RBSA/Seattle Multi-family Characterization

Data not Dogma
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RBSA Goal

Provide regional organizations and utilities with baseline information for conservation planning, program design, and evaluation.

Overall RBSA Objectives

Characterize Residential Sector
- Single-family homes (SF)
- Manufactured homes (MH)
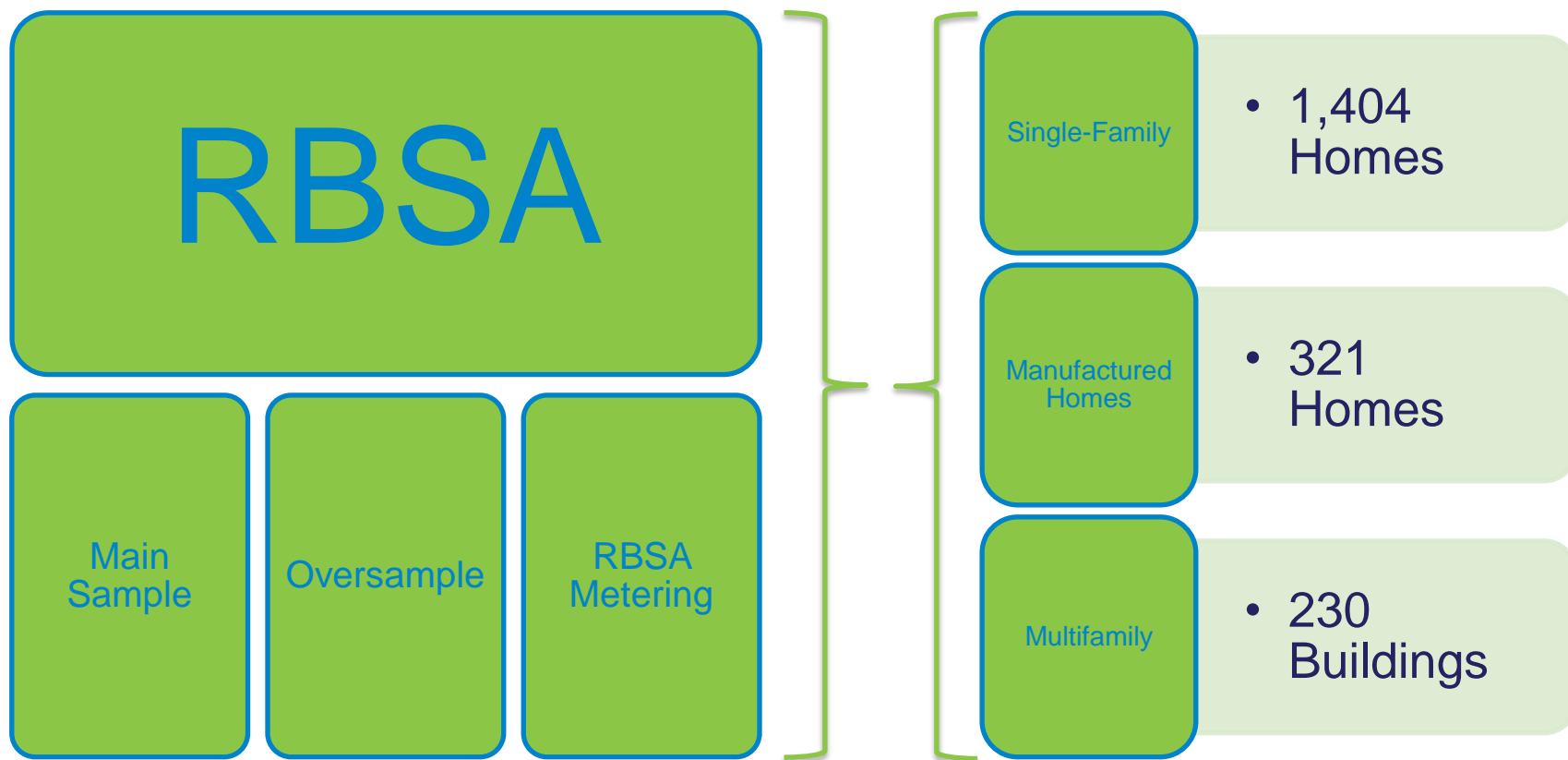- Multifamily buildings and units (MF)

Provide Representative Sample for the Multi-family Sector
- Characterize the region
- Provide a framework for individual utility oversamples.

Characterize Buildings
- Building level Energy audit
  - Building size and vintage
  - Building occupancy, ownership, management
  - Building construction and shell characteristics
  - Building level HVAC
  - Common area lighting
  - Common equipment, appliances, electronics
- Unit level systems
  - HVAC
  - Lighting
  - Appliances, Electronics
  - Occupancy, Demographics

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RBSA Structure

RBSA

- Main Sample
- Oversample
- RBSA Metering

Single-Family
- 1,404 Homes

Manufactured Homes
- 321 Homes

Multifamily
- 230 Buildings

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Multi-Family Sample Design

- Sample design objectives
- Sample frame development
- Final sample distribution

Study Design

Representative random sample of households in MF units in the *region*

- Utility oversample required for any specific geographic characterization
- Sample drawn from the RBSA RDD sample frame
- Buildings identified from respondents to phone survey

Sample target a 100 building random sample

- 2 to 3 units surveyed at random in each building
- Building case weights based on joint probability
  - Unit selection from RDD simple random sample
  - Building sample proportional to the number of unit in each building

Stratified Random Sample

- Regional sampling domain

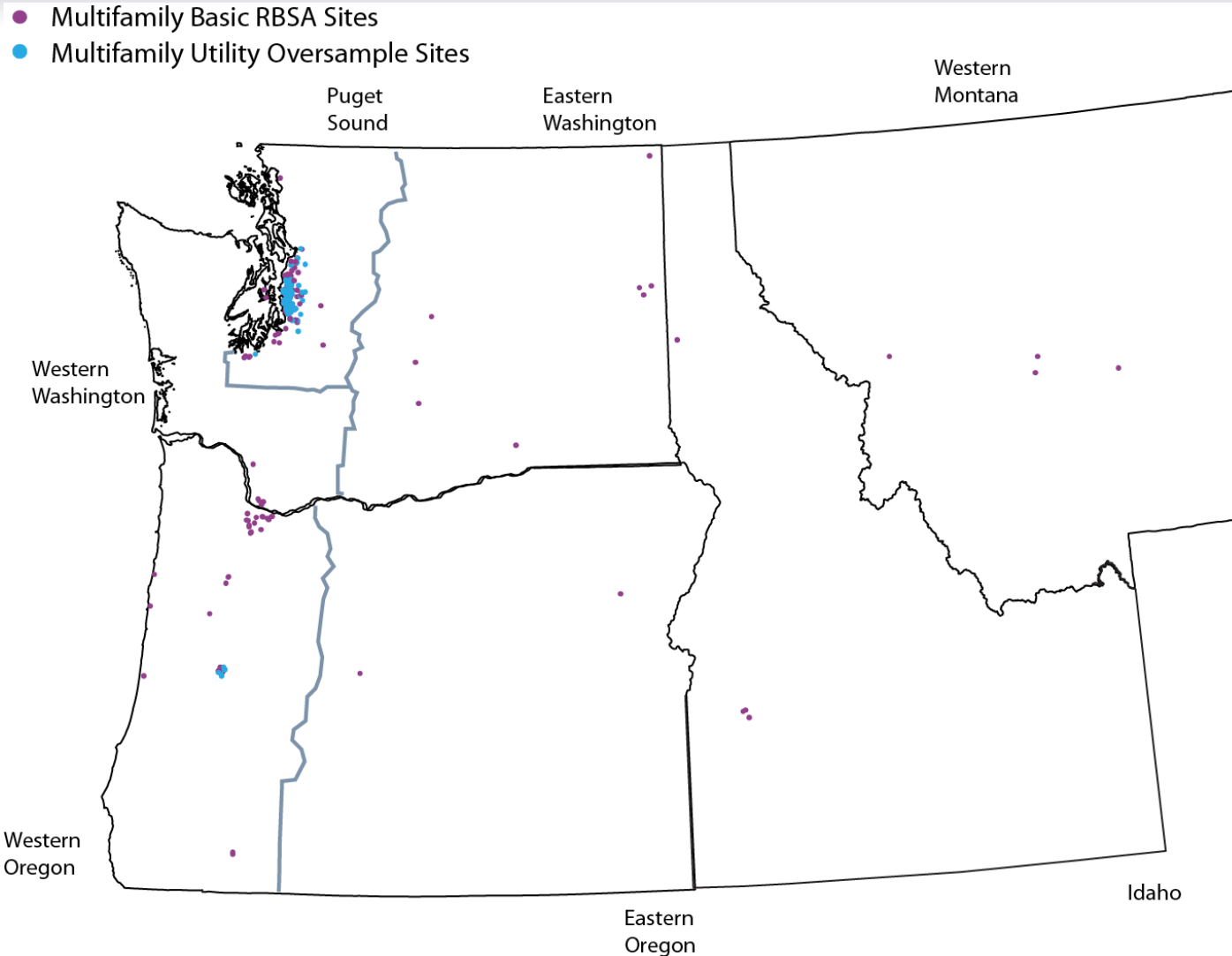- 7 non-overlapping geographic cells

- 4 Oversample utilities

- Joint probability case weights Combined with RBSA sample

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Final Multi-Family Building Sample Distribution (Incl. Utility Oversamples)

GEOGRAPHIC CELL	TOTAL SAMPLE	UTILITY OVERSAMPLES	FINAL SAMPLE	UNITS SAMPLE
ID	4	0	4	12
MT	4	0	4	10
OR	30	6	36	96
WA	62	124	186	434
Total	**100**	**130**	**230**	**552**

Final Multi-Family Sample Distribution

Legend:
- Multifamily Basic RBSA Sites
- Multifamily Utility Oversample Sites

Puget Sound · Eastern Washington · Western Montana · Western Washington · Western Oregon · Eastern Oregon · Idaho

Total Sampled Utilities by Region

REGION	TOTAL UTILITIES	SAMPLED UTILITIES	% OF TOTAL
ID	27	2	7%
MT	10	1	10%
OR	39	7	17%
WA	56	12	21%
Total	132	21	16%

Seattle: Multi-Family Sample Design Objectives

- Provide a representative sample across Building sizes

- Provide representative sample that would enhance the regional sample

- 90%/10% confidence/precision for sampling domains

- Stratified sample by building size

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Seattle: Stratified Random Sample

- Seattle Sampling Domain: Assessor records

- 8 non-overlapping cells

- Post Stratification for Seattle RBSA sample

- Joint probability case weights with regional sample

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Seattle Sample Distribution

Stratum	Description Units/Bldg	Population*		Sample		
		Buildings	Units (000)	Sampled Buildings	Total Units in Sampled Buildings	Sampled Units
1	5 to 9	2,911	19	15	103	32
2	9 to 14	1,970	22	12	142	25
3	15 to 22	1,272	23	11	209	23
4	23 to 35	803	22	18	524	39
5	36 to 58	472	21	16	762	34
6	59 to 99	246	18	14	1,102	29
7	100 to 177	143	18	13	1,743	28
8	178+	51	12	12	2,926	24
Total		7,868	155	111	7,511	234

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Seattle Multi-Family Sample Distribution

Seattle City Light Site
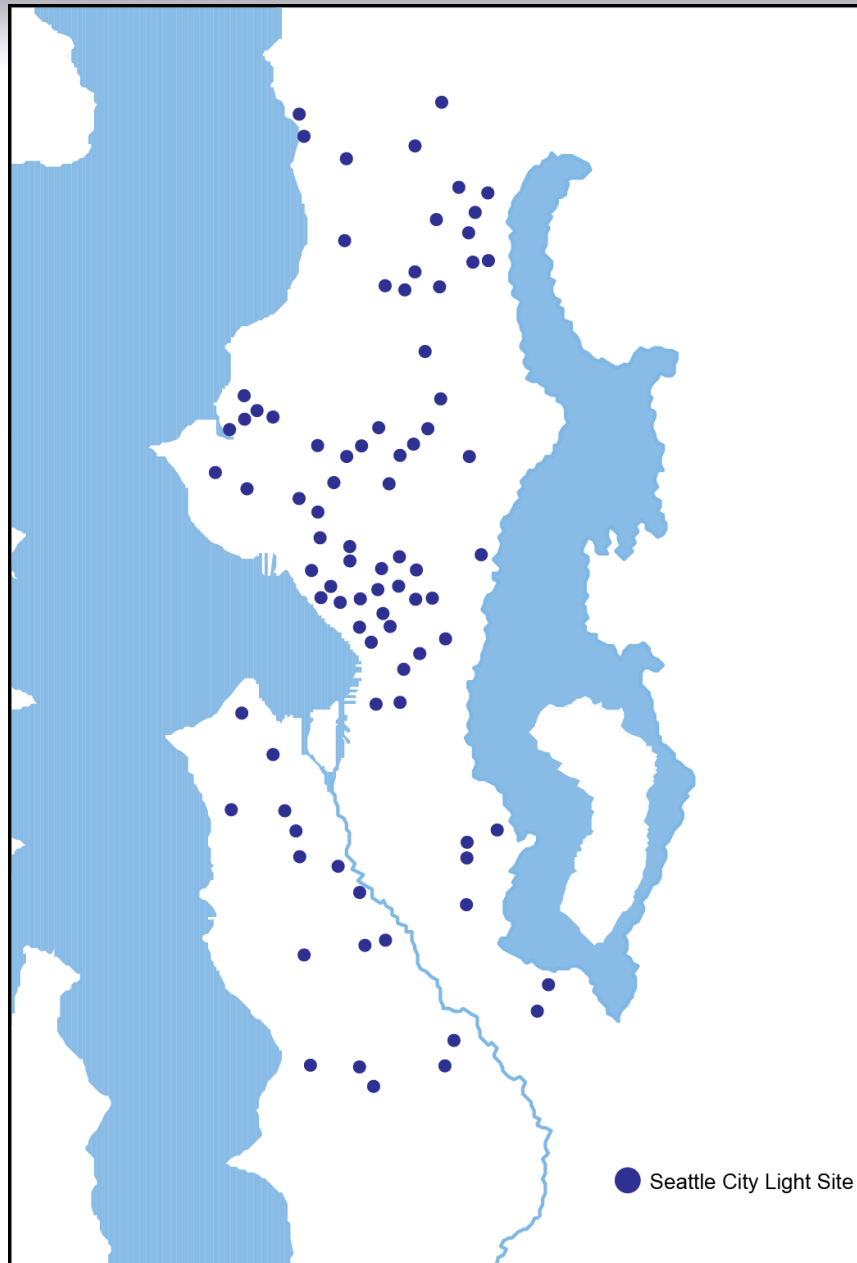
Data Collection

- Onsite data collection
- Quality management
- Billing data collection

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Overall summaries

Building size and vintage
Occupancy and Vacancy
Building shell
Unit and building HVAC, DHW
Unit and building Lighting systems
Unit appliances, electronics
Energy use (Benchmarking)

Characteristics Highlights

- Size
- Vintage
- Unit size
- Fuel Choice
- Vacancy
- Occupancy

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Building Vintage

Percentage of Total, Region
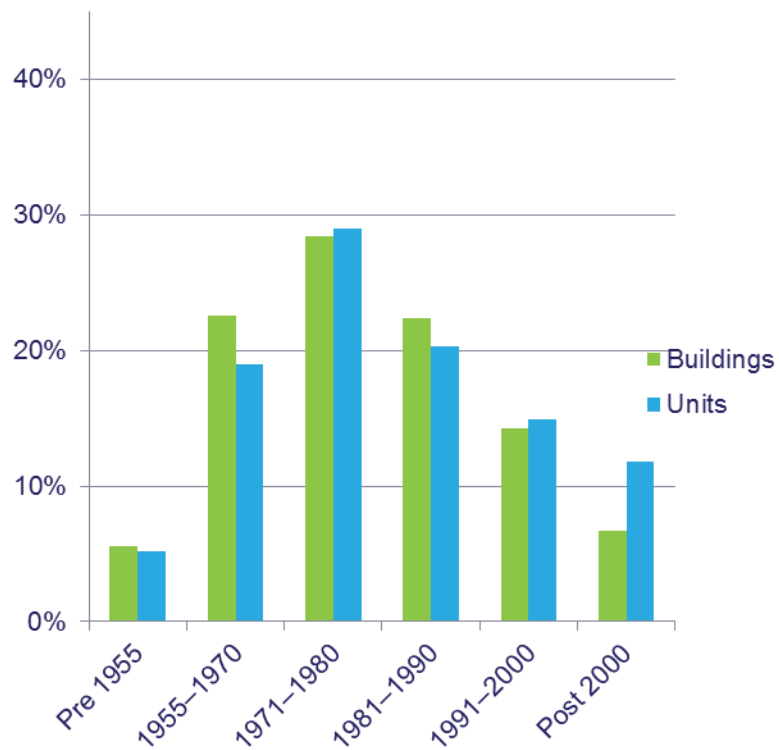
Percentage of Total, Seattle
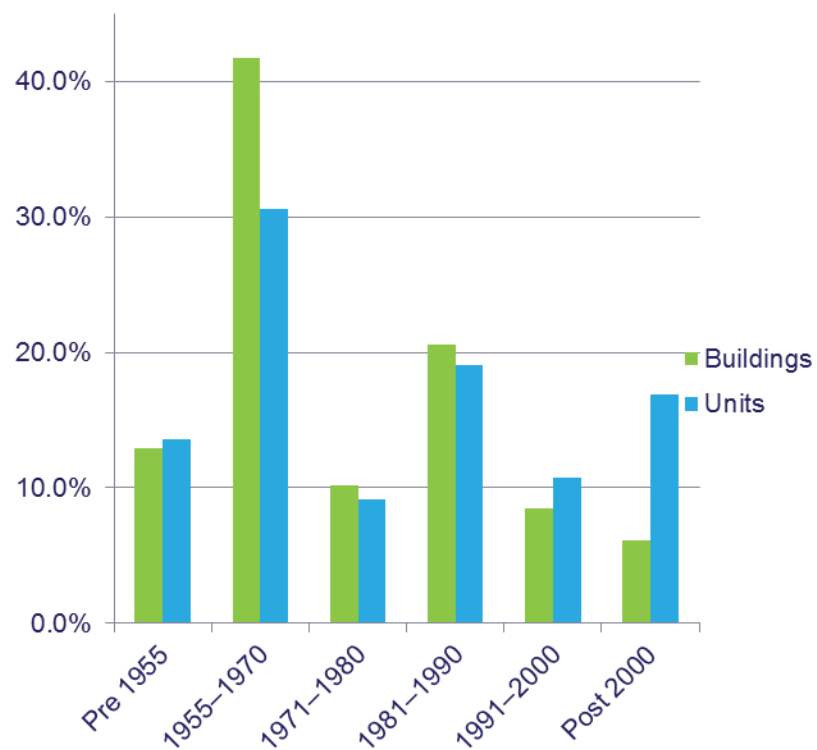
Size and Vintage

