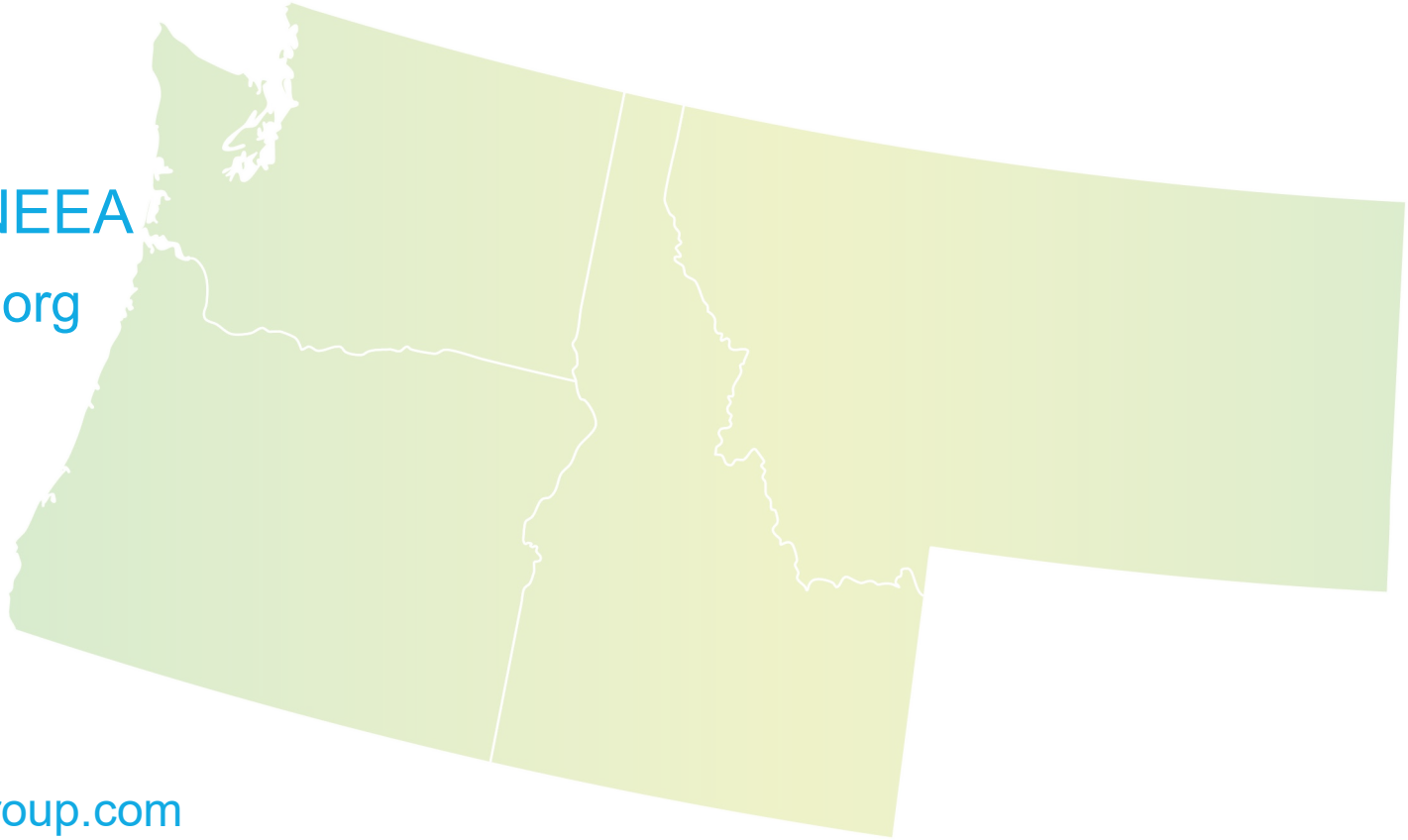

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