



2023 Pennsylvania Residential Baseline Study

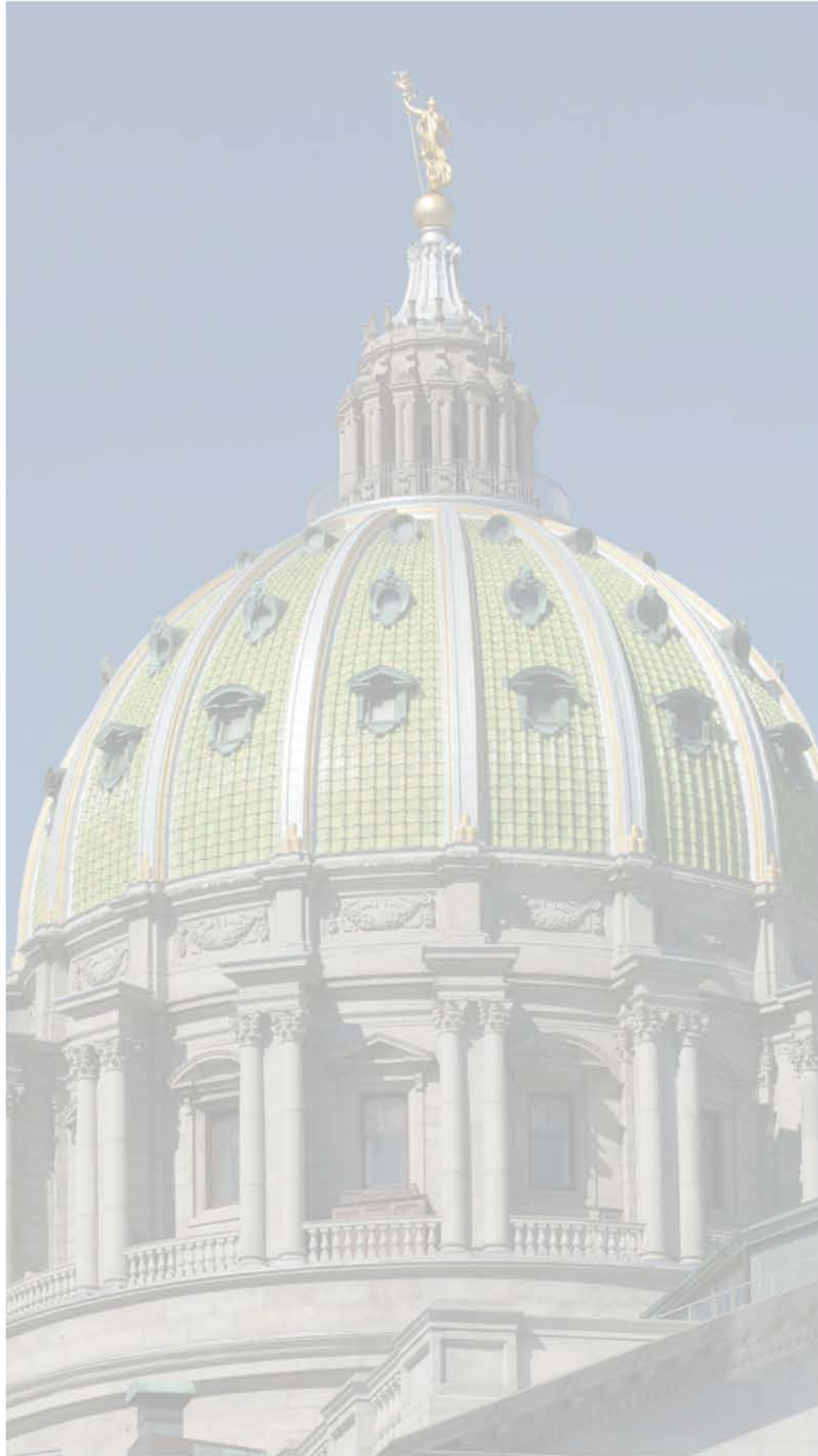
Presenter: Sam Manning & Kailey
Pratt, NMR Group Inc.
February 7th, 2024

| Agenda

- **Introduction**
 - Act 129 Background
 - Evaluation Timeline
 - Study Goals
- **Methods**
 - Sample Plan
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 - Recruitment
 - Data Collection: Self Audits & On-Site
- **Results**
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 - HERS Index Score
 - Energy Use Intensity
 - Air leakage and duct leakage
 - Insulation levels and quality
 - HVAC efficiency and fixtures
 - Appliance efficiency
 - Lighting
 - Comparisons
 - Willingness to pay for upgrades

An aerial photograph of Philadelphia, Pennsylvania, showing a dense urban landscape with various buildings, including the prominent blue, glass skyscraper of the Comcast Center. A semi-transparent white rectangular box is overlaid on the center of the image, containing the word "Introduction" in a bold, green, sans-serif font. A thin green horizontal line is positioned below the text within the box. The sky is blue with scattered white clouds.

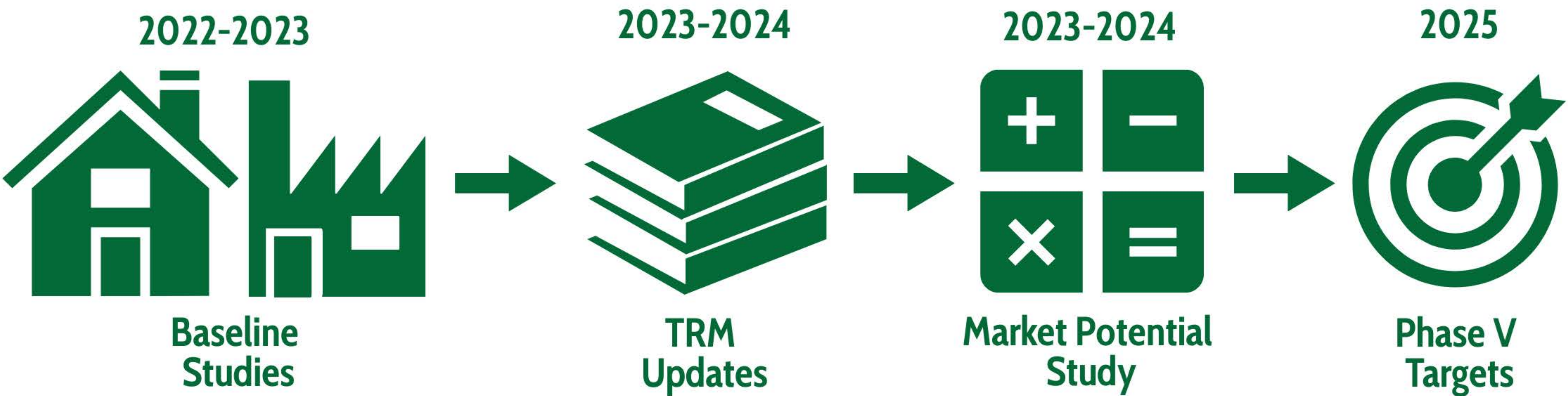
Introduction



Act 129 Background

- Commonwealth's energy efficiency law enacted 2008
- Requires the seven major electric distribution companies (EDCs) to achieve energy savings in multiyear phases
 - PECO
 - PPL
 - Duquesne Light
 - First Energy Companies
- Phase IV (June 1st, 2021 - May 31st, 2026)
 - NMR Group Inc. has been the Statewide Evaluator Team Lead since 2016
- Efficiency targets set at the start of each phase

Evaluation Timeline



Study Goals

- Characterize the measure-level efficiencies for Pennsylvania's existing residential building stock statewide and by EDC
- Determine the current saturation of energy-using equipment in the residential housing stock statewide and by EDC.
- Determine the percent of energy-using equipment by end-use that is high-efficiency equipment (e.g., ENERGY STAR).
- Estimate energy consumption by end-use and heating fuel for the residential housing stock statewide and by EDC.
- Compare current energy-efficiency levels to the previous Act 129 studies (2011, 2013 & 2018).
- Inform the update of the 2026 Technical Reference Manual (TRM) for Phase V of Act 129.
- Inform the market potential study for Phase V of Act 129.