Whole Region
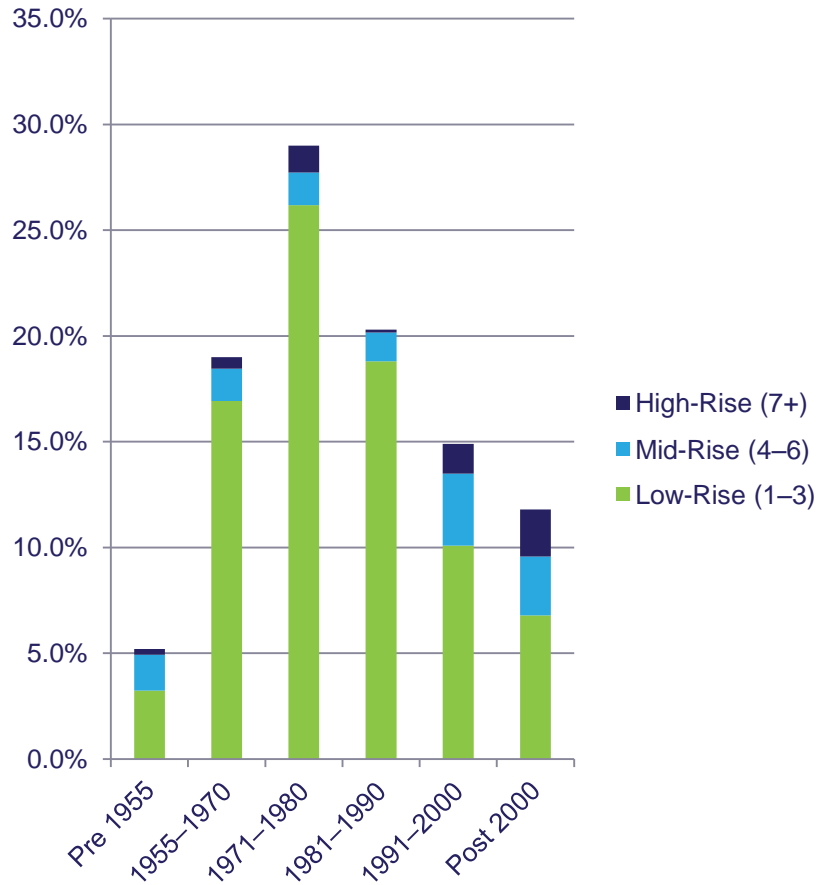
Seattle
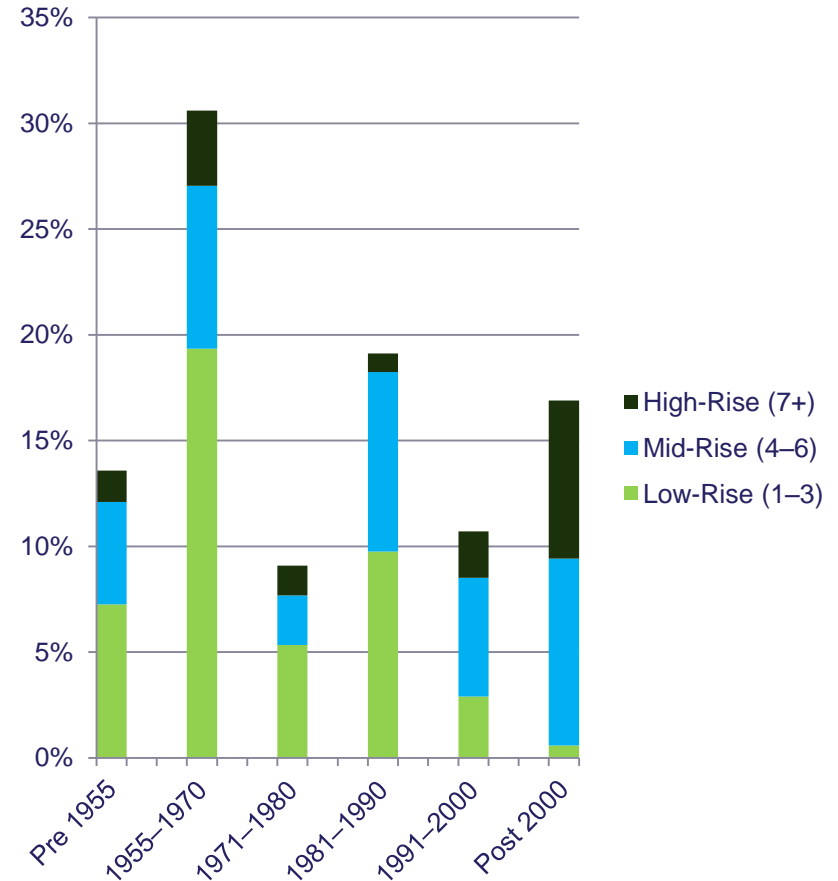
Occupancy, Comparison
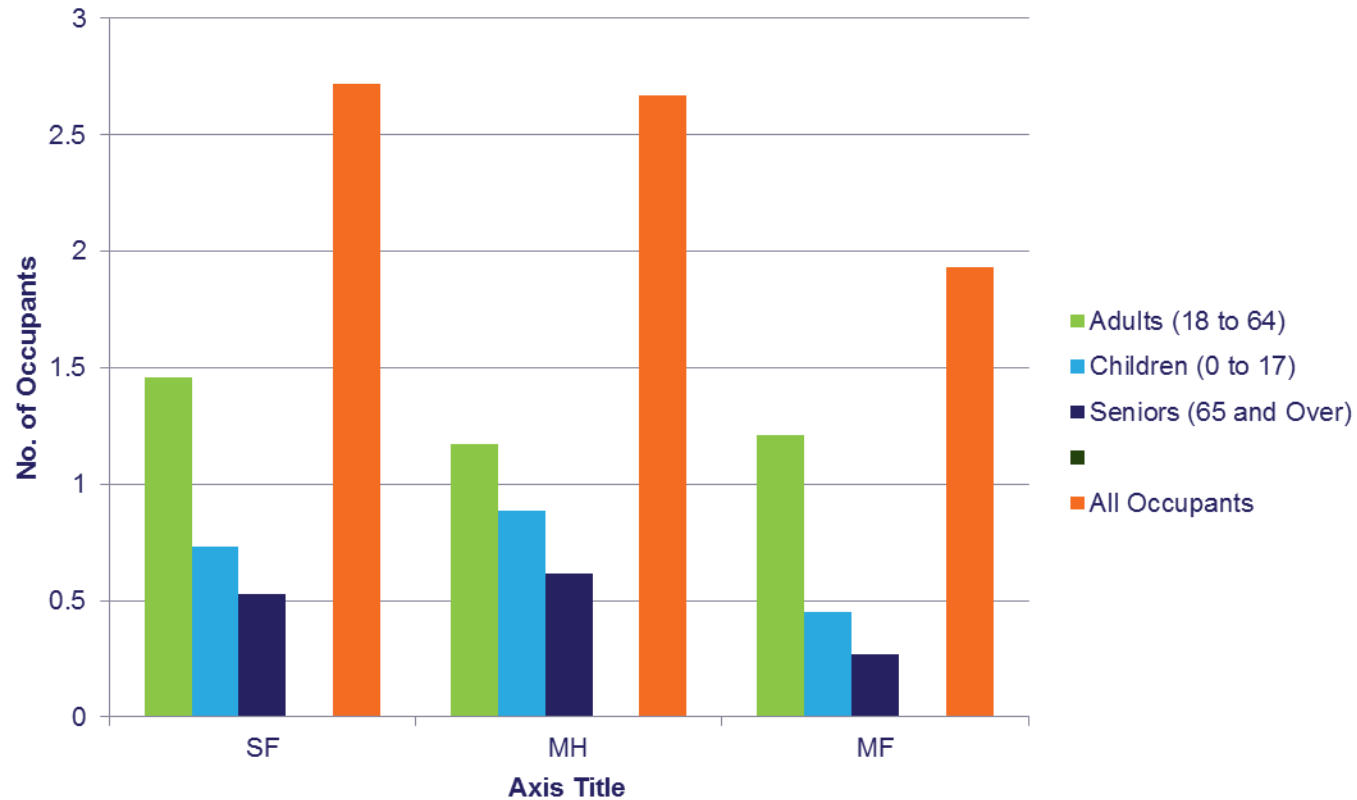
Other Building Configuration

63% of all buildings are in complexes
45% of all building have common spaces
- 59% of low rise buildings have no common area

7.0% of building area is common area
3.6% of building area is "non-residential"
Seattle 18% of building is common or non-res
- Commercial uses leased separately
- Office, Grocery, Retail, etc.

Multi-family vacancy rate: 5% (4%)
Low Income Housing: 19% (11%)
Senior and Assisted Living: 9% (14%)