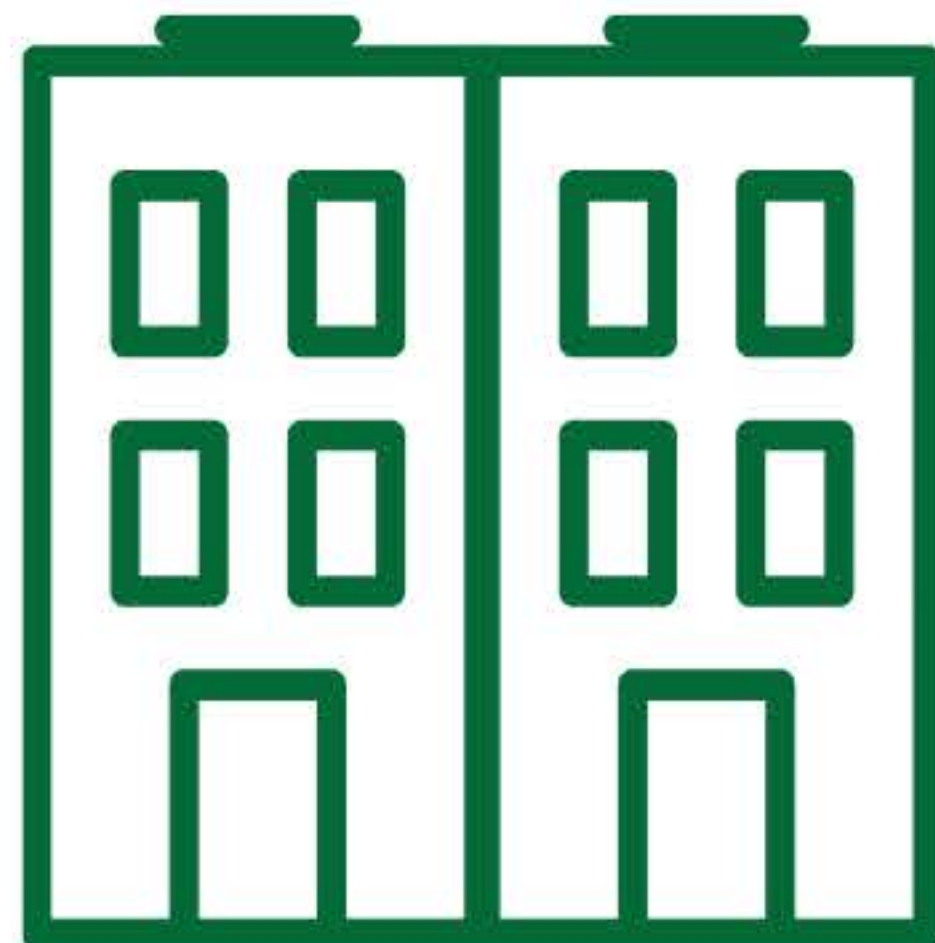


Methods

Sample Overview



189 Detached Single-family on-sites



28 Attached Single-family on-sites



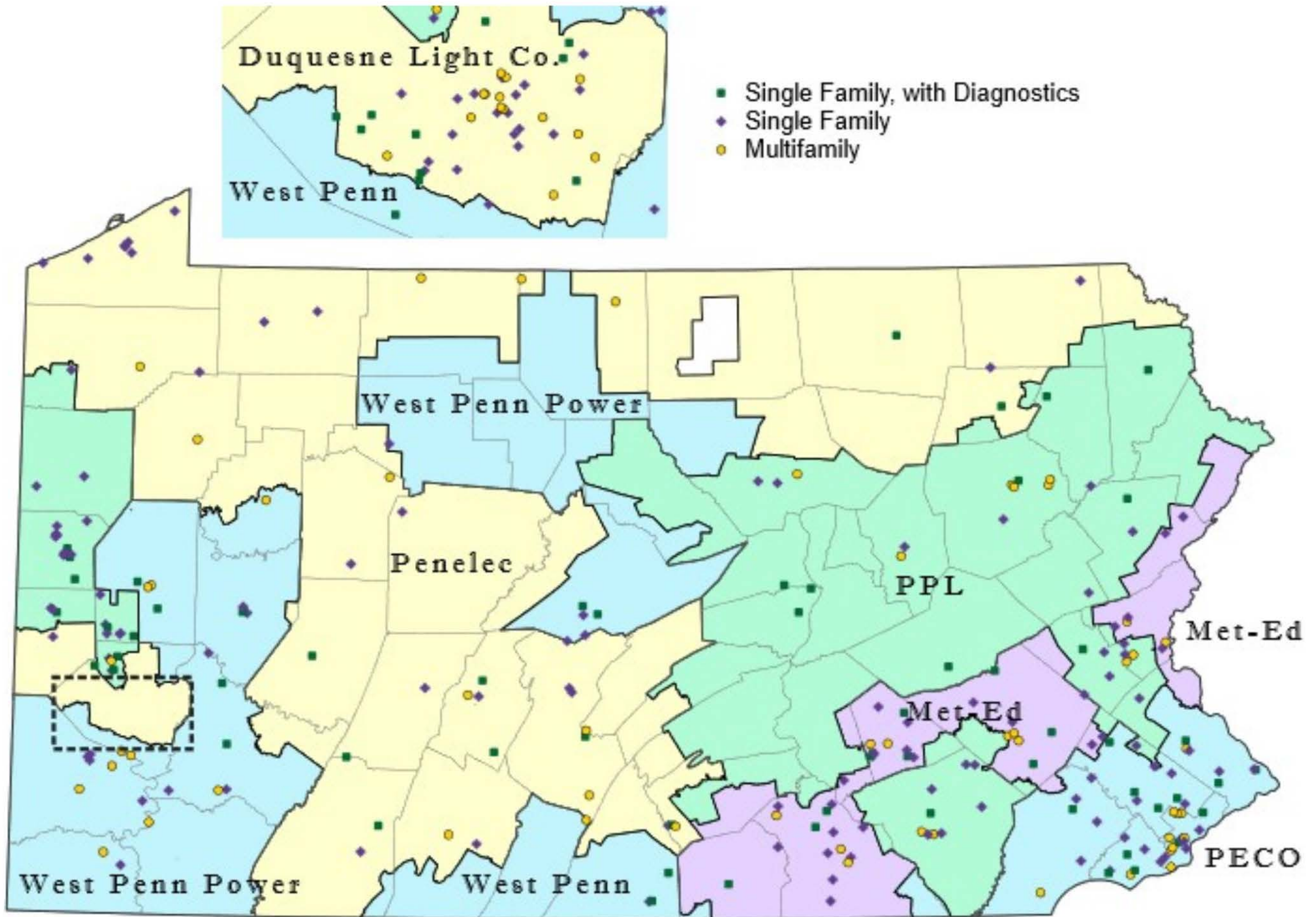
69 Multifamily on-sites



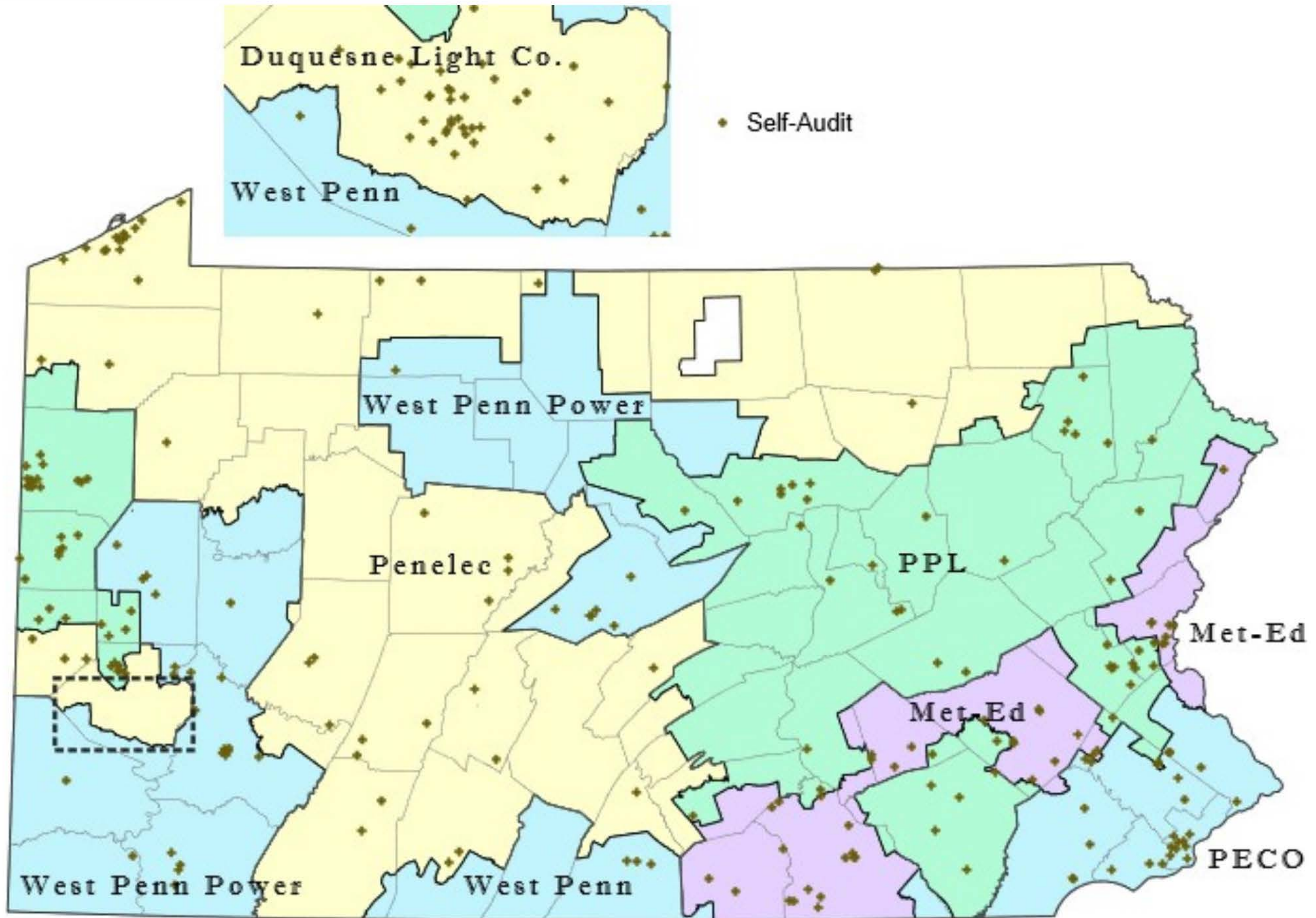
265 Self-Audits (all home types)

- On-site targets are equal count of homes across all seven EDCs (± 41 visits per EDC)
- Targets by home type, vintage, heating fuel, and income status based on U.S. Census data
- Sub-sample of 72 single-family homes received full energy modeling (diagnostic audits)
- The full sample achieved EDC level sampling error ranging from $\pm 8.8\%$ - 10% at the 90% confidence level. The diagnostic sub-sample achieved a sample error of $\pm 9.8\%$.

Sample Location: On-sites



Sample Location: Self-Audits



Sample Targets

Sample Composition by EDC

| EDC | Total Single-family | Diagnostic Sub-sample | Multifamily Sample | Full Sample |
|------------------------------|---------------------|-----------------------|--------------------|-------------|
| On-Site Results Only | | | | |
| PECO | 33 | 13 | 11 | 44 |
| PPL | 31 | 10 | 10 | 41 |
| Duquesne Light | 31 | 10 | 13 | 44 |
| FE: Met-Ed | 33 | 10 | 10 | 43 |
| FE: Penelec | 30 | 9 | 11 | 41 |
| FE: Penn Power | 30 | 9 | 2 | 32 |
| FE: West Penn | 29 | 11 | 12 | 41 |
| Statewide | 217 | 72 | 69 | 286 |
| Self-Audit Results Only | | | | |
| PECO | 19 | - | 5 | 24 |
| PPL | 40 | - | - | 40 |
| Duquesne Light | 35 | - | 6 | 41 |
| FE: Met-Ed | 38 | - | 6 | 44 |
| FE: Penelec | 41 | - | 2 | 43 |
| FE: Penn Power | 35 | - | 1 | 36 |
| FE: West Penn | 35 | - | 2 | 37 |
| Statewide | 243 | - | 22 | 265 |
| Total On-site and Self-Audit | | | | |
| PECO | 52 | 13 | 16 | 68 |
| PPL | 71 | 10 | 10 | 81 |
| Duquesne Light | 66 | 10 | 19 | 85 |
| FE: Met-Ed | 71 | 10 | 16 | 87 |
| FE: Penelec | 71 | 9 | 13 | 84 |
| FE: Penn Power | 65 | 9 | 3 | 68 |
| FE: West Penn | 64 | 11 | 14 | 78 |
| Statewide | 460 | 72 | 91 | 551 |

Sample Targets

Sample Composition by Home Type and Income Status

| Home Type | Proportion | Non-low-income | Low-income | Don't Know/ Refused | Full Sample* |
|------------------------------|------------|----------------|------------|---------------------|--------------|
| Detached | Target | 56% | 7% | -- | 63% |
| Single-family | Sample | 51% | 12% | 1% | 64% |
| Attached | Target | 14% | 5% | -- | 19% |
| Single-family | Sample | 7% | 3% | -- | 10% |
| Manufactured / Mobile | Target | 2% | 1% | -- | 3% |
| | Sample | 1% | 1% | -- | 2% |
| Multifamily | Target | 9% | 5% | -- | 14% |
| | Sample | 14% | 7% | 2% | 24% |
| Full Sample | Target | 81% | 19% | -- | 100% |
| | Sample | 73% | 23% | 4% | 100% |

* Rounding results in some rows not summing to the full sample value.

Additional Single-Family Targets

Single-Family Sample Composition - Vintage*

| Year Built | Total Single-family (n=217) | Diagnostic Sub-sample (n=72) | ACS (N= 4,536,358) |
|---------------|--------------------------------|---------------------------------|-----------------------|
| 2010 or later | 8% | 14% | 3% |
| 2000-2009 | 21% | 19% | 9% |
| 1980-1999 | 16% | 17% | 19% |
| 1960-1979 | 18% | 17% | 21% |
| 1940-1959 | 16% | 18% | 22% |
| Before 1940 | 20% | 15% | 26% |

Single-Family Sample Composition - Heating Fuel*

| Heating Fuel | Total Single-family (n=217) | Diagnostic Sub-sample (n=72) | ACS (N=4,084,005) |
|---------------------------|--------------------------------|---------------------------------|----------------------|
| Natural Gas | 61% | 64% | 53% |
| Electricity | 23% | 22% | 18% |
| Oil or Kerosene | 8% | 6% | 19% |
| Propane or Other Tank Gas | 5% | 4% | 5% |
| Wood, Coal, or Coke | 1% | 1% | 4% |
| Solar | 2% | 3% | 1% |

* Rounding results in some rows not summing to the full sample value.

*Based on a subset of 286 homes that participated in on-site visits.

Additional Multifamily Targets

Multifamily Sample Composition - Number of Units

| Number of Units in Building | Multifamily (<i>n</i> =69) | ACS (<i>N</i> = 1,175,329) |
|-----------------------------|--------------------------------|--------------------------------|
| 2 to 4 | 30% | 40% |
| 5 to 19 | 38% | 28% |
| 20 to 49 | 14% | 11% |
| 50 + | 17% | 21% |



Weights

Full Sample Weights

| EDC | Detached Single-family | | Attached Single-Family | | Multifamily | |
|--|------------------------|------|------------------------|------|-------------|------|
| | Non-LI | LI | Non-LI | LI | Non-LI | LI |
| On-site Sample Weights | | | | | | |
| PECO | 2.54 | 1.73 | 1.62 | 1.73 | 0.87 | 1.05 |
| PPL | 1.76 | 2.11 | 2.33 | 2.11 | 1.31 | 1.31 |
| Duquesne Light | 0.73 | 0.54 | 0.85 | 0.54 | 1.15 | 0.35 |
| FE: Met-Ed | 0.77 | 0.47 | 1.07 | 0.33 | 0.38 | 0.72 |
| FE: Penelec | 0.95 | 0.45 | 0.95 | 0.45 | 0.26 | 0.60 |
| FE: Penn Power | 0.25 | 0.16 | 0.25 | 0.16 | 0.63 | 0.63 |
| FE: West Penn Power | 1.13 | 0.65 | 1.13 | 0.65 | 0.45 | 0.56 |
| Self-audit Sample Weights | | | | | | |
| PECO | 5.19 | 2.67 | 1.50 | 2.67 | 3.24 | 0.97 |
| PPL | 1.68 | 1.52 | 1.73 | 1.52 | -- | -- |
| Duquesne Light | 0.69 | 0.30 | 0.69 | 0.30 | 1.77 | 0.86 |
| FE: Met-Ed | 0.58 | 0.87 | 0.79 | 0.23 | 0.69 | 0.69 |
| FE: Penelec | 0.68 | 0.27 | 0.68 | 0.27 | 1.80 | 1.80 |
| FE: Penn Power | 0.22 | 0.09 | 0.22 | 0.09 | 1.17 | 1.17 |
| FE: West Penn Power | 0.89 | 0.47 | 0.89 | 0.47 | 2.69 | 2.69 |
| Full Sample Weights (Combined On-site and Self-audit) | | | | | | |
| PECO | 3.37 | 2.08 | 1.56 | 2.08 | 1.35 | 1.01 |
| PPL | 1.56 | 1.36 | 1.99 | 1.36 | 2.52 | 2.52 |
| Duquesne Light | 0.67 | 0.39 | 1.23 | 0.39 | 1.38 | 0.49 |
| FE: Met-Ed | 0.67 | 0.60 | 0.91 | 0.27 | 0.42 | 1.38 |
| FE: Penelec | 0.80 | 0.34 | 0.80 | 0.34 | 0.40 | 1.15 |
| FE: Penn Power | 0.24 | 0.11 | 0.24 | 0.11 | 0.81 | 0.81 |
| FE: West Penn Power | 1.00 | 0.54 | 1.00 | 0.54 | 0.76 | 0.86 |

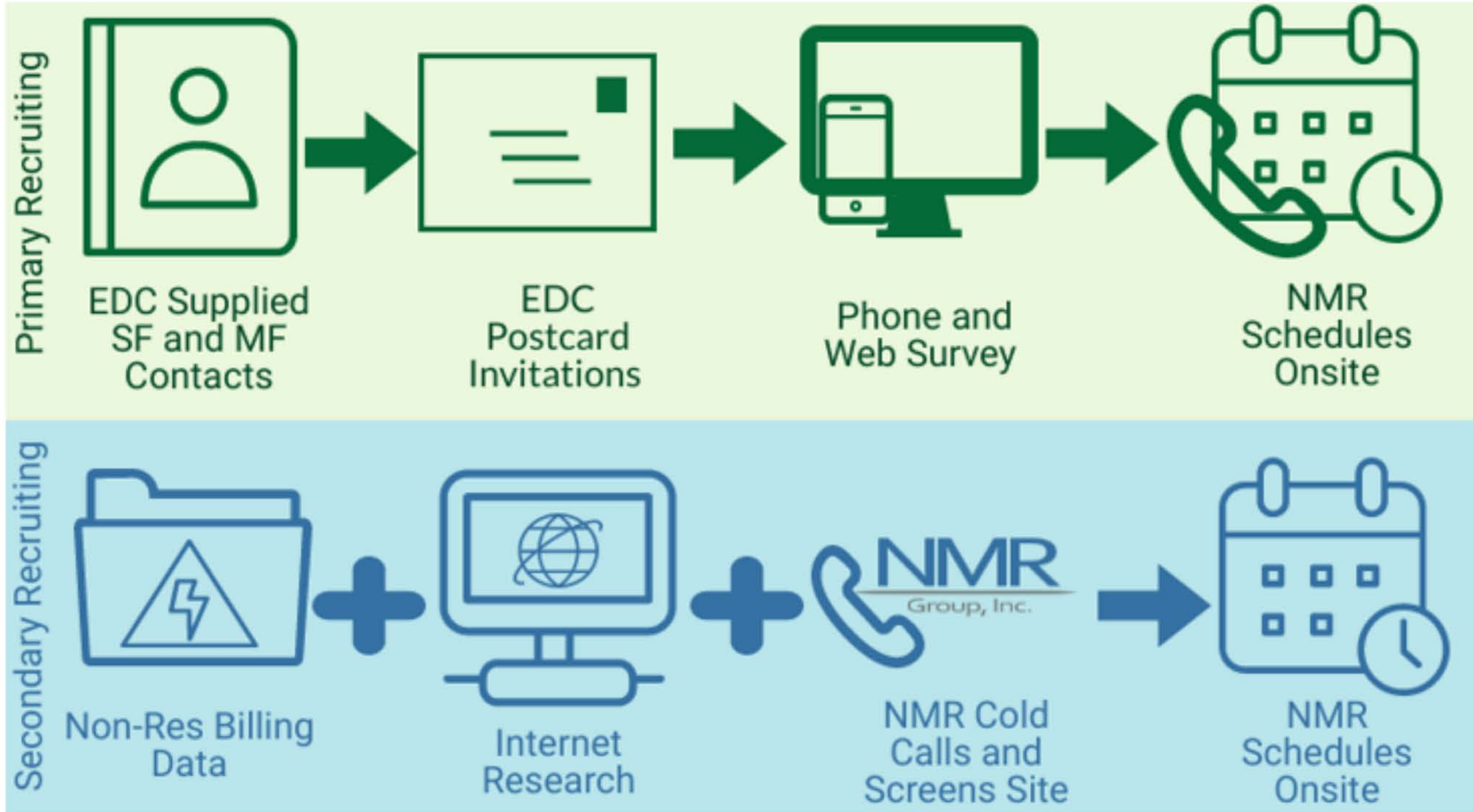
Weights

Diagnostic Sample Weights

| Primary Heating Fuel Type | Detached Single-family | Attached Single-family |
|---------------------------|------------------------|------------------------|
| Electric | 0.90 | 0.68 |
| Non-electric | 1.02 | 1.18 |



Recruitment



Recruitment

Outreach Attempts

| EDC | Number of Postcards Sent | Number of Participants Emailed | Number of MF Secondary Emailed |
|---------------------|--------------------------|--------------------------------|--------------------------------|
| PECO | 5,700 | 3,839 | 1,280 |
| PPL | 5,702 | 3,901 | 1,049 |
| Duquesne Light | 5,365 | 3,658 | 231 |
| FE: Met-Ed | 5,487 | 4,183 | 998 |
| FE: Penelec | 5,531 | 2,637 | 873 |
| FE: Penn Power | 5,498 | 3,336 | 191 |
| FE: West Penn Power | 5,564 | 3,177 | 695 |
| Total | 38,847 | 24,731 | 5,317 |

Cancellations

| Number of Hours Before Appointment | Single-Family Basic Visits | Single-Family Full Visits | Multifamily Visits | Total |
|------------------------------------|----------------------------|---------------------------|--------------------|-----------|
| More than 24 hours | 10 | 10 | 0 | 20 |
| 1 to 24 hours | 16 | 7 | 5 | 28 |
| No show | 2 | 4 | 1 | 7 |
| Total | 28 | 21 | 6 | 55 |

Self-Audit

12:29


NMR
Group, Inc.

5 items to go


Add Item 1:
Choose the Category and Type of item to add. Click Help if you are not sure which Type you have.

Note: Heat pumps—like ductless mini-splits—are in the Heating category.
Click an image to enlarge.

Refrigerators include mini-fridges, but not beverage coolers.



Beverage coolers or wine fridges are smaller refrigerator-like devices dedicated to storing drinks at a modest temperature. They typically have glass fronts and are usually installed under counters. A standard dorm/hotel-room style mini-fridge should be entered as a

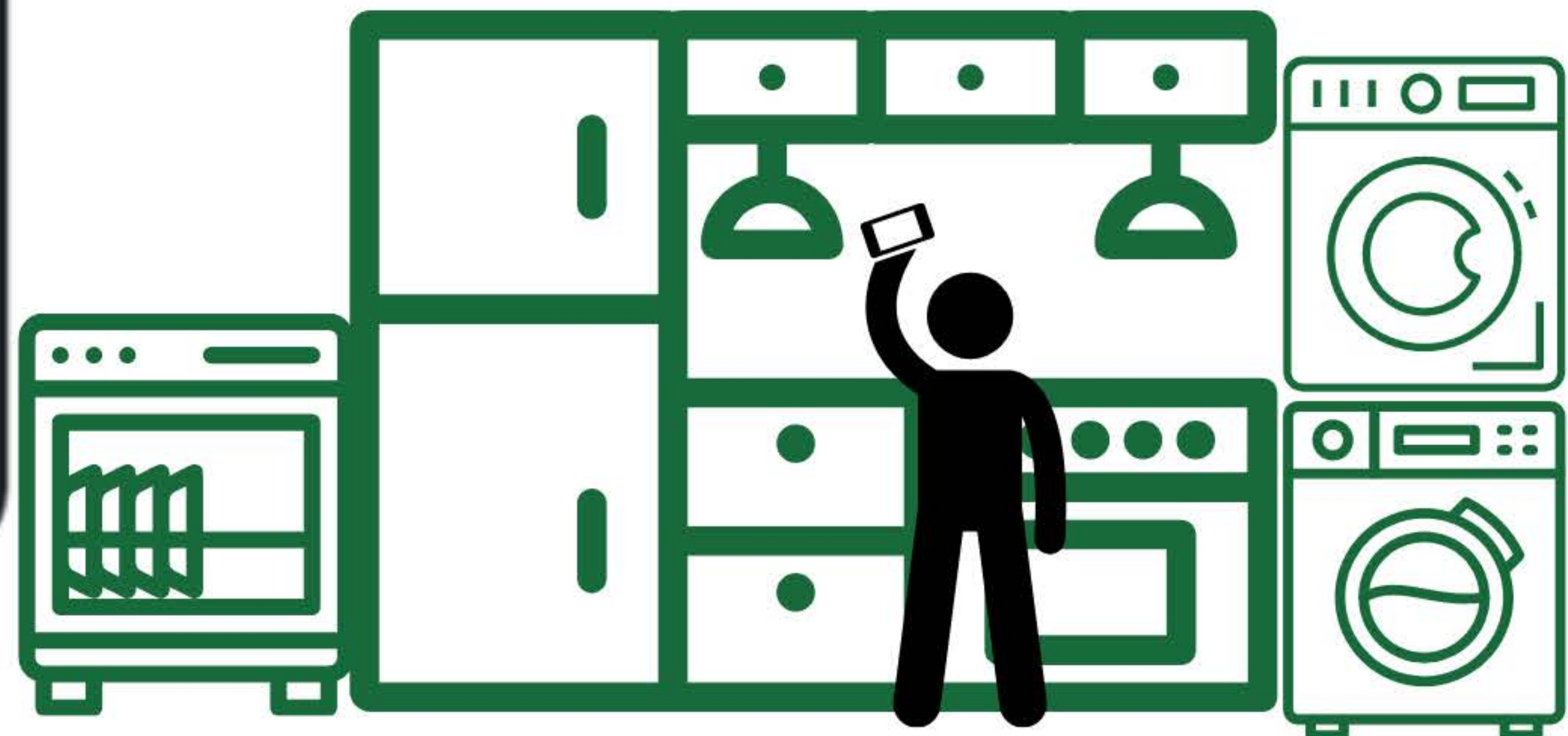


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The label is usually near the top of the left or right inside wall of the refrigerator compartment, but sometimes it is on the back wall, edge of the door, or inside the freezer. **Mini-fridge:** If the label is not in any of these locations, it might be on the back of the refrigerator.