Common Area by building size
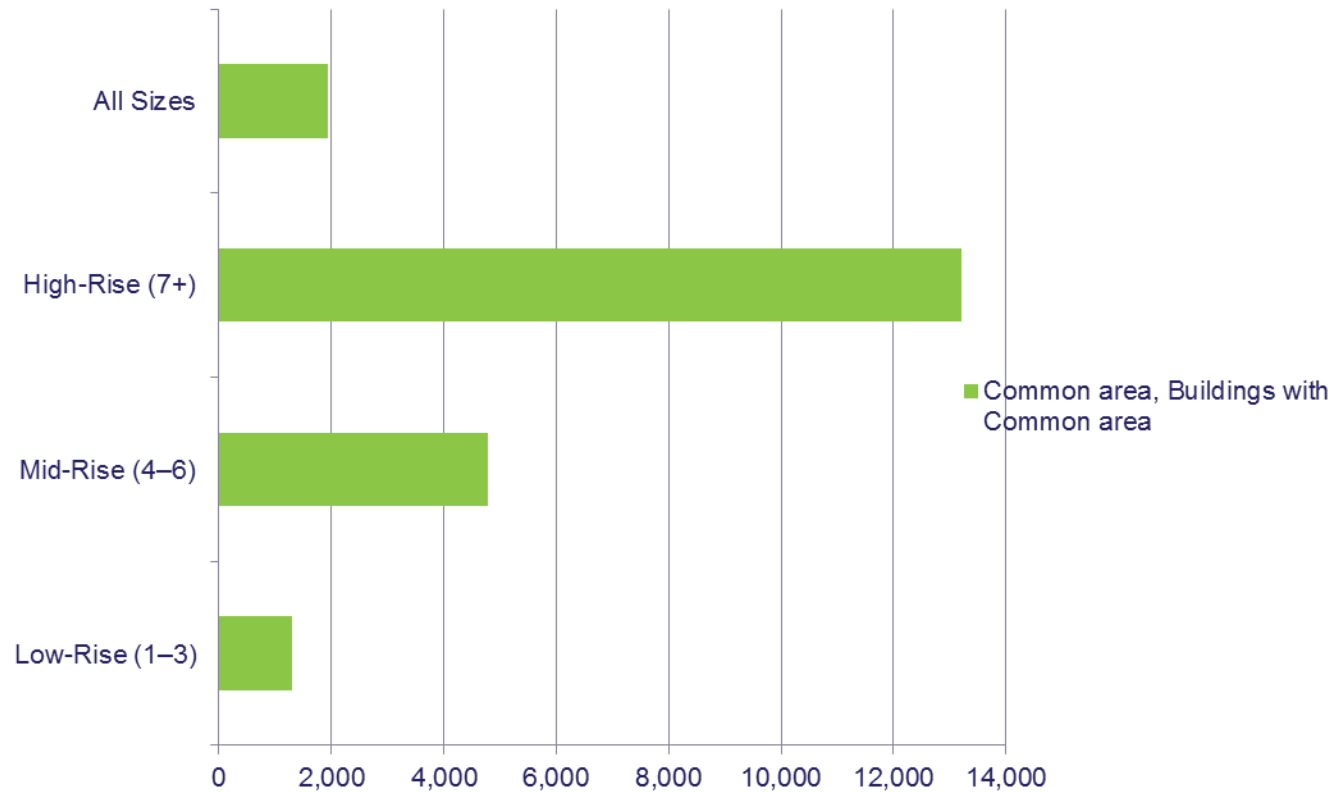
Building Ownership, Region
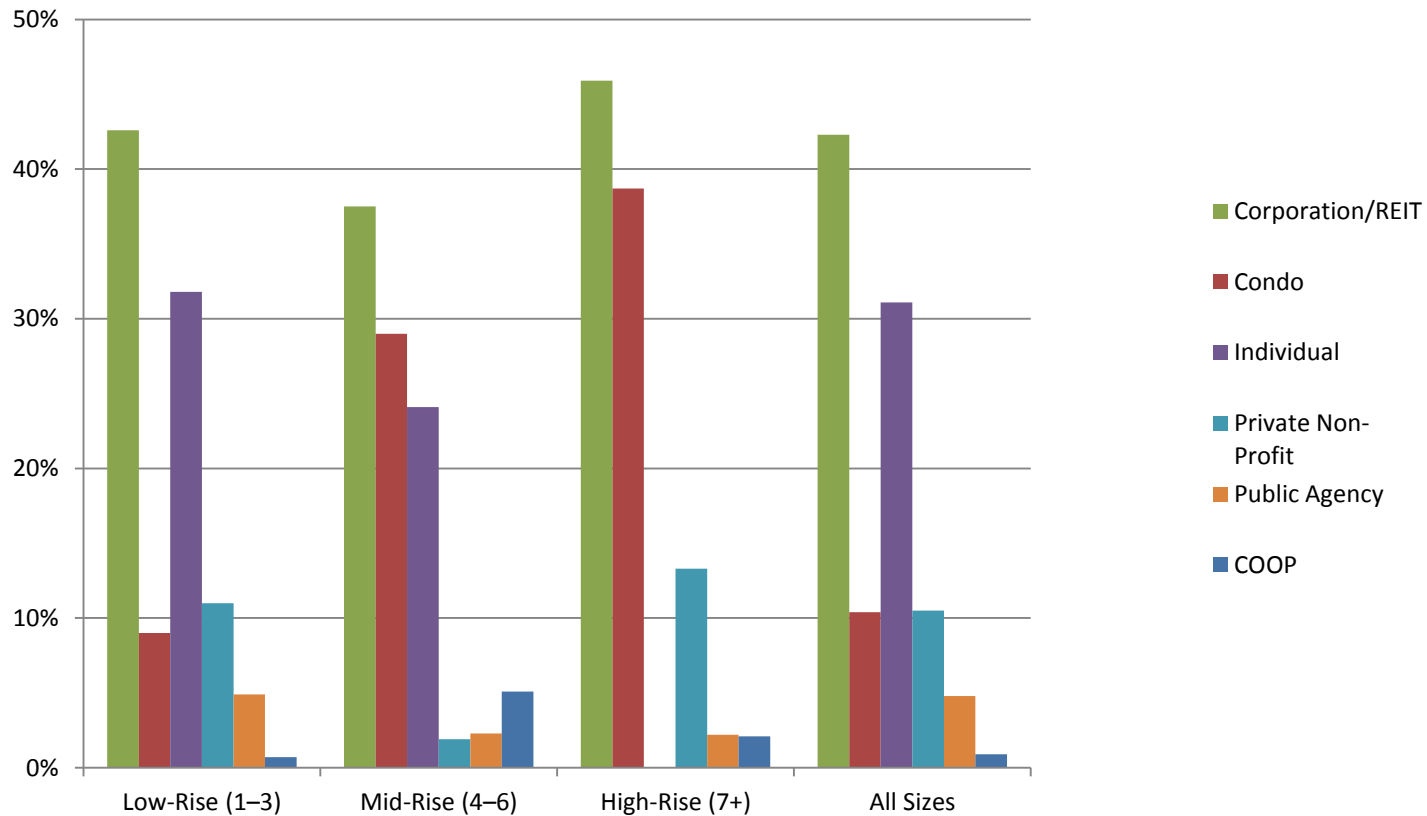
Building Ownership, Seattle
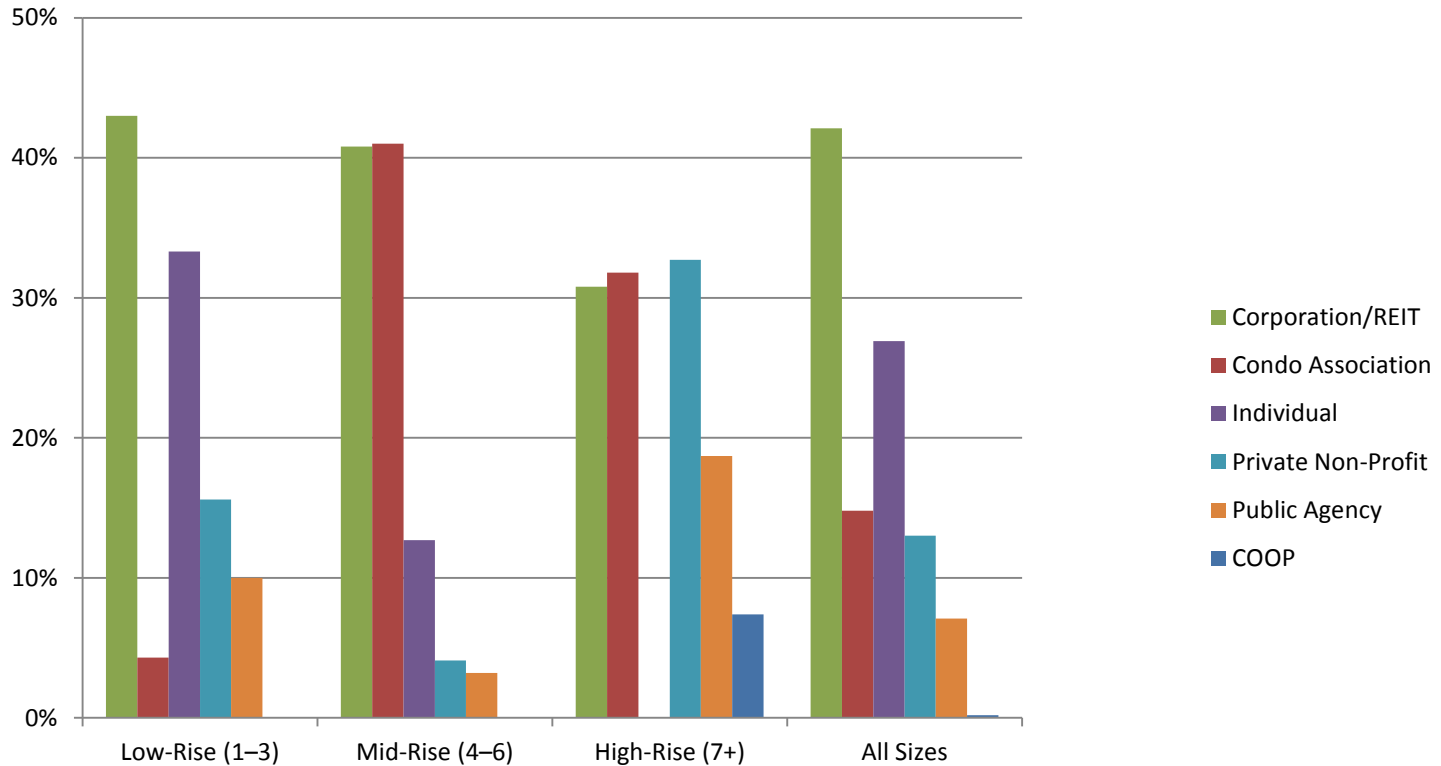
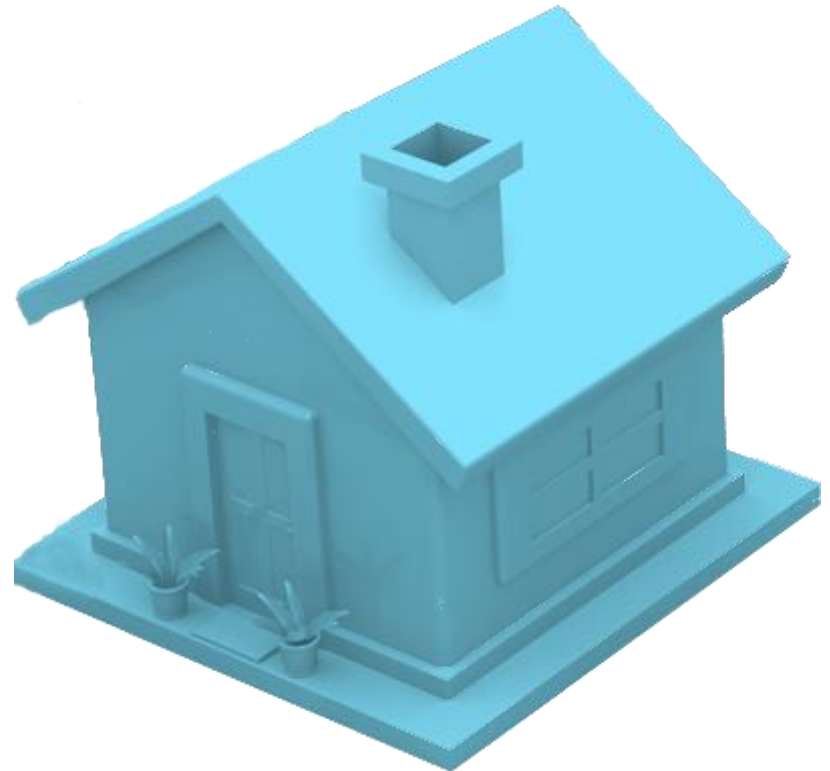# Low Income, Senior Housing
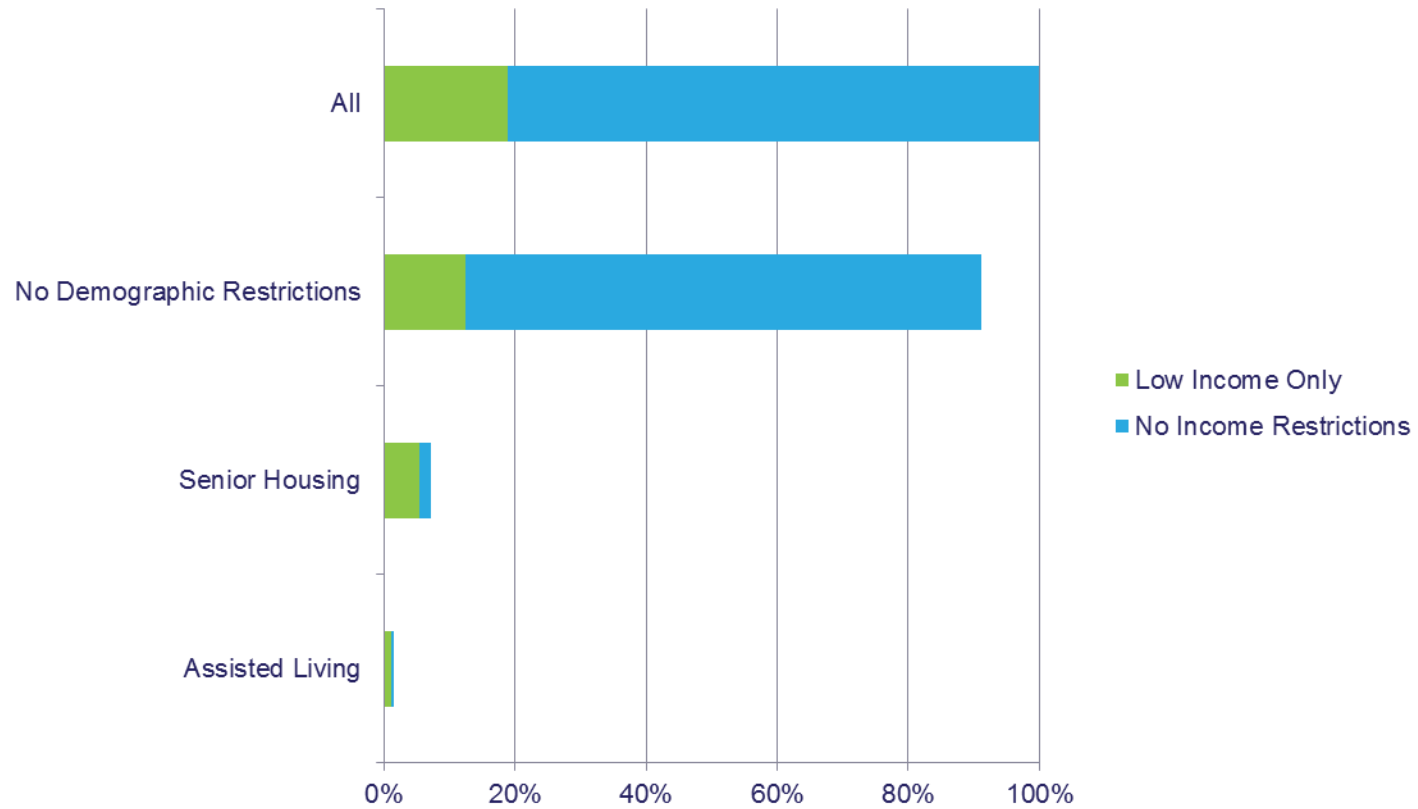
Distribution of Use Types
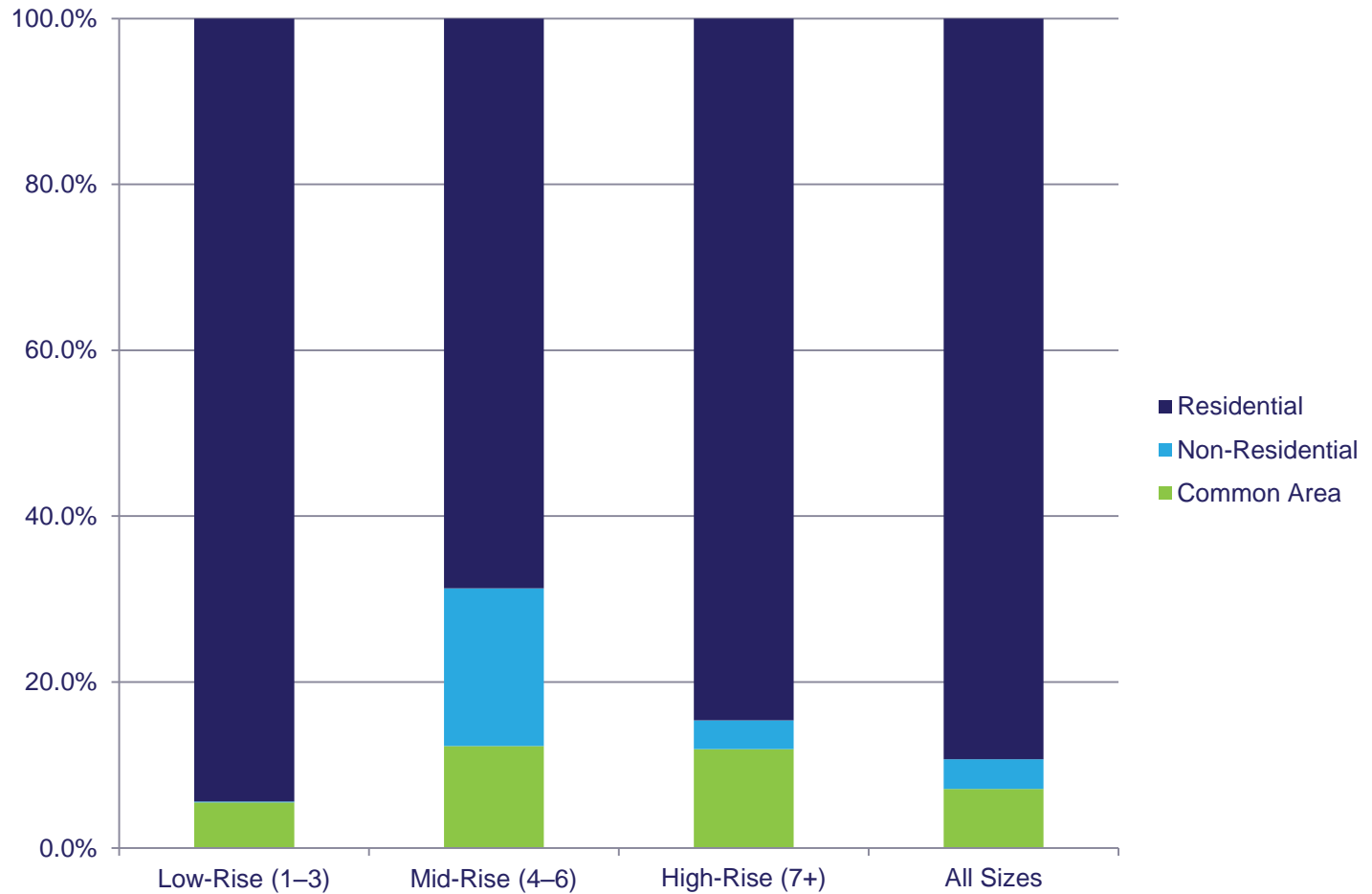
Construction Type by Building Size
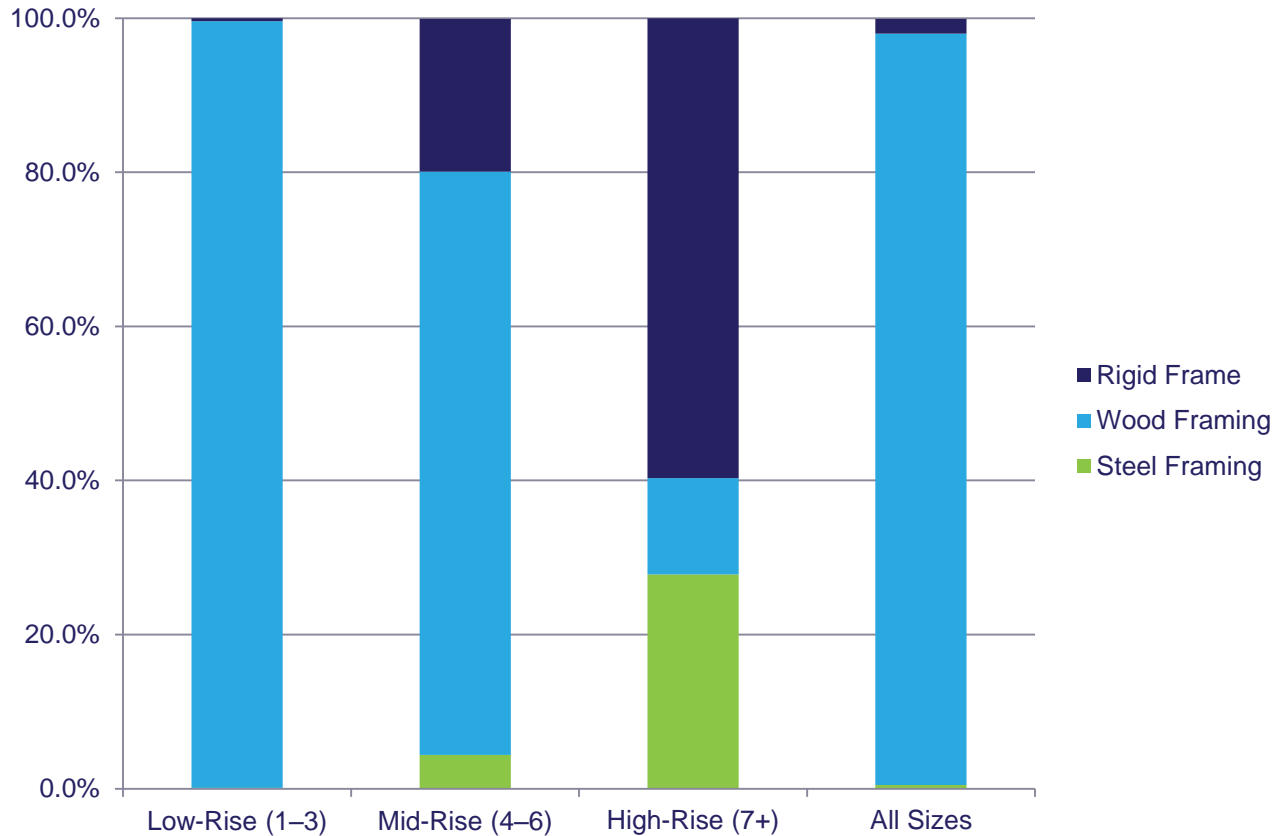
Building Envelope