Please enter Photo 2 of the item as described above. [? Help](#)



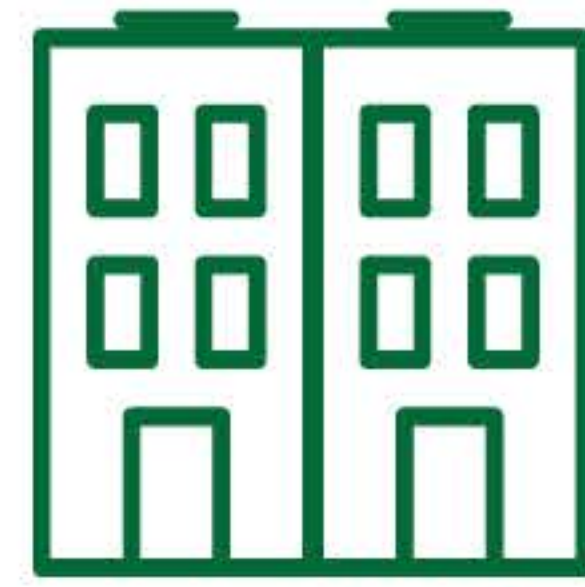
Results



General Characteristics



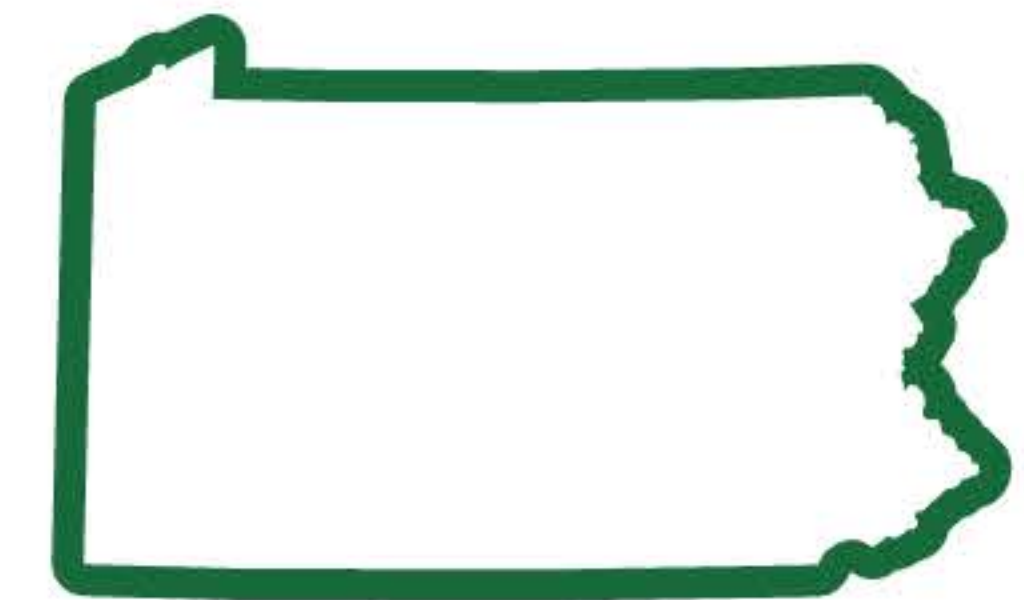
Detached
Single-family



Attached
Single-family



Multifamily
homes



Statewide

Average Age*

54 yrs

52 yrs

64 yrs

56 yrs

Avg. Conditioned Floor Area*

2,498 sq.ft.

1,598sq.ft.

878 sq.ft.

2,019 sq.ft.

*Based on a subset of 286 homes that participated in on-site visits.

HERS Index Score



Homes, regardless of vintage, are 58% less efficient than a home built to code in 2018. *



Lower = More Efficient

- Home Energy Rating System (HERS) Index created by Residential Energy Services Network (RESNET)
- Score of 100 = Home built to 2006 IECC standards
- Each additional point = 1% decrease in efficiency
- Score of 62 = Home built to 2018 IECC standards
- Score of 0 = Zero Net Energy Home

*Based on a subset of 72 homes that received full energy modeling.

HERS Score

HERS Score by Home Type*

| | Detached Single-family | Attached Single-family | Statewide |
|----------------|------------------------|------------------------|--------------|
| <i>n-value</i> | 61 | 11 | 72 |
| Min | 58 | 58 | 58 |
| Max | 488 | 115 | 488 |
| Mean | 107.1 | 76.9 | 107.8 |
| Median | 88 | 71 | 86 |
| Std. Dev. | 63.1 | 17.5 | 59.4 |

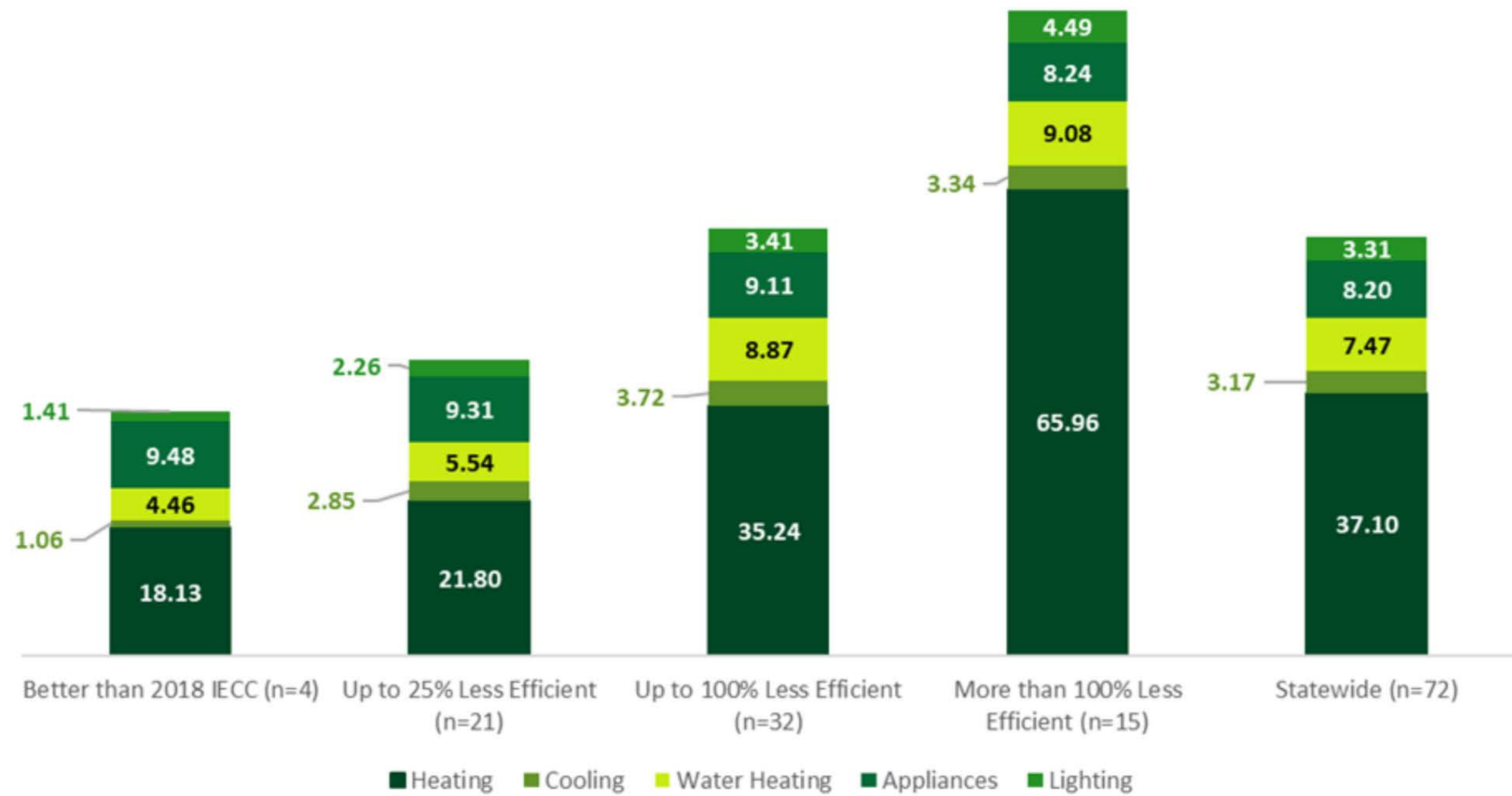
HERS Score by Vintage*

| | Before 1940 | 1940-1959 | 1960-1979 | 1980-1999 | 2000-2009 | 2010 or later | Statewide |
|----------------|--------------|--------------|--------------|-------------|-------------|---------------|--------------|
| <i>n-value</i> | 11 | 13 | 12 | 12 | 14 | 10 | 72 |
| Min | 72 | 86 | 58 | 59 | 59 | 63 | 58 |
| Max | 488 | 199 | 196 | 176 | 176 | 76 | 488 |
| Mean | 148.1 | 116.8 | 114.3 | 82.5 | 82.5 | 70.1 | 107.8 |
| Median | 94 | 107 | 104.5 | 79 | 77.5 | 70 | 86 |
| Std. Dev. | 122.3 | 31.8 | 41.8 | 31.7 | 28.7 | 3.9 | 59.4 |

*Based on a subset of 72 homes that received full energy modeling.

Energy Use Intensity

Total Energy Consumption
EUI (kBtu/sq.ft./yr)*



*Based on a subset of 72 homes that received full energy modeling.

Energy Use Intensity

Electric Only EUI (kWh/sq.ft./yr)*



*Based on a subset of 72 homes that received full energy modeling.

Air Infiltration

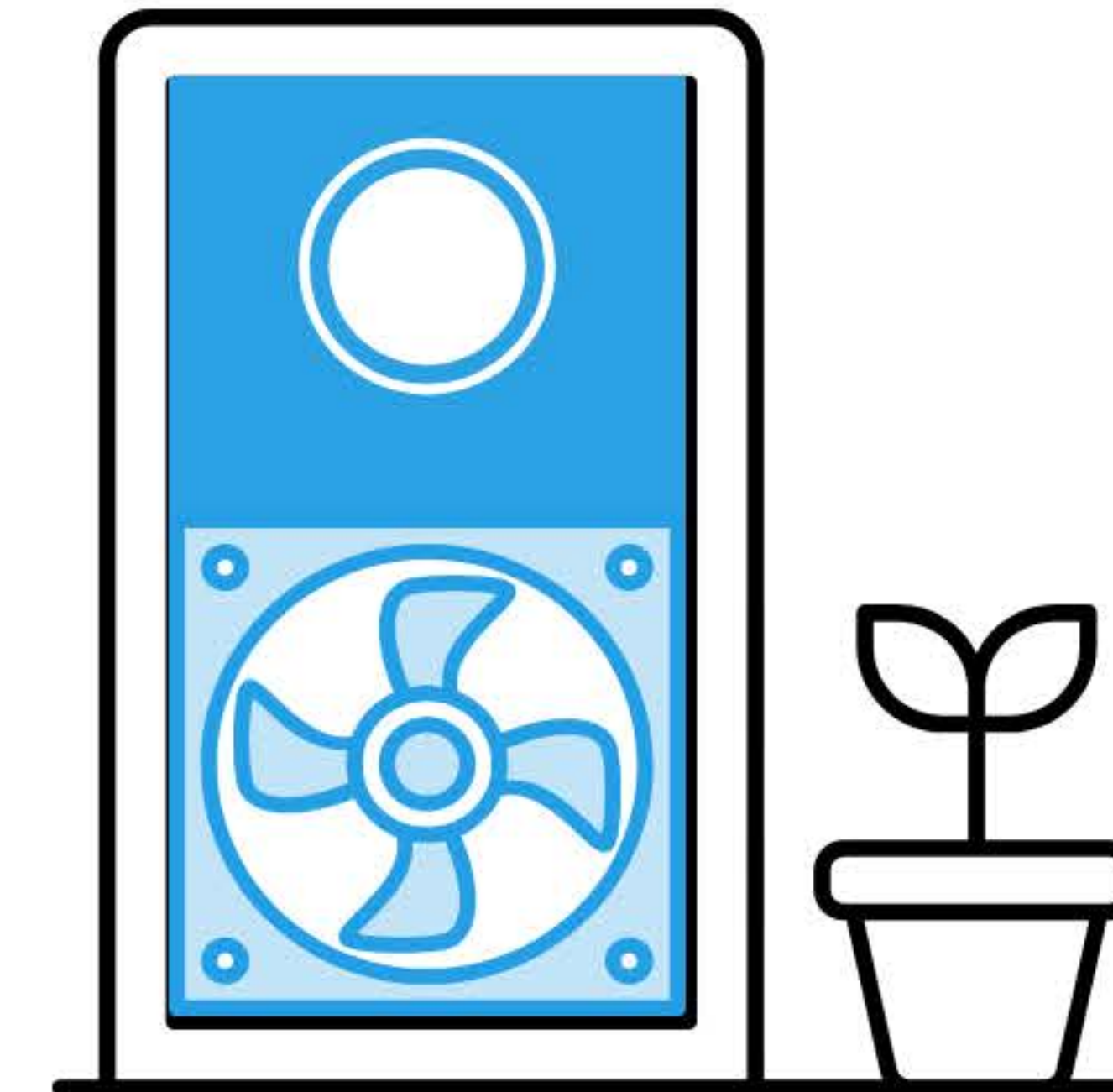


Homes have 280% more (worse) air infiltration than a home built to code in 2018. *



Lower = More Efficient

- Measured in Air Changes per Hour with a pressure gradient of 50 pascals (ACH50)
- Results from blower door tests
- 3 ACH50 = 2018 standard



*Based on a subset of 72 homes that received full energy modeling.

Air Infiltration (ACH50)

ACH50 by Home Type*

| | Detached Single-family | Attached Single-family | Statewide |
|----------------|------------------------|------------------------|-------------|
| <i>n-value</i> | 61 | 11 | 72 |
| Min | 2.5 | 1.6 | 1.6 |
| Max | 52.9 | 11.3 | 52.9 |
| Mean | 11.8 | 6 | 11.4 |
| Median | 9.1 | 5 | 8.6 |
| Std. Dev. | 9.3 | 2.9 | 79 |

ACH50 by Vintage*

| | Before 1940 | 1940-1959 | 1960-1979 | 1980-1999 | 2000-2009 | 2010 or later | Statewide |
|----------------|-------------|-------------|-------------|------------|------------|---------------|-------------|
| <i>n-value</i> | 11 | 13 | 12 | 12 | 14 | 10 | 72 |
| Min | 5.6 | 8.6 | 5.8 | 3.3 | 1.6 | 3.4 | 1.6 |
| Max | 52.9 | 29.9 | 25.5 | 18.3 | 24.7 | 6.7 | 52.9 |
| Mean | 19.2 | 16.6 | 11.3 | 9.2 | 6.1 | 4.2 | 11.4 |
| Median | 13.1 | 15.3 | 8.6 | 8.9 | 5.1 | 3.9 | 8.6 |
| Std. Dev. | 14.5 | 6.6 | 6.3 | 4.5 | 5.6 | 1 | 9 |

*Based on a subset of 72 homes that received full energy modeling.

Duct Leakage



Duct systems had 90% more (worse) leakage than those in a home built to code in 2018.*



Lower = More Efficient

- Duct leakage to Outside (LTO)
- Measured in cubic feet per minute with a pressure gradient of 25 pascals (CFM25)
- 8 CFM25 LTO = 2009 standard
- 4 CFM25 Total = 2015/2018 standard

*Based on a subset of 66 homes that received full energy modeling.

Duct Leakage to Outside

Duct Leakage to Outside by Home Type*

| | Detached Single-family | Attached Single-family | Statewide |
|----------------|------------------------|------------------------|------------|
| <i>n-value</i> | 58 | 10 | 68 |
| Min | 0 | 0 | 0 |
| Max | 29.9 | 20.2 | 29.9 |
| Mean | 7.9 | 4.4 | 7.6 |
| Median | 5.4 | 4.6 | 4.7 |
| Std. Dev. | 8.4 | 6.4 | 8.1 |

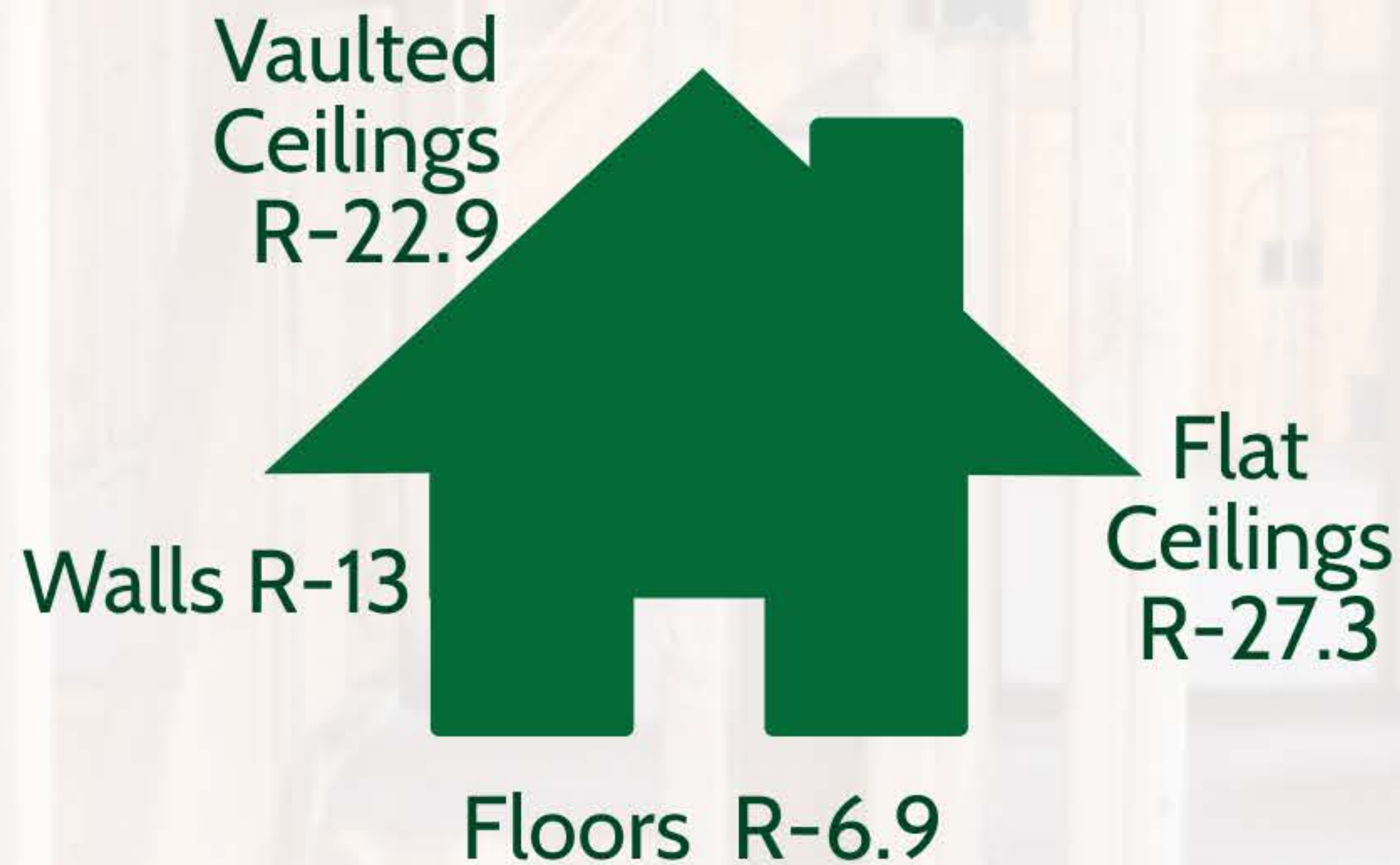
Duct Leakage to Outside by Vintage*

| | Before 1940 | 1940-1959 | 1960-1979 | 1980-1999 | 2000-2009 | 2010 or later | Statewide |
|----------------|-------------|------------|-------------|------------|------------|---------------|------------|
| <i>n-value</i> | 11 | 13 | 9 | 11 | 14 | 10 | 68 |
| Min | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Max | 26.6 | 17.6 | 27.1 | 29.9 | 20.2 | 8.3 | 29.9 |
| Mean | 10.5 | 6.9 | 12.9 | 7.1 | 5.1 | 2.7 | 7.6 |
| Median | 7.9 | 9.1 | 15 | 4.6 | 1.7 | 0.8 | 4.7 |
| Std. Dev. | 10.5 | 6.7 | 9.6 | 8.8 | 6.6 | 3.3 | 8.1 |

*Based on systems in a subset of 66 homes that received full energy modeling.