- Component description
- Insulation
- Overall Heat-loss Rate

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Building Shell Heat Loss Characteristics

Insulation of frame walls typical of construction standards

Floors dominate by slab (mostly uninsulated): 63% of floors

66% of floors over crawlspace uninsulated

Window mostly replaced:

- 55% low-E, 83% double or better
- 15.6% window to wall ratio
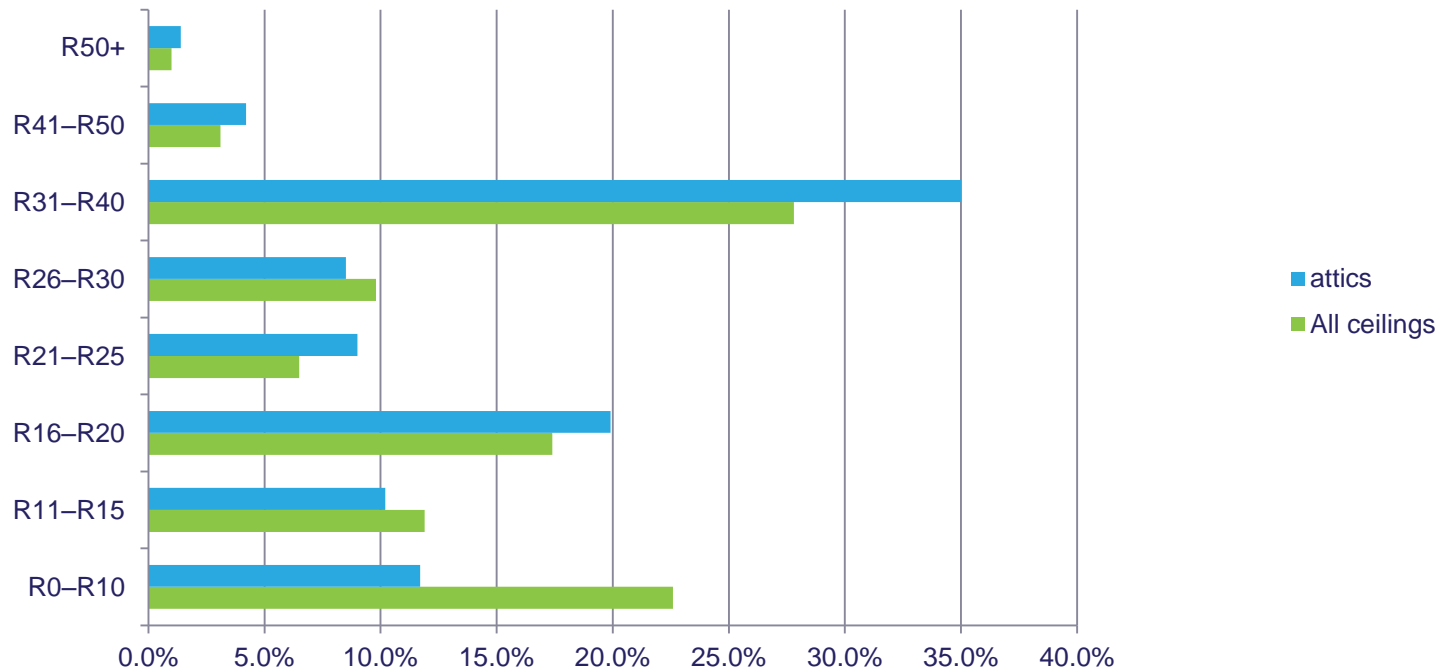
Overall heatloss rate (UA) about 200 Btuh/°F per unit

- Heatloss rate per unit reduced 60% reduction since 1970
- Across all buildings UA/sf about 0.21 Btuh/°F
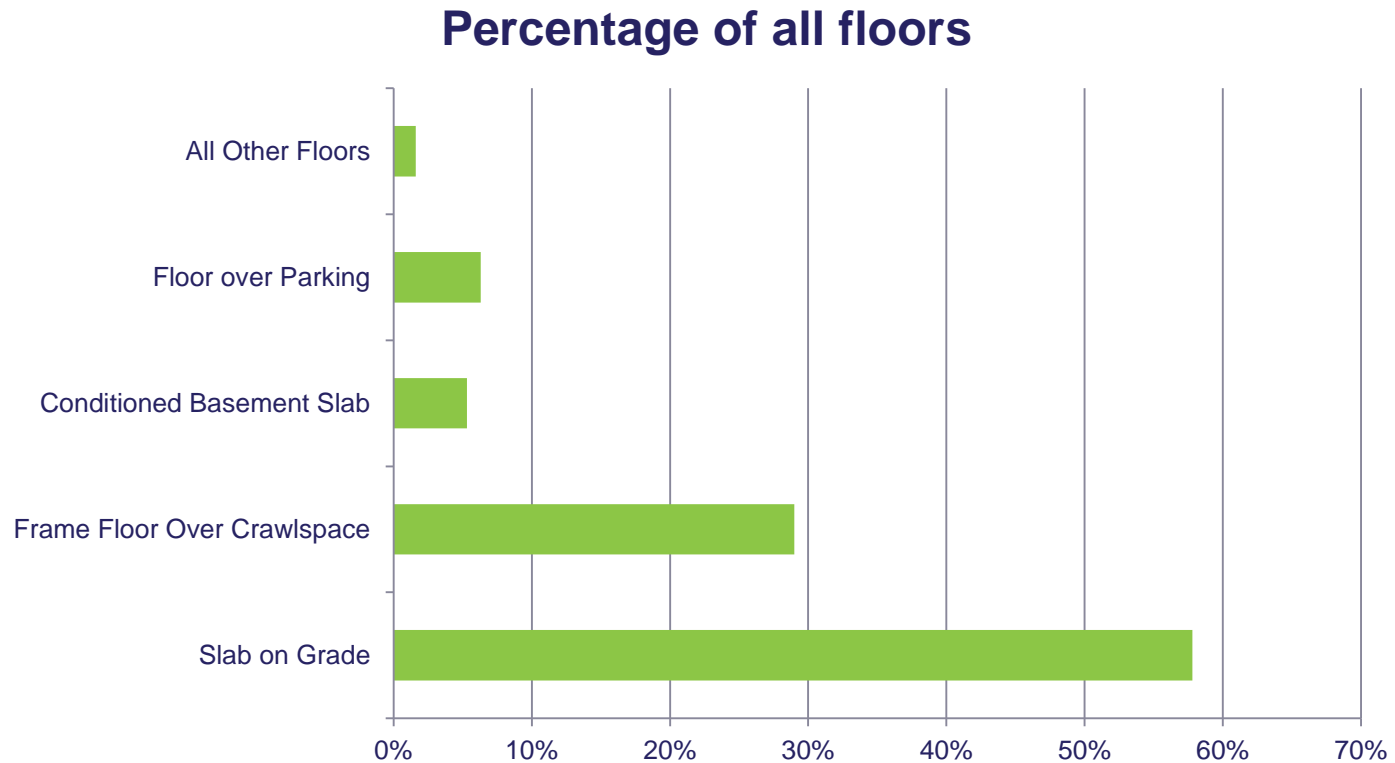- Overall unit heat loss rate average of 200 Btuh/°F

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Window Types,
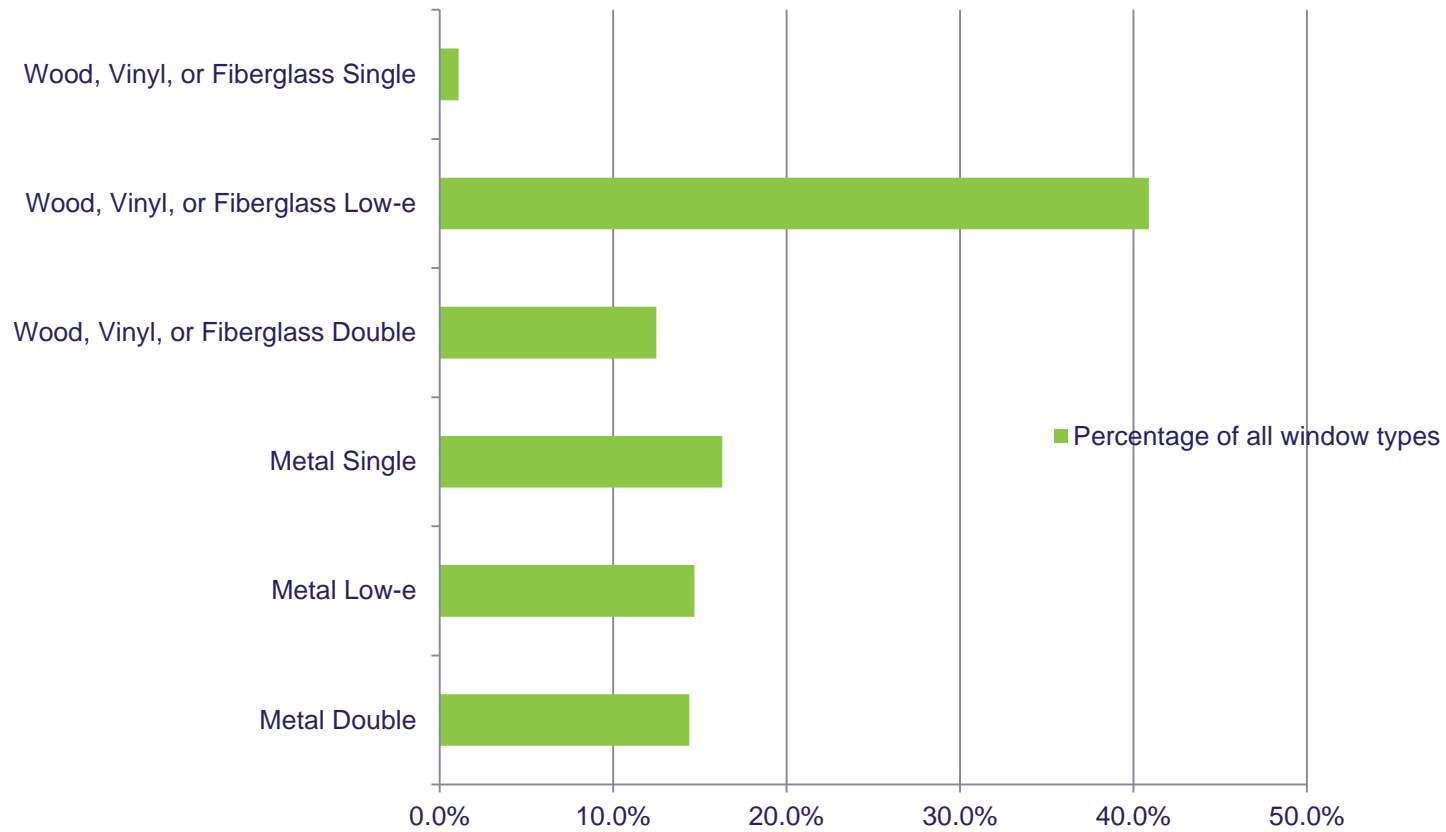
Building Ceiling Insulation

Distribution of Floor Types
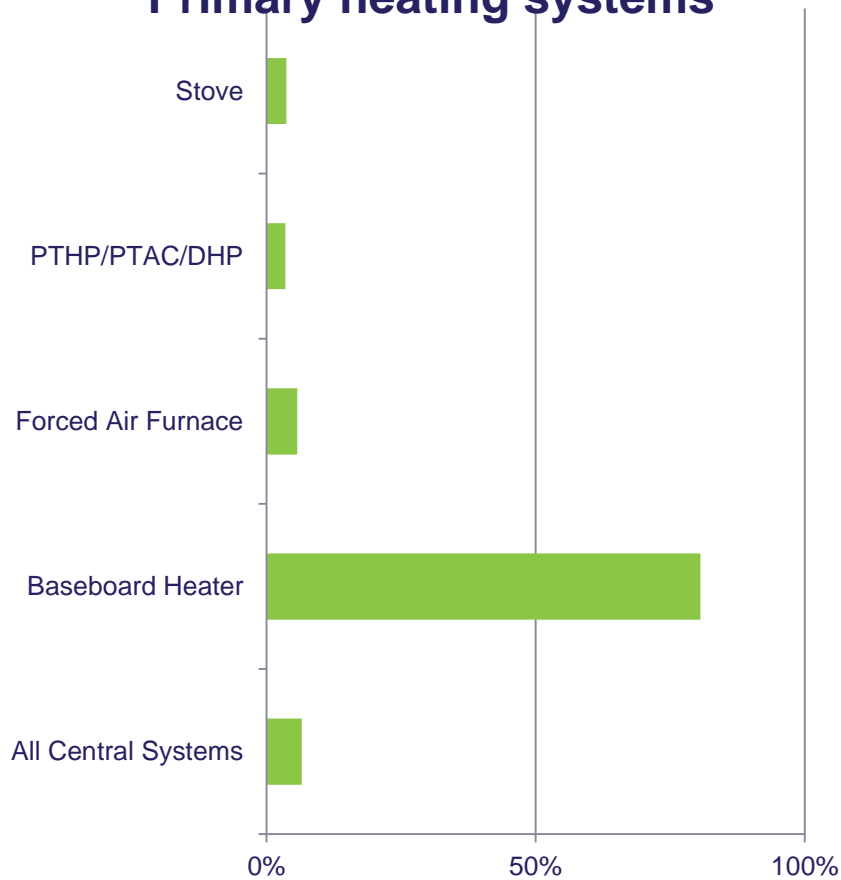

Percentage of all floors

Characteristics Highlights, Cont.

- HVAC
- Water heating
- Lighting
- Appliances
- Consumer electronics

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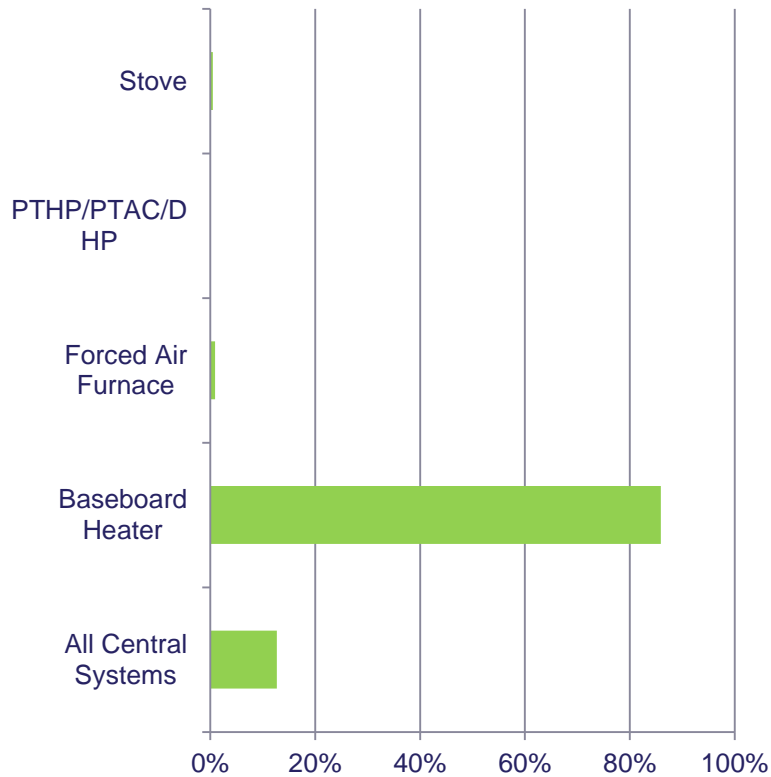
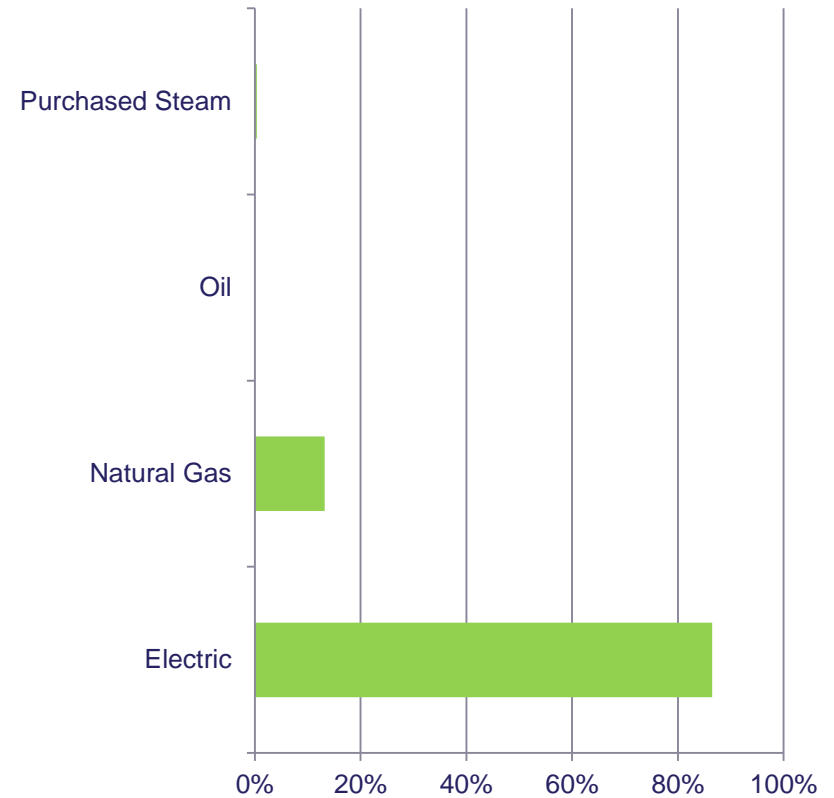# Primary Heating Systems, Region