Insulation Levels

(On-site sample)

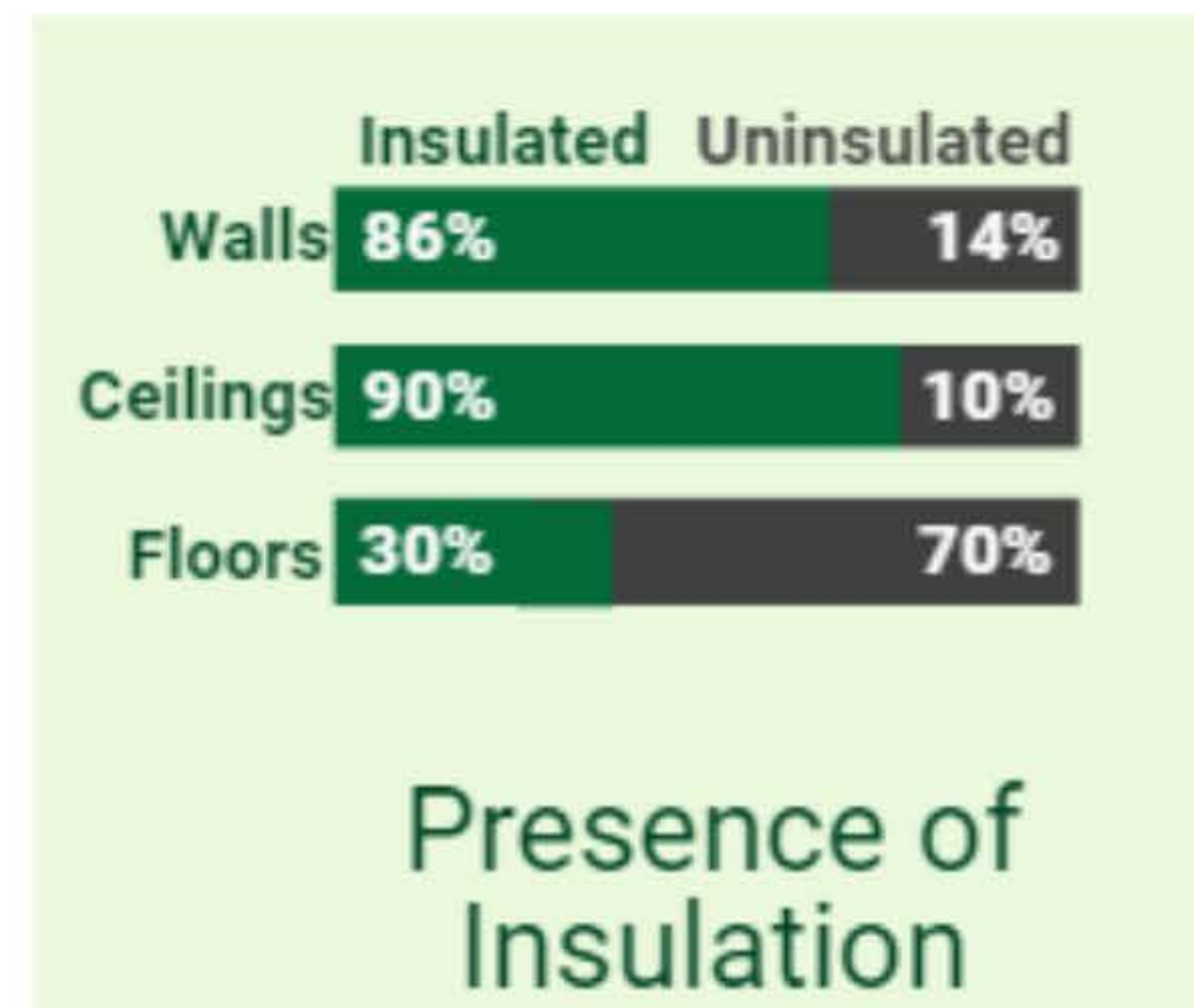


Walls, ceilings, and floors are between 35% and 77% less efficient than a home built to code in 2018.



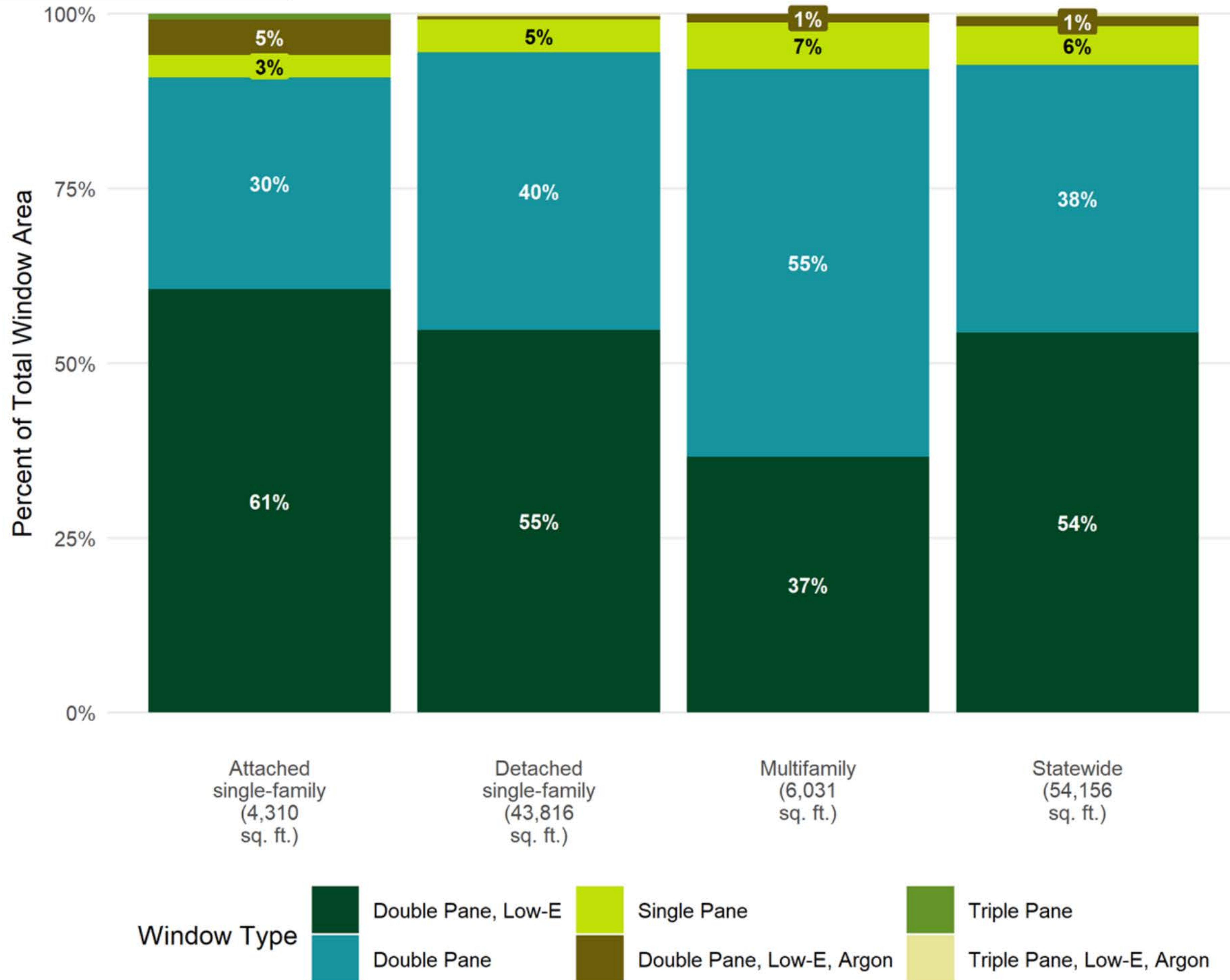
Higher R-value = More Efficient

- "R-value" is a measure of material's resistance to the flow of heat.
- Fiberglass batts were the most common insulation type in ceilings, walls, and floors.
- 70% of floors, 14% of walls, and 10% of ceilings have *no* insulation
- 2018 standards*:
 - Ceilings: R-49
 - Walls: R-20
 - Floors: R-30 (or R-19 if it fills cavity)



*Standards only apply to new construction.

Windows



*Based on a subset of 286 homes that participated in on-site visits.

Primary Heating

42% of heating systems were ENERGY STAR qualified.



Fuel

- Natural Gas: 50%
- Electricity: 36%
- Fuel Oil: 12%
- Propane: 3%
- Wood/Pellet: <1%



Type

- Furnace: 44%
- Boiler: 21%
- ASHP: 19%
- Elec. Baseboard: 10%
- Other: 6%



Efficiency

- Furnace: 89.1 Annual Fuel Utilization Efficiency (AFUE)
- Boiler: 85.4 AFUE
- Heat Pump: 7.5 Heating Seasonal Performance Factor (HSPF2)

Primary Cooling

51% of permanent cooling systems and 32% of room ACs were ENERGY STAR qualified.



Fuel

- Electric



Type*

- Central AC: 44%
- Room AC: 23%
- ASHP: 21%
- Ductless HP: 2%
- Other: 3%
- None: 7%



Efficiency

- Room AC: 10.6 Energy Efficiency Ratio (CEER)
- Central AC: 13.2 Seasonal Energy Efficiency Ratio (SEER2)
- Ductless/ASHP: 14.8 SEER2

*Based on a subset of 286 homes that participated in on-site visits.

Water Heating

13% of water heaters were ENERGY STAR qualified.



Fuel

- Natural Gas: 48%
- Electric: 47%
- Oil: 3%
- Propane: 2%



Type

- Storage: 87%
- Indirect: 3%
- Instantaneous: 3%
- Tankless Coil: 3%
- Heat pump: 2%
- Combi Boiler: 1%

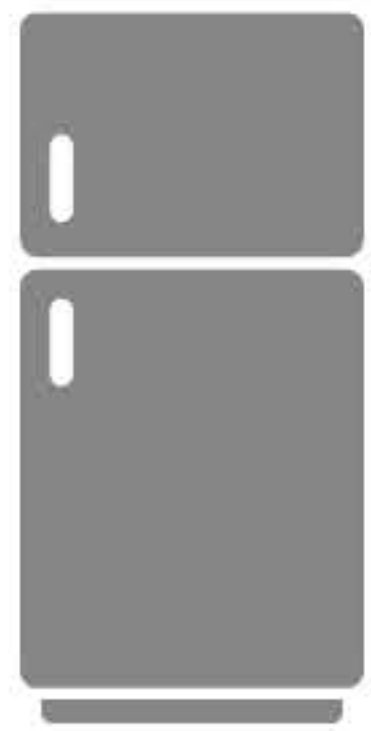


Efficiency

- Storage (Fossil): 0.62 Uniform Energy Factor (UEF)
- Storage (Electric): 0.92 UEF
- Instantaneous: 0.93 UEF
- Indirect: 0.80 Energy Factor (EF)
- Tankless coil: 0.48 EF
- Heat pump: 3.20 UEF

Faucets and Showerheads

66% of faucets and 11% of showerheads are low-flow.



Kitchen

Avg. Quantity*
1.2

Avg. Flow Rate*
1.8 gpm



Bathroom

Avg. Quantity*
2.3

Avg. Flow Rate*
1.6 gpm



Utility

Avg. Quantity*
0.4

Avg. Flow Rate*
2.1 gpm



All Faucets

Avg. Quantity*
3.9

Avg. Flow Rate*
1.8 gpm



Showerheads

Avg. Quantity*
1.7

Avg. Flow Rate*
2.0 gpm

*Based on a subset of 286 homes that participated in on-site visits.

Thermostats

Thermostat Penetration

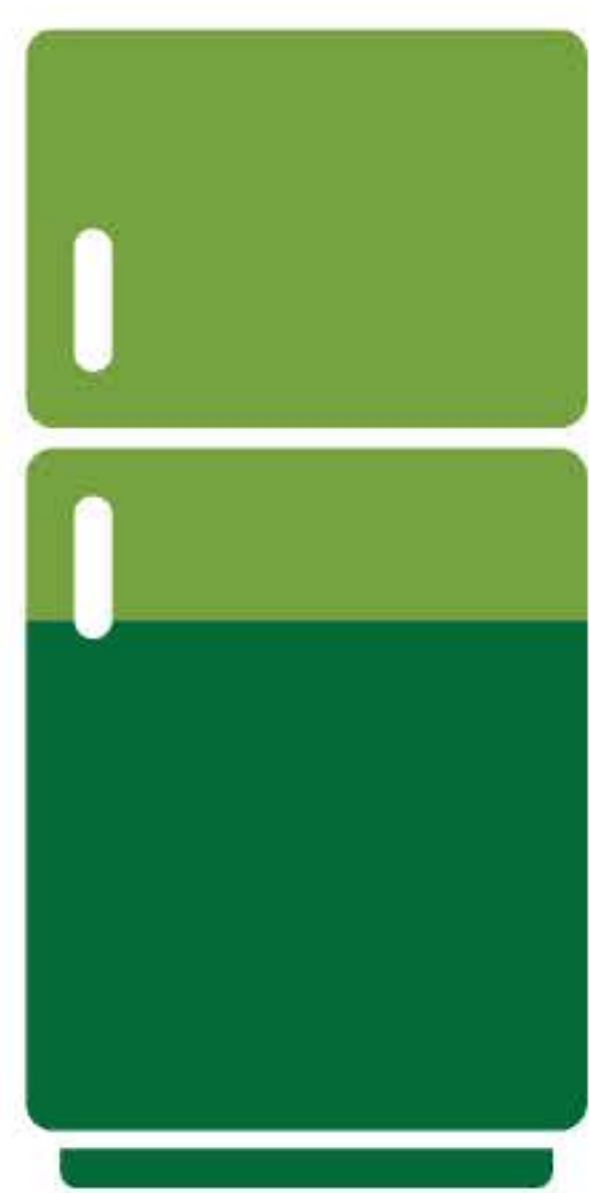
| Type | Detached Single-family | Attached Single-family | Multifamily | Statewide ¹ |
|----------------|------------------------|------------------------|-------------|------------------------|
| <i>n-value</i> | 180 | 25 | 54 | 259 |
| Programmable | 59% | 56% | 39% | 55% |
| Manual | 28% | 28% | 54% | 33% |
| Smart | 11% | 12% | -- | 9% |
| Wi-fi | 7% | 4% | 4% | 6% |
| None | -- | -- | 3% | 1% |

¹ Since some homes have more than one thermostat, column totals can sum to more than 100%.

Thermostat Saturation

| Type | Detached Single-family | Attached Single-family | Multifamily | Statewide |
|----------------|------------------------|------------------------|-------------|-----------|
| <i>n-value</i> | 210 | 26 | 72 | 308 |
| Programmable | 56% | 58% | 32% | 53% |
| Manual | 27% | 27% | 63% | 32% |
| Smart | 10% | 12% | -- | 8% |
| Wi-Fi | 7% | 4% | 3% | 7% |

Residential Appliances



Refrigerators



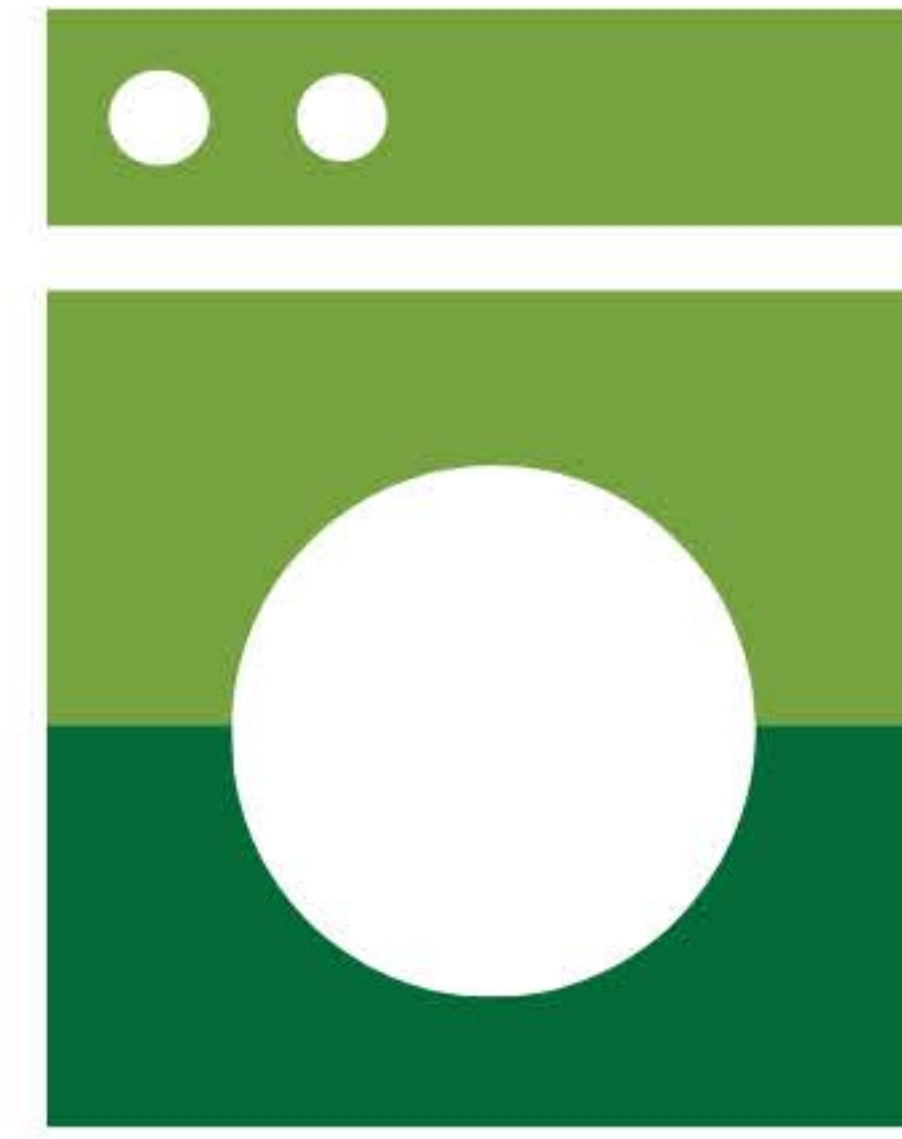
Freezers



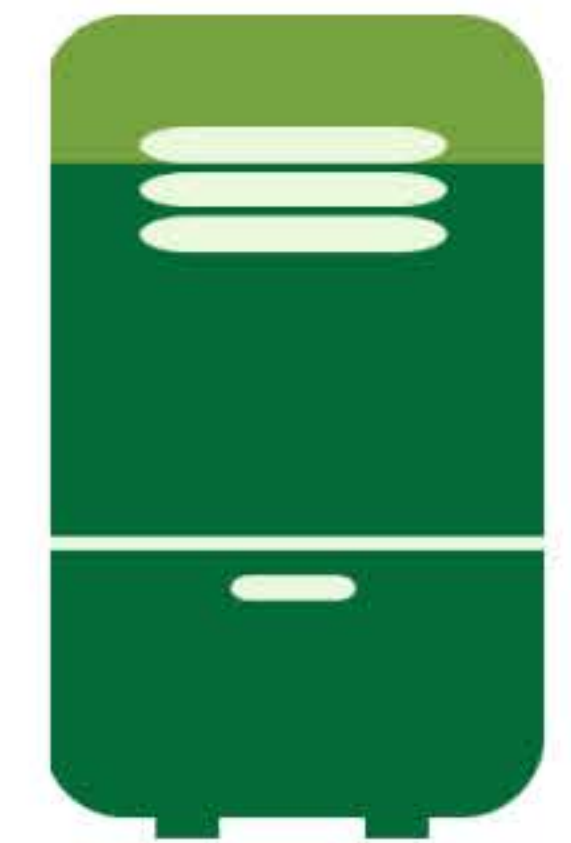
Dishwashers



Clothes Washers



Clothes Dryers



Dehumidifiers

% ENERGY STAR

49%

22%

75%

56%

36%

87%

Avg. Age

11 yrs

13 yrs

10 yrs

9 yrs

11 yrs

7 yrs

Avg. Efficiency

565 kWh

407 kWh/yr

293 kWh/yr

2.2 IMEF

3.4 CEF

1.8 IEF

Lighting Penetration

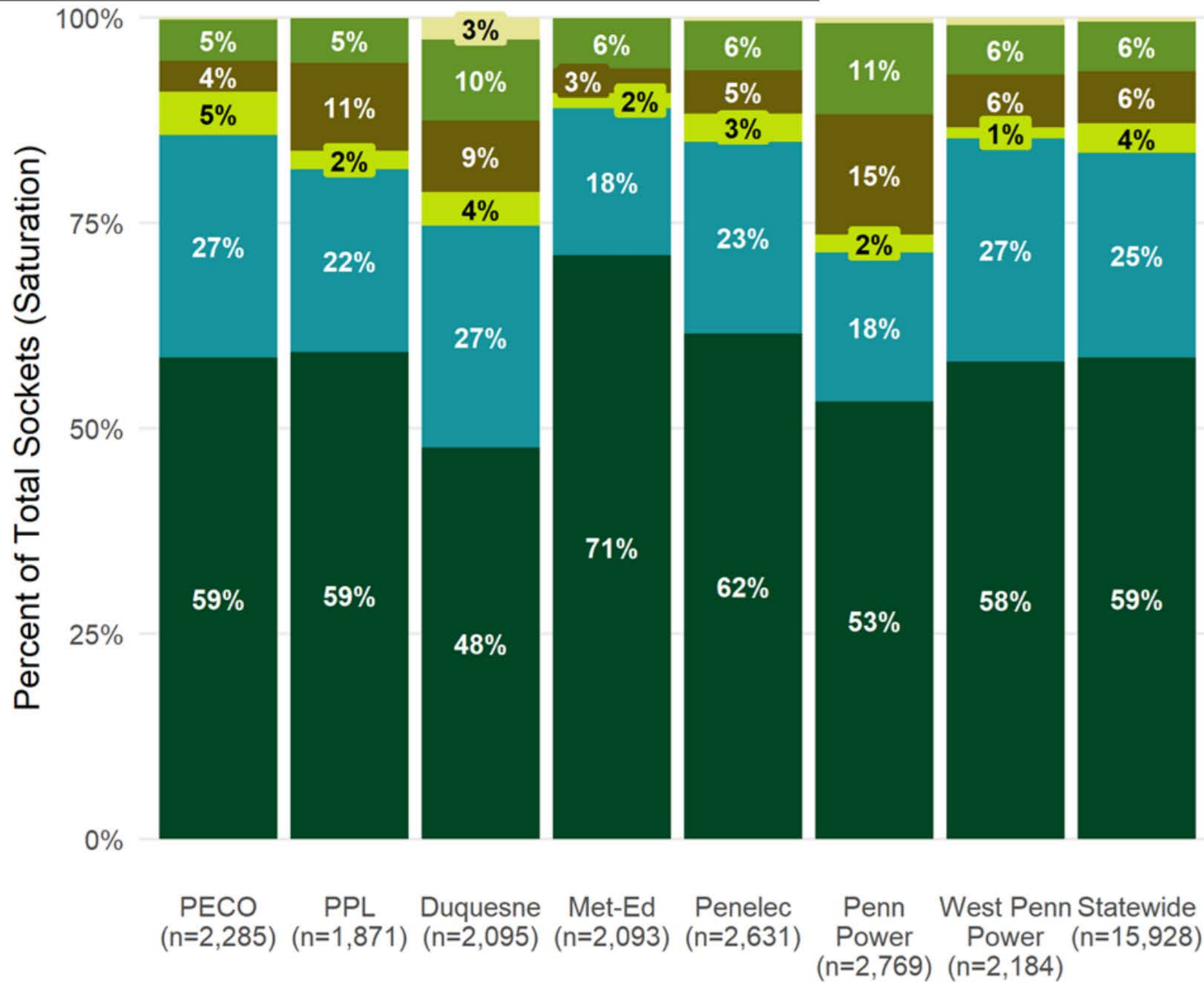
- Penetration: The number of homes that have at least one of a given bulb type
- LED bulbs were found in virtually all (99%) homes in the statewide sample. Incandescent bulbs were found in three-quarters (75%) of homes, and CFLs, in just over one-half (54%) of homes.