Primary heating systems

Stove
PTHP/PTAC/DHP
Forced Air Furnace
Baseboard Heater
All Central Systems

0%   50%   100%

Percent Fuel Type

Oil
Natural Gas
Electric

0%   20%   40%   60%   80%   100%

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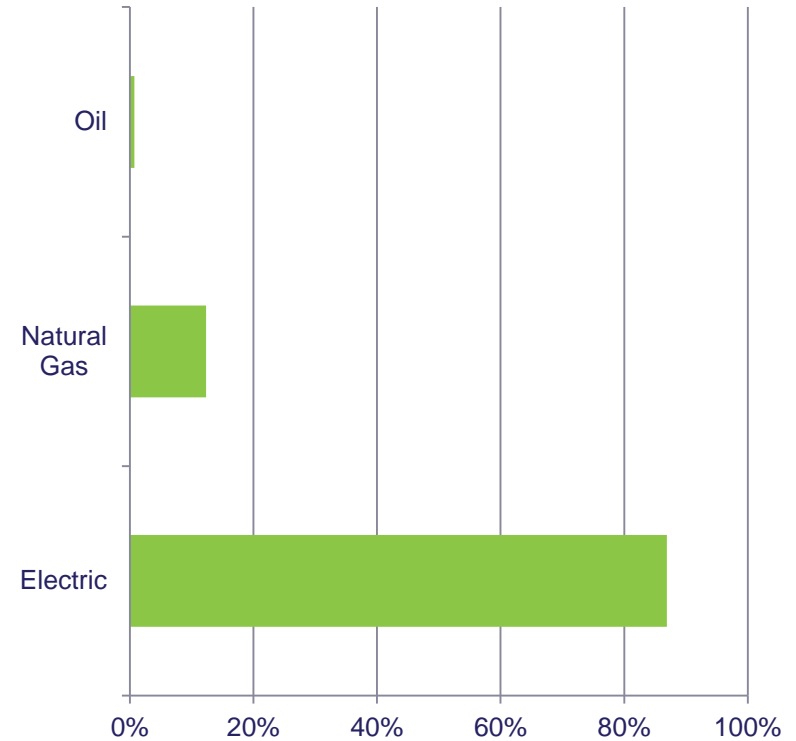
Seattle Primary Heating Systems

Primary HVAC

Category	Value
Stove	~0%
PTHP/PTAC/DHP	0%
Forced Air Furnace	~1%
Baseboard Heater	~85%
All Central Systems	~13%

Primary Fuel

Category	Value
Purchased Steam	0%
Oil	0%
Natural Gas	~13%
Electric	~86%

Primary Heating Systems

93 % of all units are heated independently
- 81% of these systems are electric
- Almost all of the electric heating systems are zonal systems

Central systems are used in 35% of high-rise buildings, 6% of low rise buildings
- 86% of central systems rely on natural gas
- 11% of central systems use Oil fuel

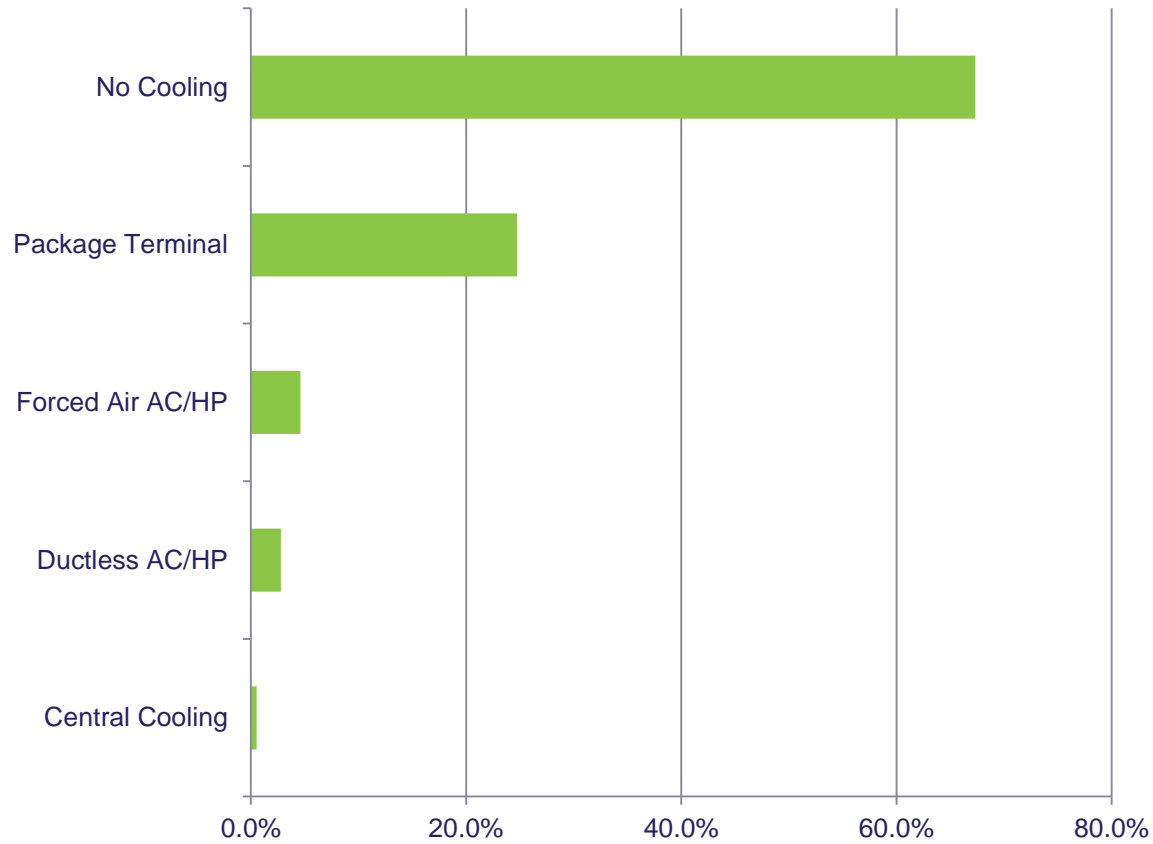Seattle: 87% of units heated independently
- 98% are electric

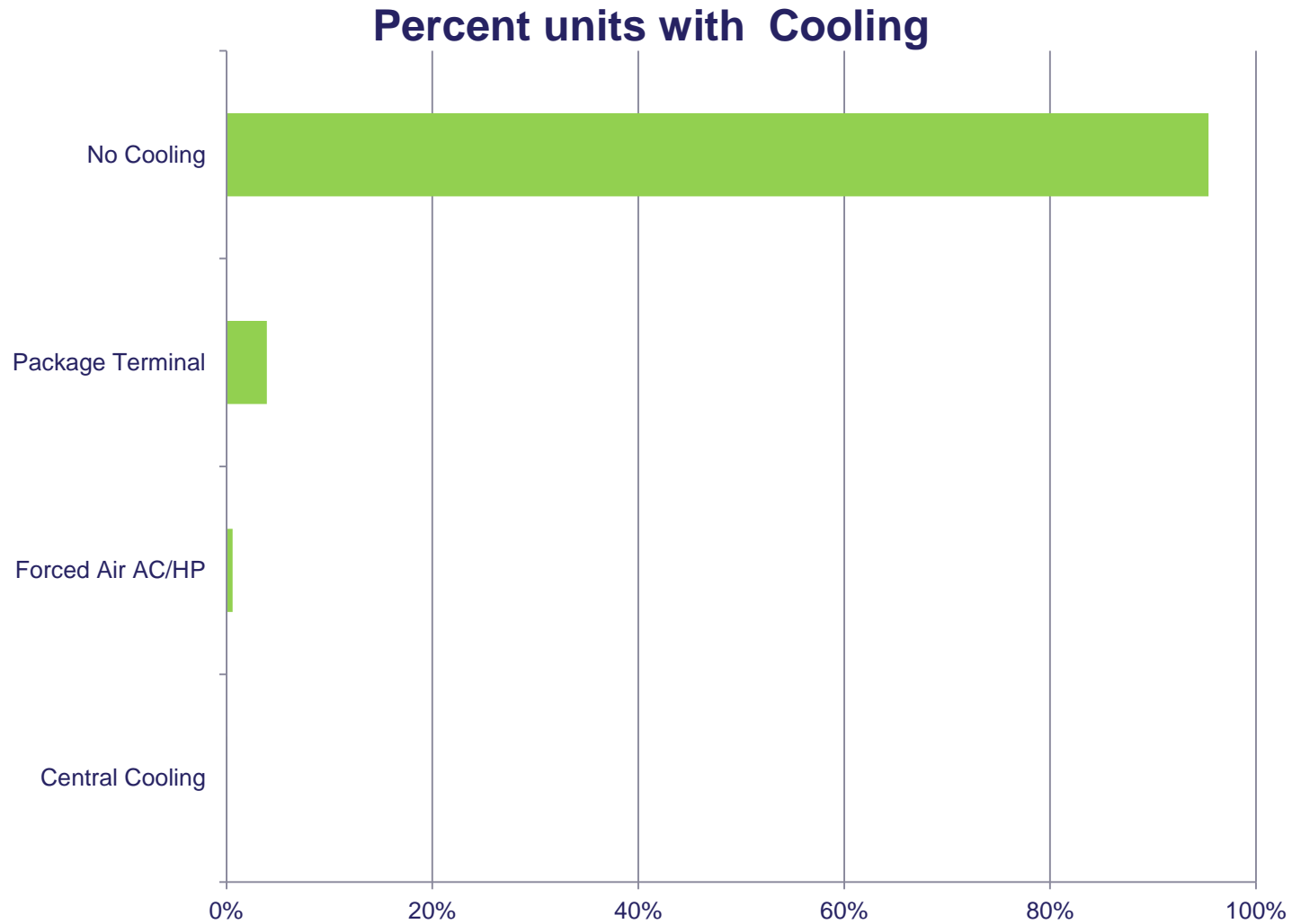Seattle: 13% of all units are centrally heated
- 99% gas heated,
- Purchased steam in the rest

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Unit Cooling Systems

Percent Units with Cooling

Categories (top to bottom): No Cooling, Package Terminal, Forced Air AC/HP, Ductless AC/HP, Central Cooling

X-axis: 0.0%, 20.0%, 40.0%, 60.0%, 80.0%

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Cooling Systems, Seattle
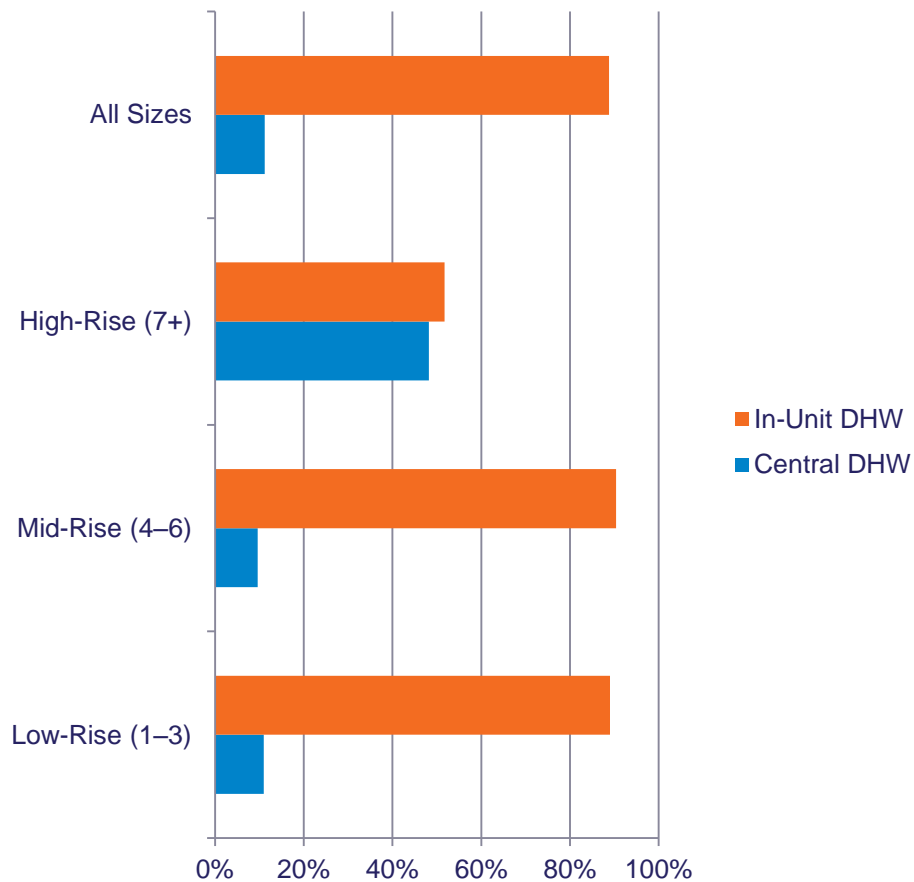
Percent units with Cooling

Water Heating

- Fuel type
- Central vs. In-unit

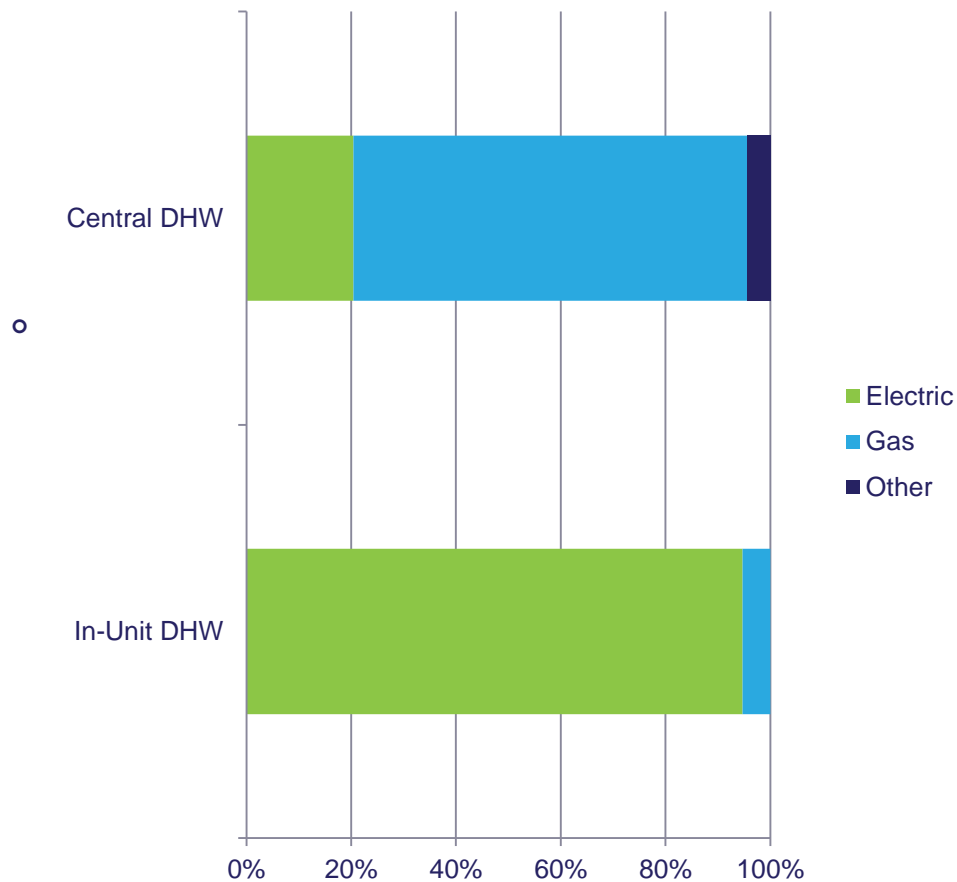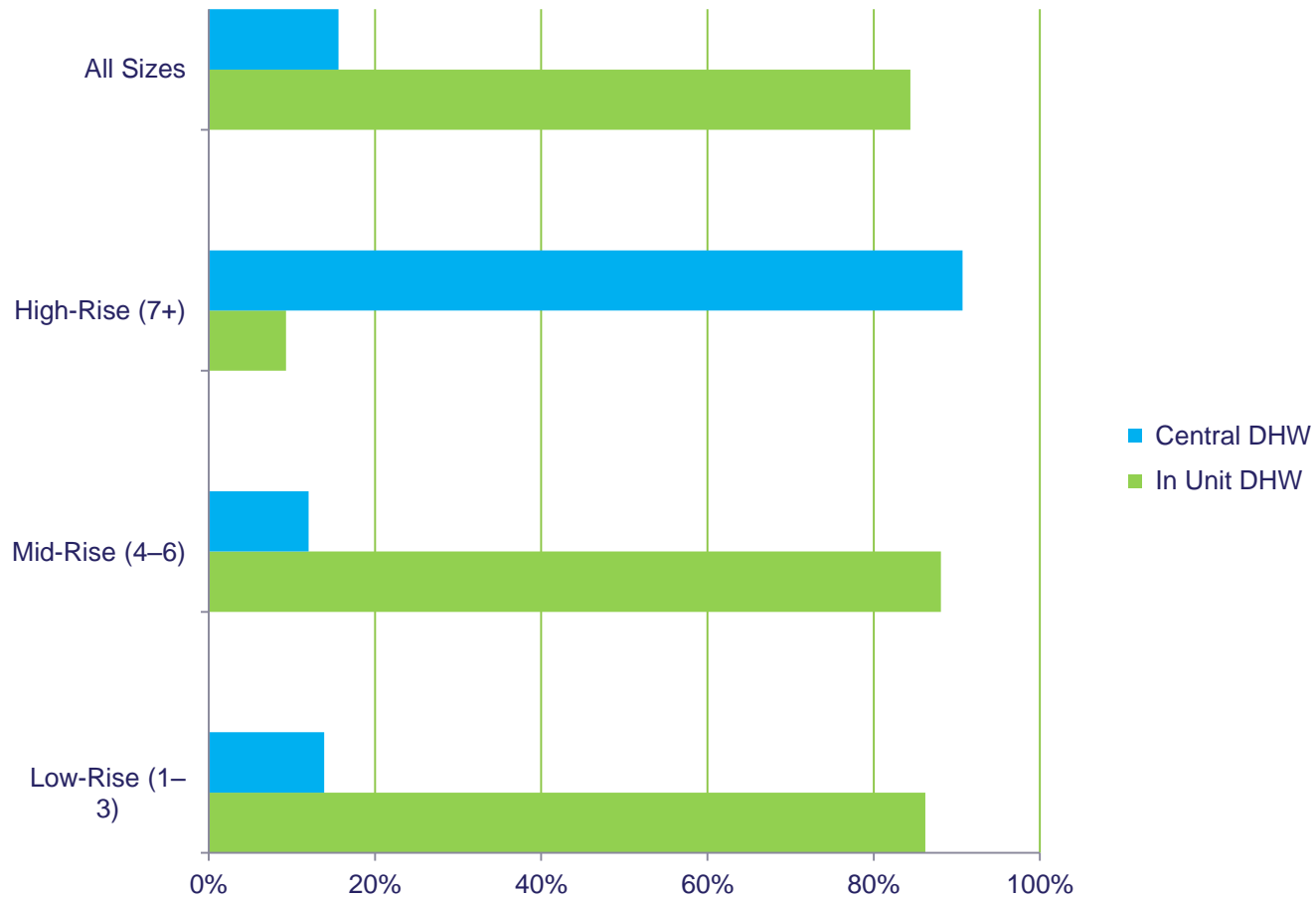# DHW Systems & Fuel Choice

DHW System Type

Fuel Saturations DHW

Seattle DHW systems

Showerhead Flow

Showerhead Flow GPM

Pie chart:
- 25.10% — <=1.5
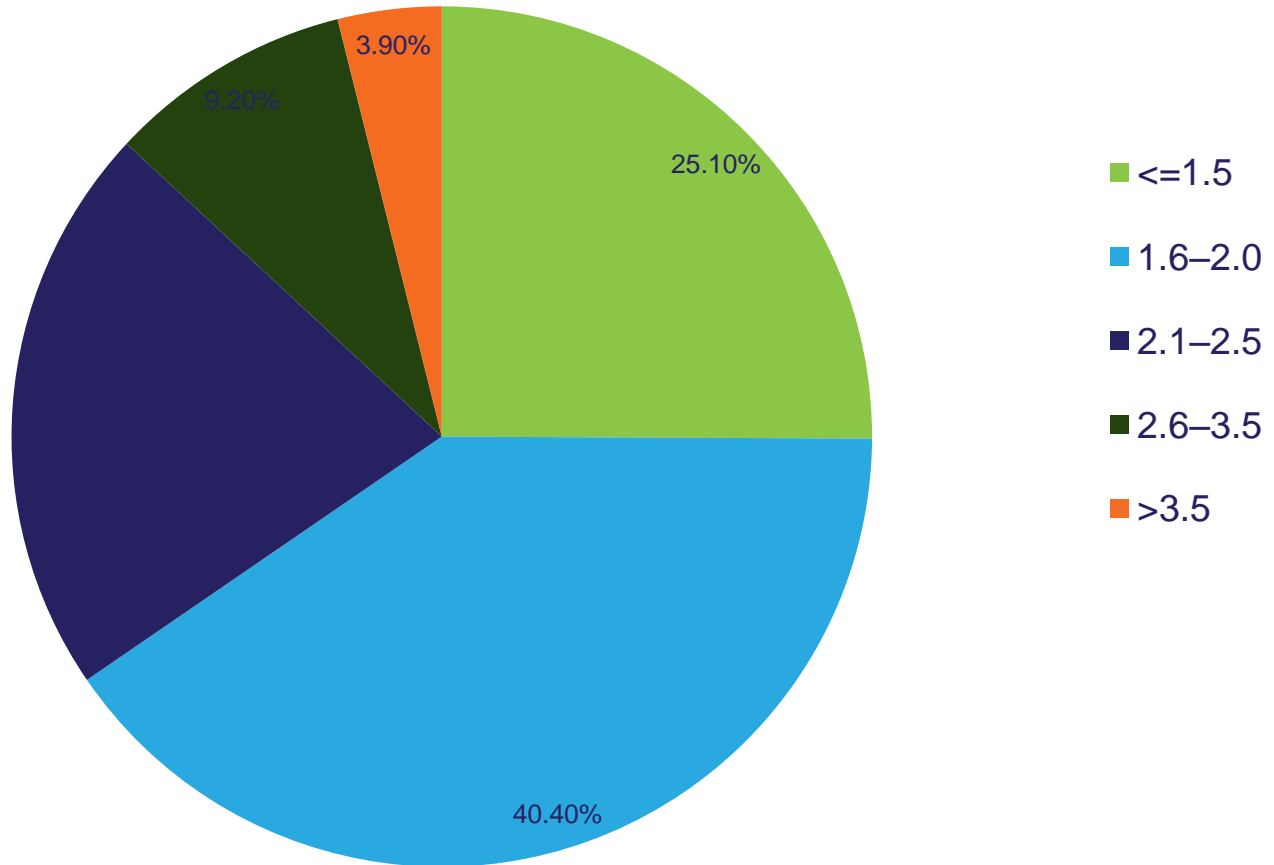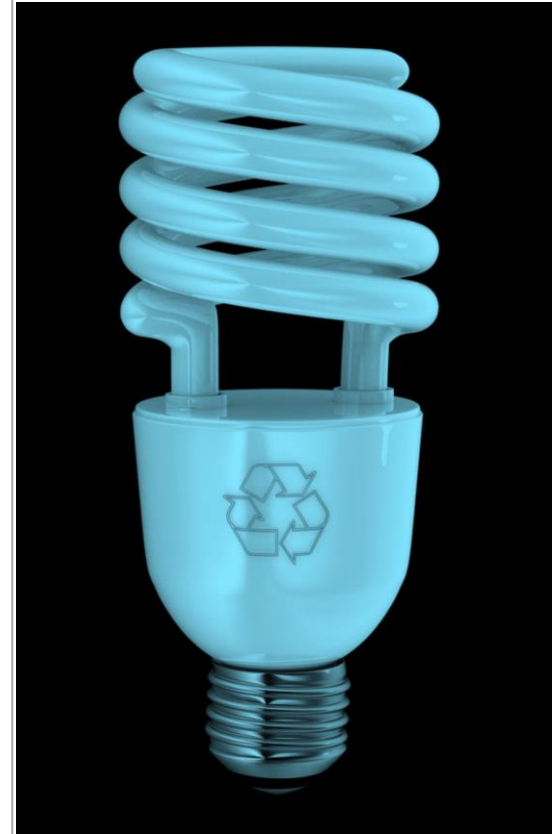- 40.40% — 1.6–2.0
- 2.1–2.5
- 9.20% — 2.6–3.5
- 3.90% — >3.5

Legend:
- <=1.5
- 1.6–2.0
- 2.1–2.5
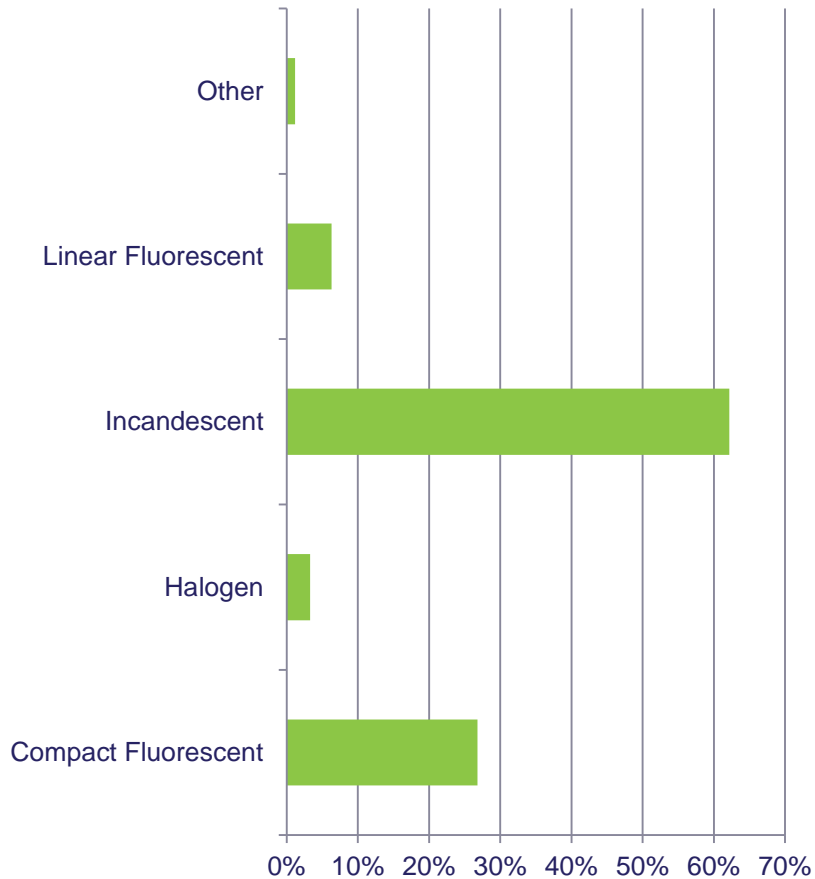- 2.6–3.5
- >3.5

Lighting

- Specific lamp and fixture overviews
  - Number and type of lamps
  - EISA review
  - CFL summaries
- Whole-house LPD

Unit and Common Area Lighting
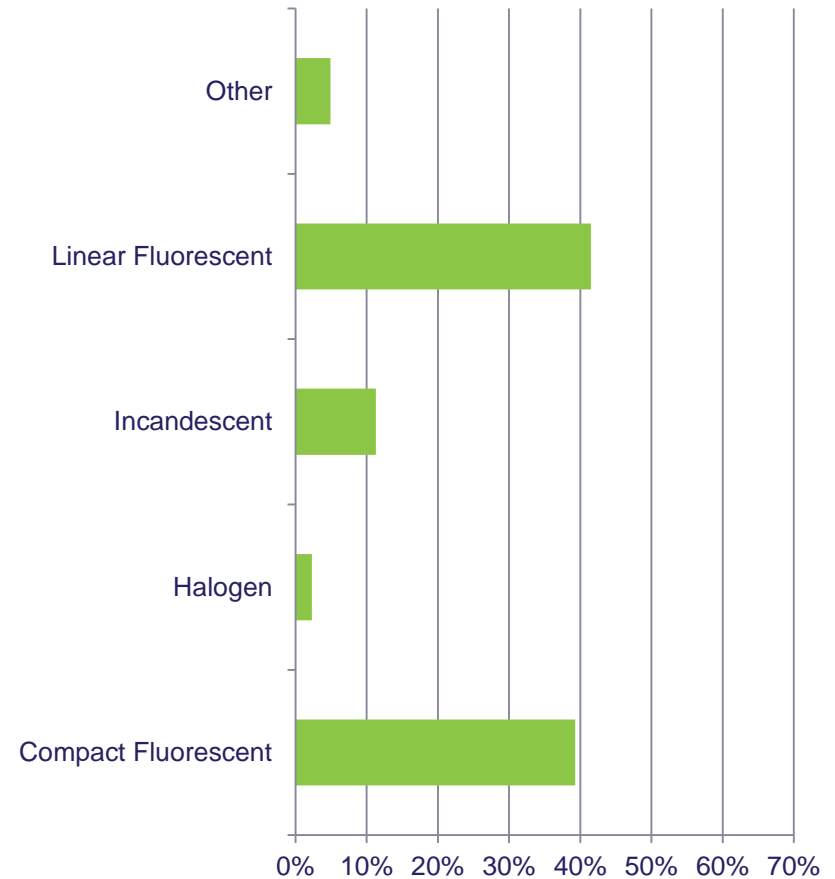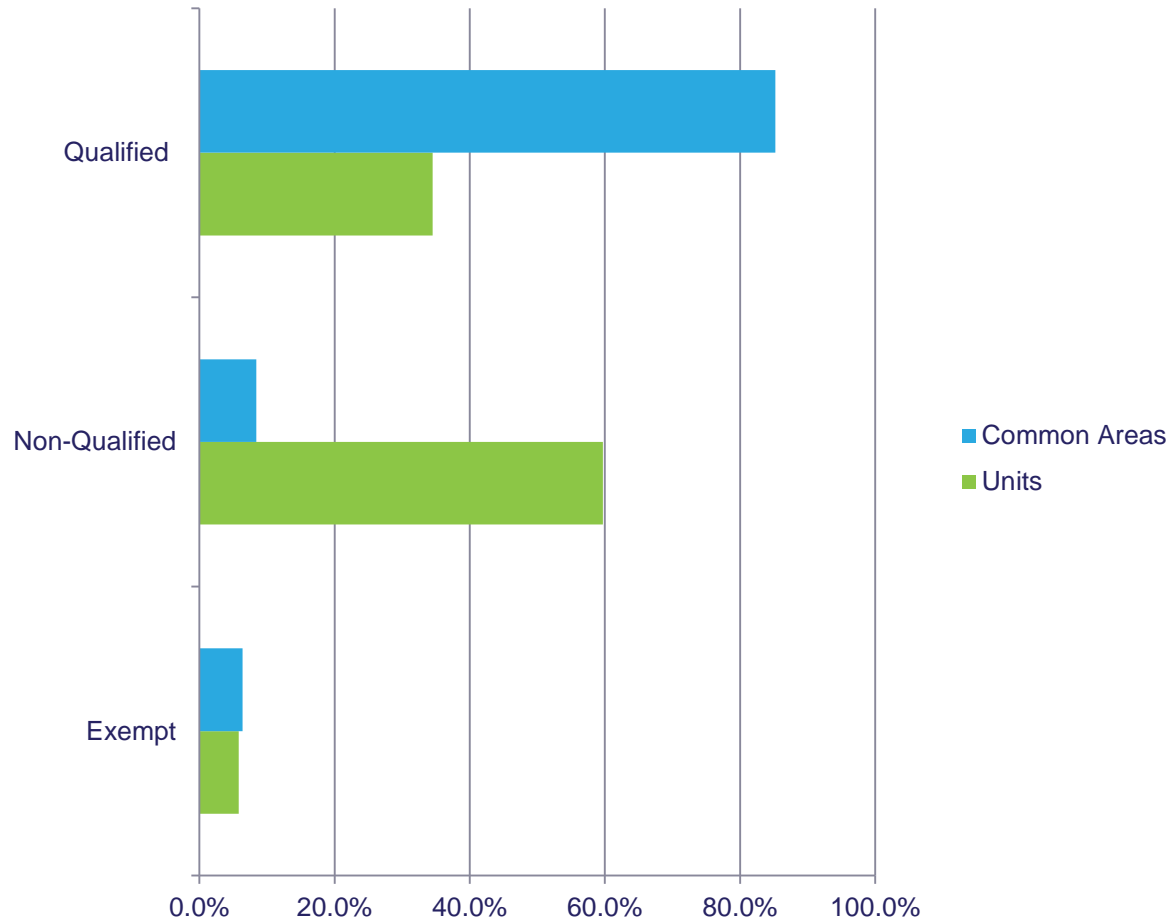
Lamp Types, Units

Lamp Types, Common Area

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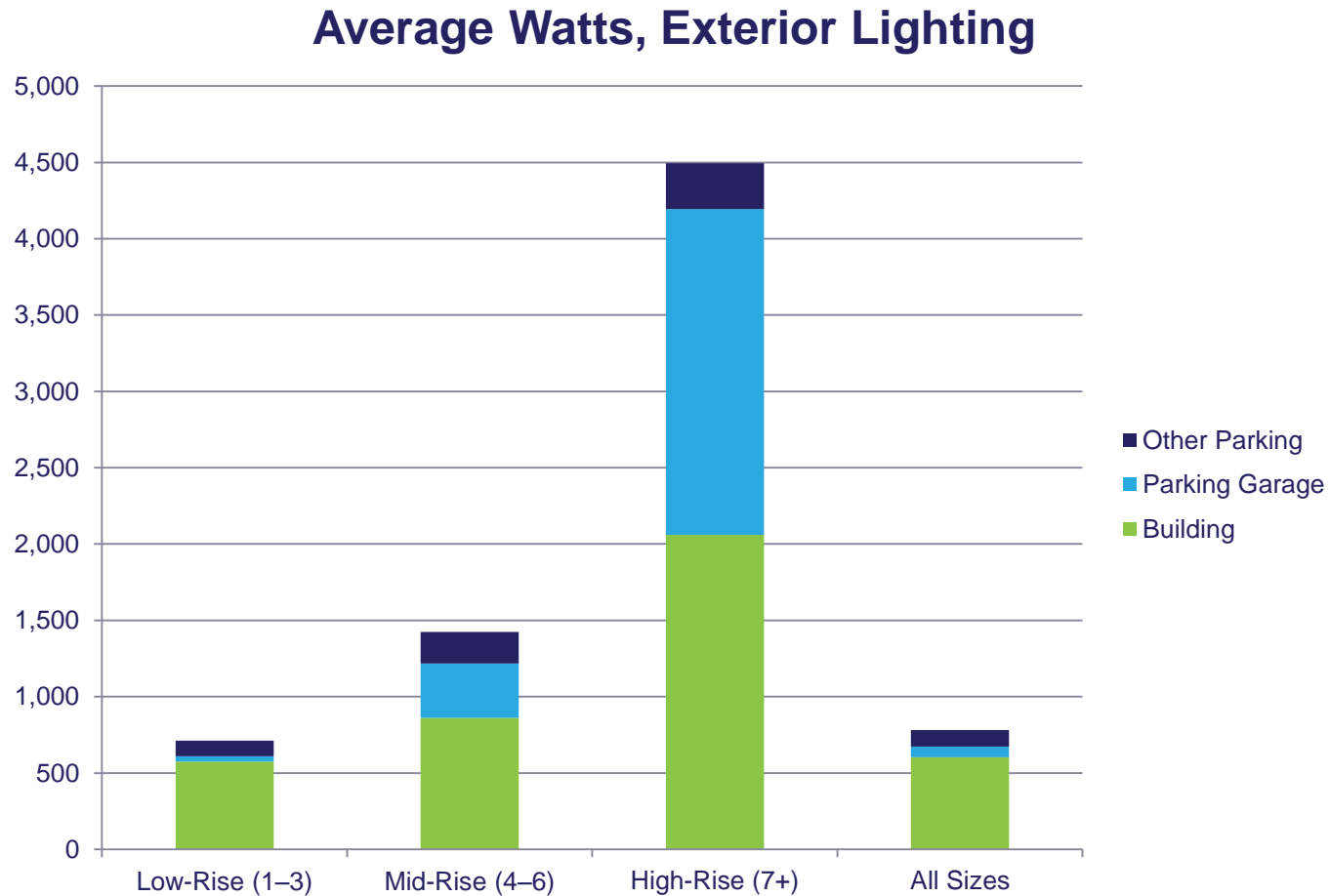# EISA Status: Units, Common Areas
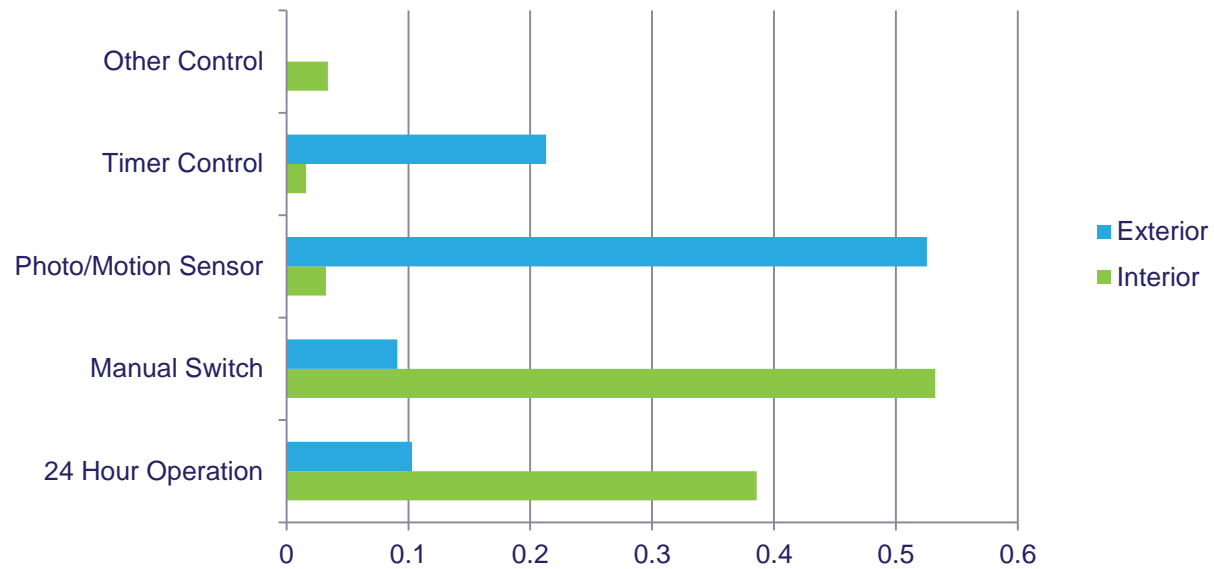
Overall Lighting Power

Unit level LPD: 1.44 W/sf
Common Area LPD: 0.58 W/sf
Exterior LPD: 0.07 W/sf (of interior common area)

Exterior Lighting Power by Building Size

Average Watts, Exterior Lighting
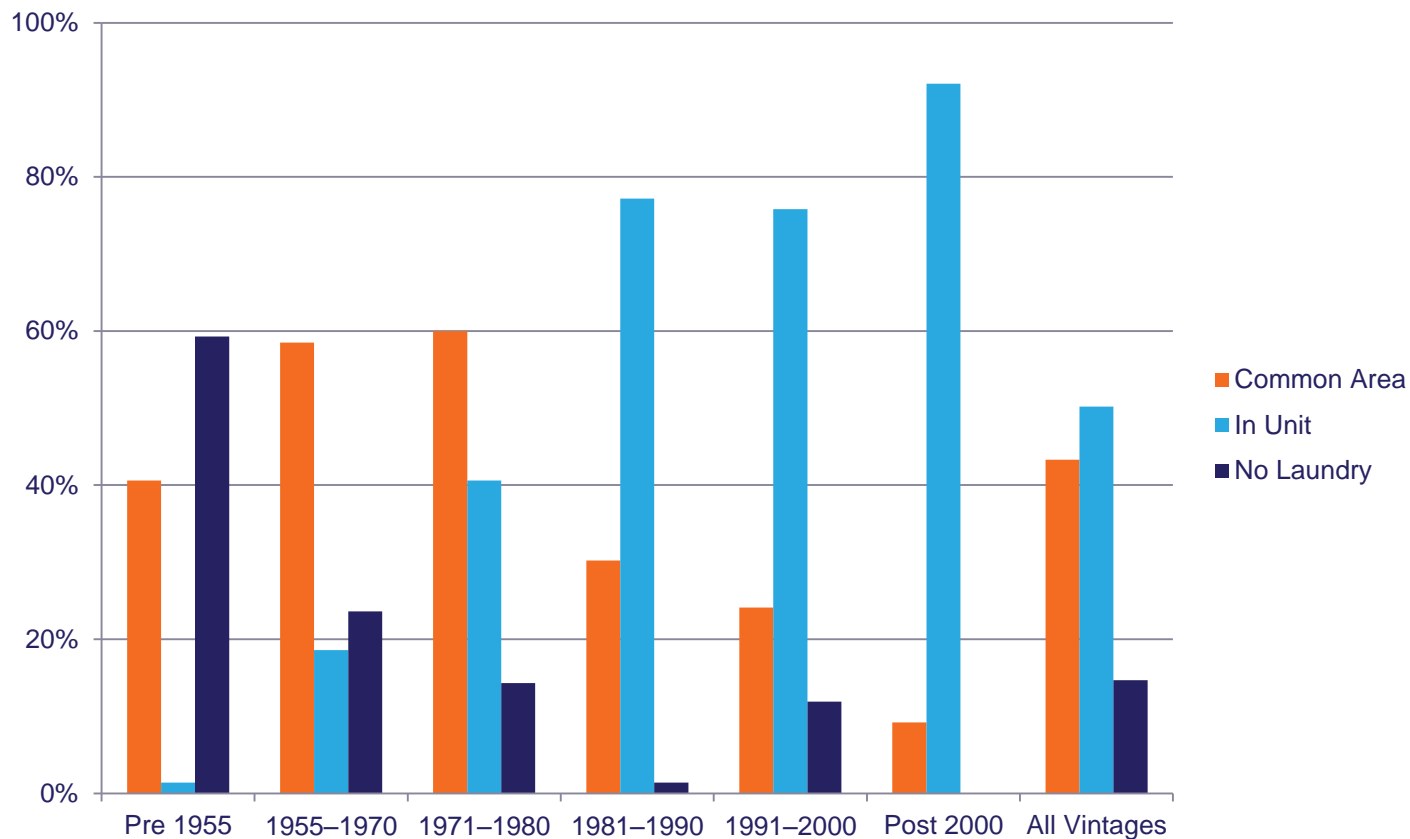
Building Lighting Control

Other Loads

- Laundry
- Pools and Spas
- In-Unit Appliances
  - Refrigerator
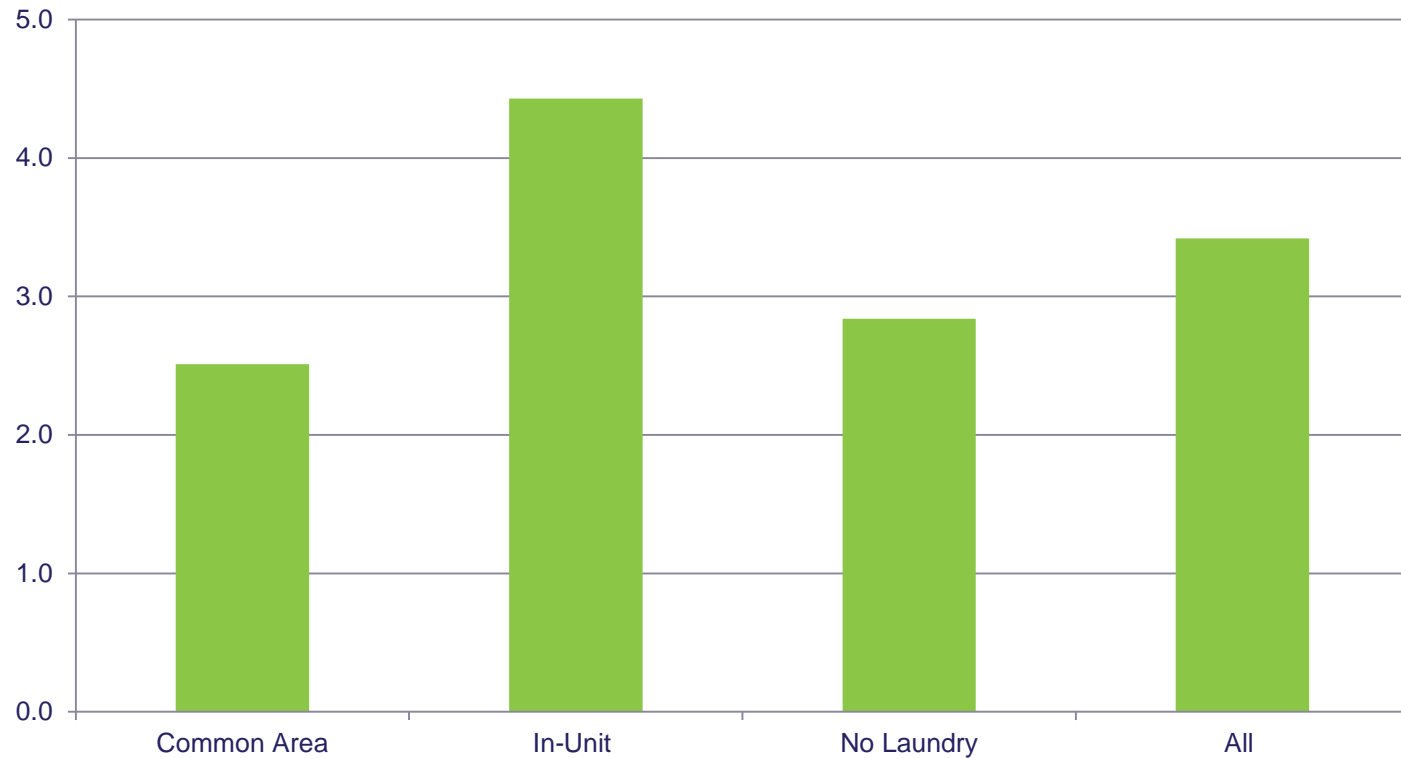 - Dishwashers
- In-Unit Electronics
  - Televisions
  - Other

Laundry Location by Building Vintage

Laundry Use

Washer Loads per Week by Location

Pools and Spas by Location
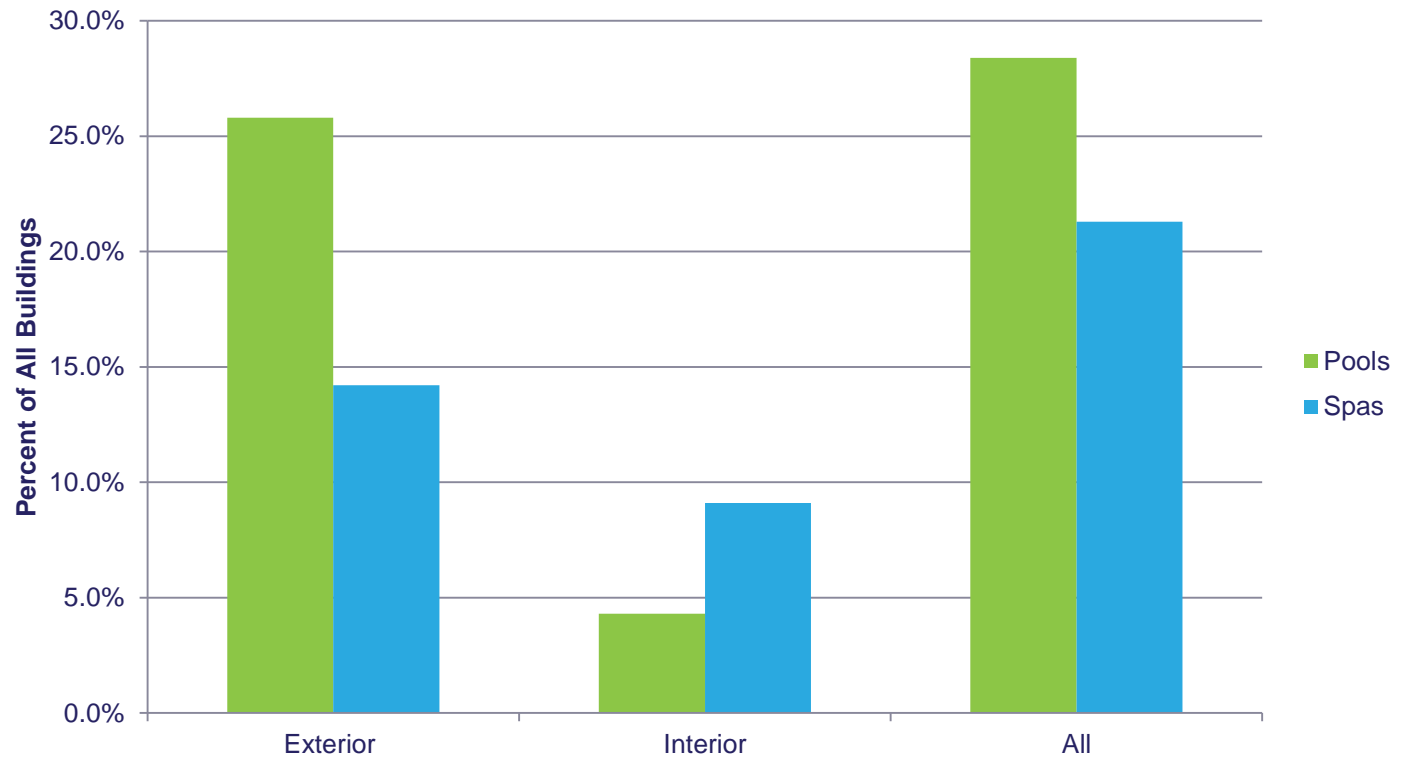
In-unit Appliance Saturations

Appliance	Number of Appliances per Unit (n = 552)		
	Region (MF)	SCL (MF)	Mean (SF)
Clothes Washer	0.47	0.37	0.99
Dishwasher	0.78	0.63	0.89
Dryer	0.47	0.37	0.99
Freezer	0.04	0.0	0.53
Refrigerator	1.03	1.20	1.29

Comparison Multi Family and Single Family Units

Category	MF Units	SCL Units	SF Units
Televisions Per Unit	1.52	1.16	2.29
Primary Television On-Time Hours Per Day Per Unit	6.76	4.72	5.61
Units With Set-Top Boxes	75.1%	87.8%	80.6%
Set-Top Boxes With DVR Capability	12.6%	12.7%	28.6%
Units With Gaming Systems	20.9%	18.3%	33.2%
Computers Per Unit	0.71	1.03	1.67
Units With Computers	51.0%	73.9%	90.5%
Audio Systems Per Unit	0.80	.92	1.99
Total Subwoofers Per Unit	0.25	.23	0.47
Powered Subwoofers Per Unit	0.11	.13	0.20

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Energy Benchmarking Highlights

- **Total energy use summaries**
  - Electric
  - Gas

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Total Fuel Use (kWh equivalent)

Legend:
- All Utility Fuel Building Use per Unit
- Units Only per Unit kWh Use
- Common Area per Unit Use
- Gas Use KWh therm Equivalent per Unit

Gas Use

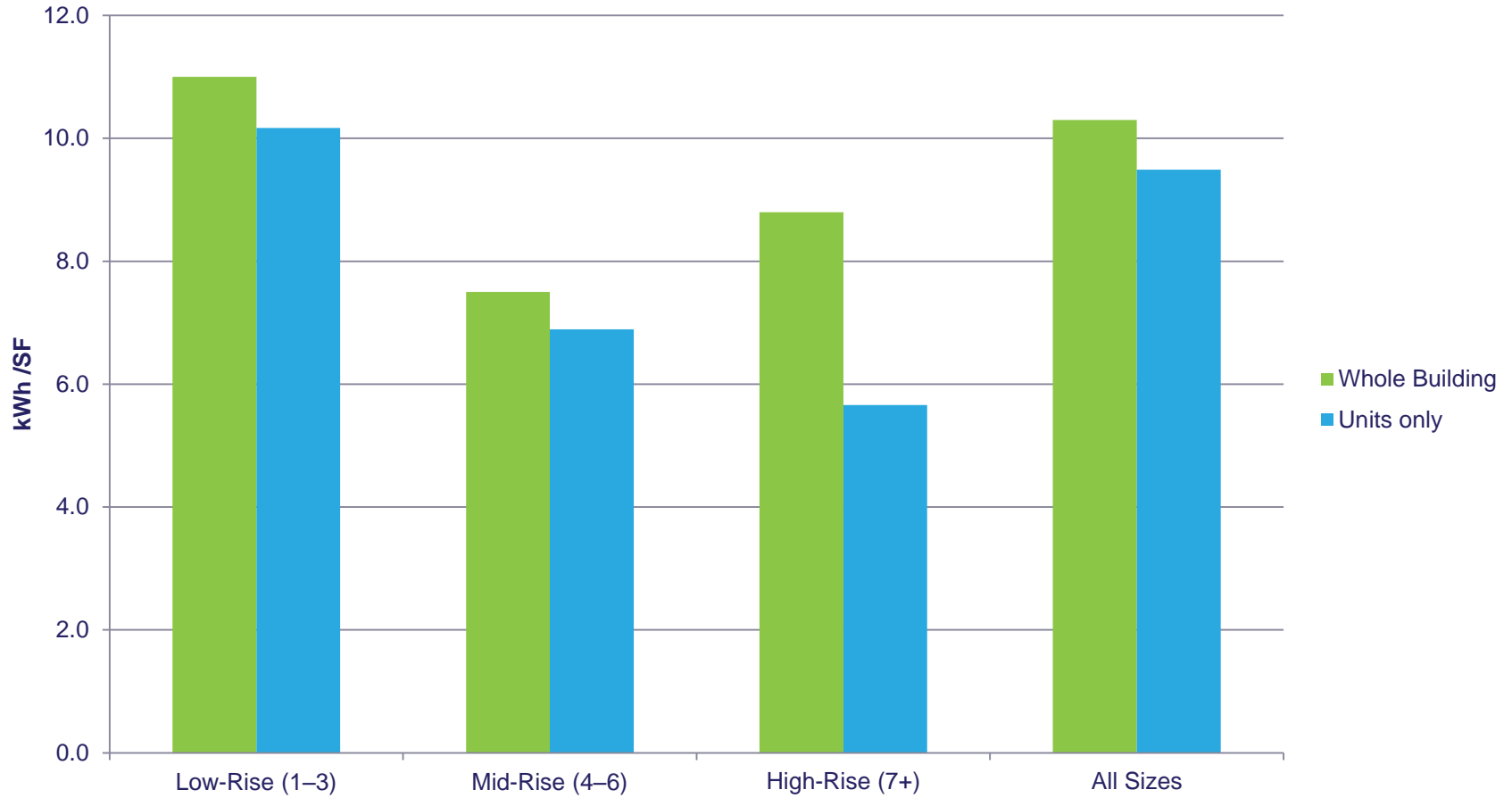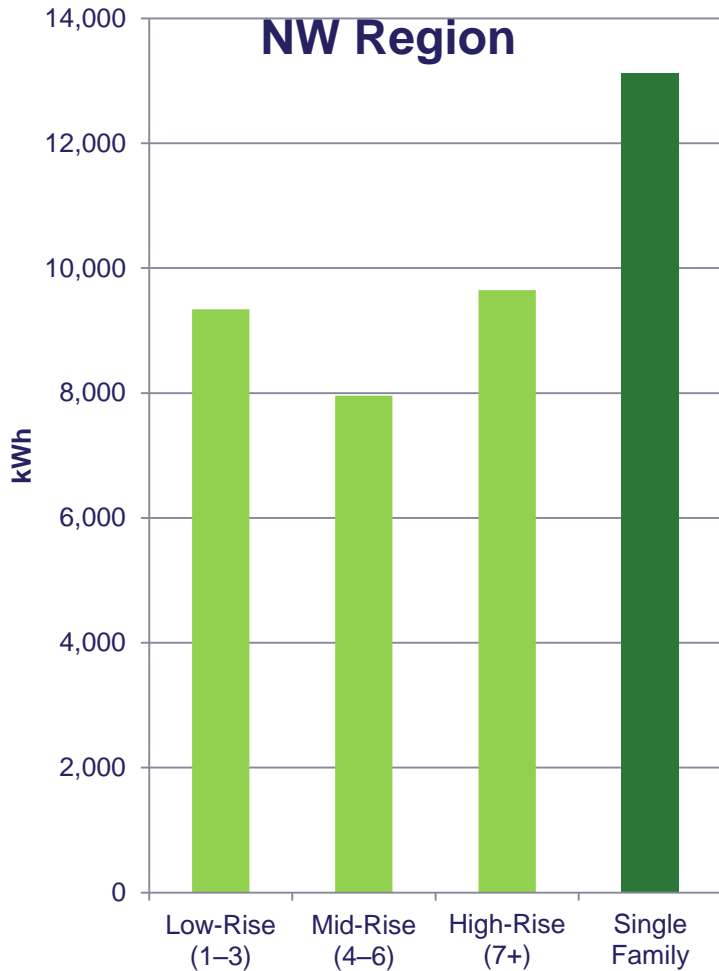- Gas use per unit
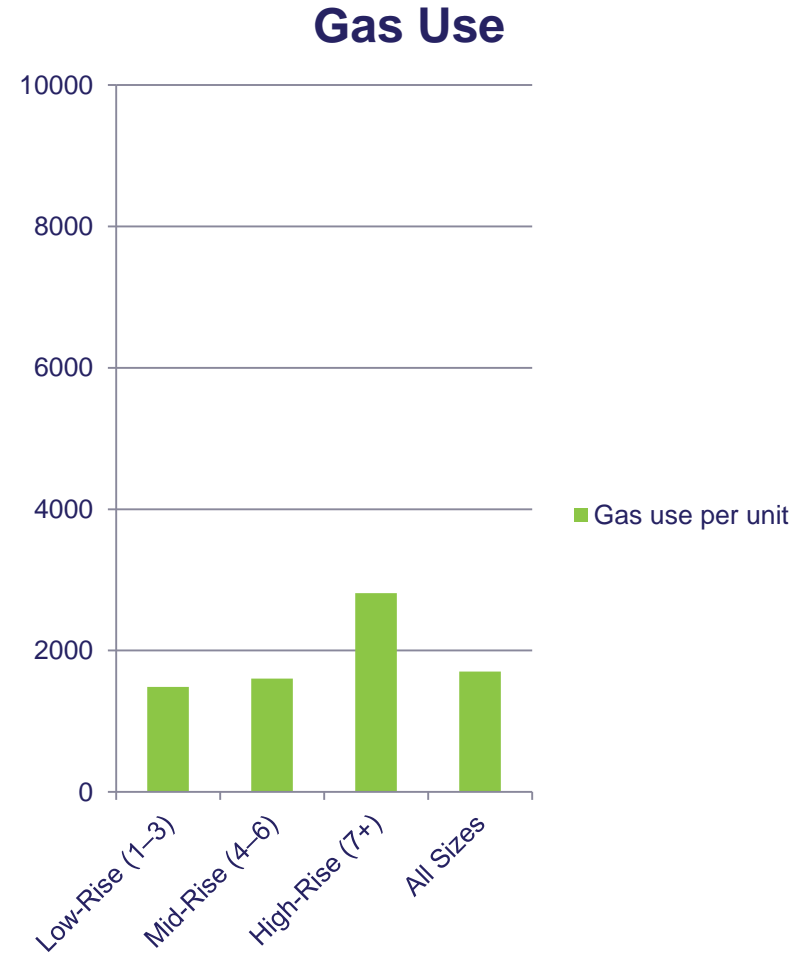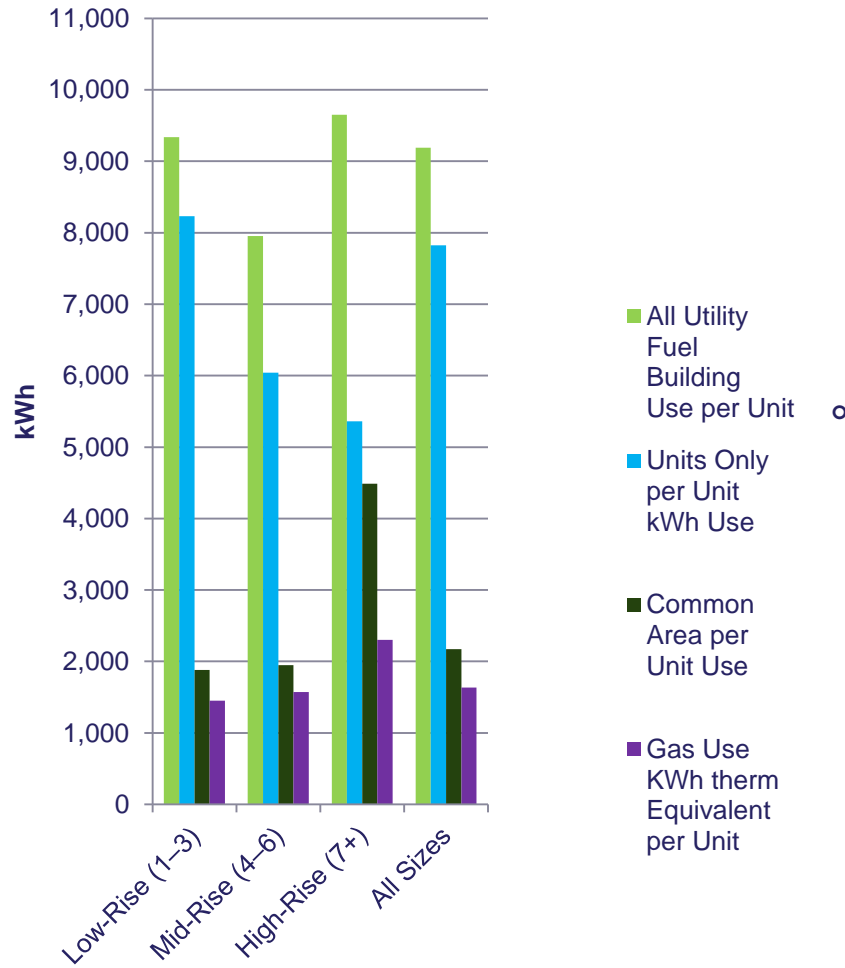
Seattle: Total Fuel Use
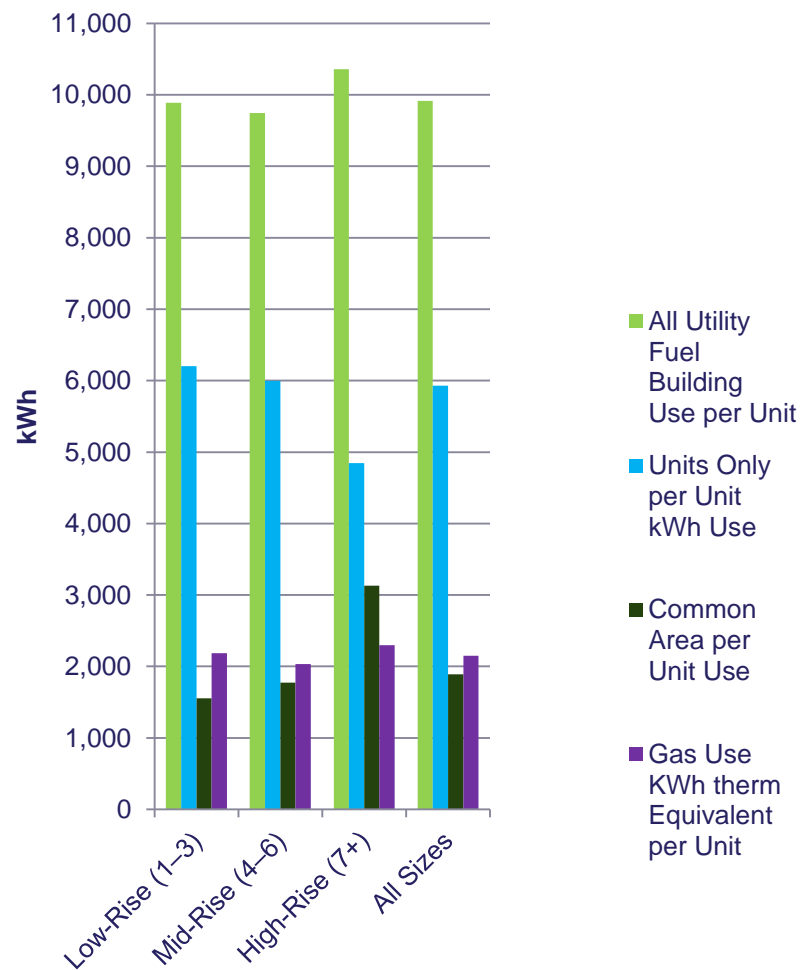
Electric EUI by Building Size

Per Unit Electric Use

Conclusions

Multi- family Buildings:
- Low Rise (3 stories or less),
  - 94% of buildings,
  - 82% of units
  - 93% Electric heated (mostly zonal)
- Mid rise (4 to 6 Stories)
  - Mostly in higher density urban areas
  - 5% of buildings
  - 12% of units
  - 98% Electric Heated (mostly zonal)
- High Rise (7+ stories)
  - Urban core exclusively
  - 1% of buildings
  - 6% of units
  - 65% electric heat (mostly zonal)
  - 35% central systems (mostly gas)

Seattle: Conclusions

Multi- family Buildings:

- Low Rise (3 stories or less),
  - 70% of buildings,
  - 45 % of units
  - 83 % Electric heated (mostly zonal)
- Mid rise (4 to 6 Stories)
  - Mostly in higher density urban areas
  - 26 % of buildings
  - 38% of units
  - 93% Electric Heated (mostly zonal)
- High Rise (7+ stories)
  - Urban core exclusively
  - 3% of buildings
  - 17% of units
  - 87% electric heat (mostly zonal)
  - 13% central systems (mostly gas)

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Conclusions

Multi-Family units
- Lighting very similar to single family homes
  - LPD: 1.44 W/sf
  - Similar saturation of lamps types
- Similar Appliances
  - Older refrigerators
  - Increasing in unit laundry facilities
- Electronics
  - Lower saturation per household
  - Televisions
  - Audio systems
  - Computers, gaming systems
- Energy use
  - Unit electric energy use similar across building size
  - Region: 30% lower per unit electric energy use,
  - Seattle: 14% lower per unit electric energy use
  - Region: 80% lower per unit gas use
  - Seattle: 75% lower per unit gas use

Questions & Answers (30 min.)