Bulb Type Penetration*

| Type | PECO | PPL | Duquesne Light | Met-Ed | Penelec | Penn Power | West Penn Power | Statewide |
|--------------|------|-----|----------------|--------|---------|------------|-----------------|-----------|
| <i>n</i> | 44 | 40 | 44 | 43 | 41 | 32 | 41 | 285 |
| LED | 98% | 98% | 100% | 100% | 100% | 100% | 98% | 99% |
| Incandescent | 66% | 72% | 93% | 49% | 83% | 81% | 68% | 75% |
| CFL | 41% | 48% | 68% | 53% | 63% | 94% | 51% | 54% |
| Fluorescent | 36% | 55% | 59% | 33% | 49% | 81% | 59% | 49% |
| Halogen | 20% | 28% | 36% | 28% | 27% | 25% | 20% | 28% |
| Empty Socket | 5% | 2% | 36% | 2% | 10% | 31% | 17% | 10% |

*Based on a subset of 286 homes that participated in on-site visits.

| Lighting Saturation*



*Based on a subset of 286 homes that participated in on-site visits.

Comparisons Over Time

| | 2011 | 2013 | 2018 | 2023 |
|--|------|------------------|--------------------|----------------------|
| Lighting | | | | |
| CFL Saturation (Interior) | 17% | 22% ^a | 20% ^{a,b} | 7% ^{a,b,c} |
| CFL Saturation (Exterior) | 12% | 19% ^a | 21% ^a | 7% ^{a,b,c} |
| LED Saturation (Interior) | 1% | 2% ^a | 20% ^{a,b} | 60% ^{a,b,c} |
| LED Saturation (Exterior) | -- | 2% ^a | 18% ^{a,b} | 58% ^{a,b,c} |
| LED Penetration (Interior) | 9% | 17% ^a | 74% ^{a,b} | 99% ^{a,b,c} |
| Appliances (Percent ENERGY STAR) | | | | |
| Refrigerator | 20% | 31% ^a | 31% ^a | 48% ^{a,b,c} |
| Freezer | 7% | 15% ^a | 10% ^a | 19% ^{a,c} |
| Clothes Washer | 24% | 26% | 40% ^{a,b} | 52% ^{a,b,c} |
| Clothes Dryer | -- | -- | 4% | 27% ^c |
| Dishwasher | 38% | 44% | 57% ^{a,b} | 70% ^{a,b,c} |
| Dehumidifier | -- | -- | 83% | 90% |
| Room AC | 21% | 26% | 33% ^a | 32% ^a |
| Shell (Average R-value)¹ | | | | |
| Flat Ceiling | R-24 | R-25 | R-23 | R-29 |
| Cathedral Ceiling | R-24 | R-25 | R-21 | R-26 |
| Ambient Walls | R-15 | R-13 | R-11 | R-15 |
| Frame Floor to UC Bsmt/ECS | R-16 | R-19 | R-12 | R-23 |
| Conditioned Foundation Wall | R-14 | R-13 | R-10 | R-13 |

^a Significantly different from the 2011 sample at the 95% confidence level.

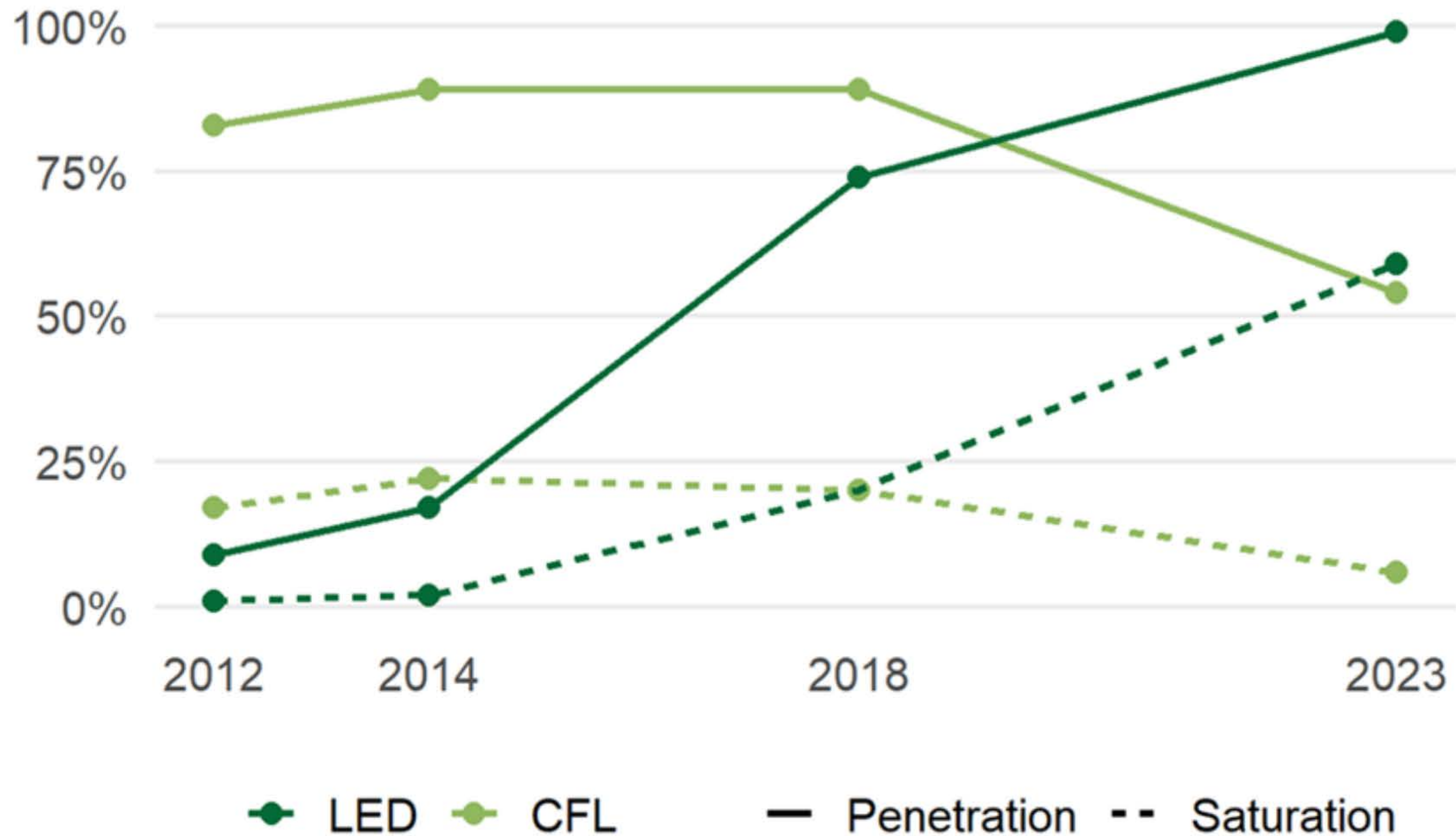
^b Significantly different from the 2013 sample at the 95% confidence level.

^c Significantly different from the 2018 sample at the 95% confidence level.

¹ There is no recorded information on standard deviations among insulated-only subsamples for prior years, so significance testing cannot be performed for these measures.

Comparison of Lighting

LEDs are replacing inefficient bulbs.



Comparisons by Income

- Results are from site visits that divulged income status.
- Building shell efficiency is typically higher in non-low-income homes.
- Low-income homes had higher saturation of CFL bulbs, and lower saturation of LED bulbs.

| | Low-Income (Sites=65) | Non-Low-Income (Sites=210) |
|--------------------------------|--------------------------|-------------------------------|
| Lighting | | |
| Efficient Lighting Saturation | 74% | 73% |
| CFL Saturation | 9% | 7%^a |
| LED Saturation | 54% | 59%^a |
| Shell (Average R-value) | | |
| Flat Ceiling | 24.3 | 27.6 |
| Vaulted Ceiling | 17.1 | 24.3 |
| Ambient Walls | 11.6 | 13.2 |
| Frame Floor to UC Bsmt/ECS | 1.2 | 9.0^a |
| Conditioned Foundation Walls | 7.9 | 7.8 |

^a Significantly different from the low-income sample at the 95% confidence level.

Comparisons by Income

- Results include on-site and self-audit data that divulged income status
- Mechanical equipment efficiencies were higher in non-low-income homes, but the differences were not statistically significant
- Low-income homes had higher rates of ES certified dehumidifiers and Room ACs

| | Low-Income (Sites=131) | Non-Low-Income (Sites=397) |
|--|---------------------------|-------------------------------|
| Appliances (Percent ENERGY STAR) | | |
| Refrigerator | 49% | 52% |
| Freezer | 7% | 24%^a |
| Clothes Washer | 44% | 58%^a |
| Clothes Dryer | 27% | 33% |
| Dishwasher | 60% | 76%^a |
| Dehumidifier | 100% | 85%^a |
| Room AC | 33% | 30% |
| Mechanical Equipment Efficiency | | |
| Heating Equipment (AFUE) | 87.8 | 89.6 |
| Cooling Equipment (SEER2) ¹ | 13.3 | 13.8 |
| Water Heating Equipment (UEF) ² | 0.79 | 0.84 |

¹ Includes all systems with SEER2 ratings and SEER ratings converted to SEER2.

² Includes all systems with UEF ratings and EF ratings converted to UEF.

^a Significantly different from the low-income sample at the 95% confidence level.

Comparisons by EDC

| | PECO | PPL | Duquesne Light | FE: Met-Ed | FE: Penelec | FE: Penn Power | FE: West Penn |
|--|------------------|--------------------|----------------|----------------------|------------------------|--------------------------|--------------------------|
| Lighting | | | | | | | |
| LED Saturation | 59% ^c | 59% ^c | 48% | 71% ^{a,b,c} | 62% ^{a,b,c,d} | 53% ^{a,b,c,d,e} | 58% ^{c,d,e,f} |
| CFL Saturation | 5% ^c | 5% ^c | 10% | 6% ^c | 6% ^c | 11% ^{a,b,d,e} | 6% ^{c,f} |
| Total Efficient Bulb Saturation ¹ | 67% | 75% ^{a,c} | 66% | 80% ^{a,b,c} | 73% ^{a,c,d} | 79% ^{a,b,c,e} | 71% ^{a,b,c,d,f} |
| LED Penetration | 98% | 98% | 100% | 100% | 100% | 100% | 98% |
| Appliances (Percent ENERGY STAR) | | | | | | | |
| Refrigerator | 44% | 56% | 45% | 62% ^a | 51% | 51% | 37% ^{b,c,d} |
| Freezer | 6% | 30% ^a | 27% | 23% | 28% ^a | 29% ^a | 25% |
| Clothes Washer | 58% | 53% | 46% | 55% | 61% | 56% | 47% |
| Clothes Dryer | 36% ^c | 28% | 17% | 27% | 31% | 36% | 31% |
| Dishwasher | 67% | 67% | 74% | 84% ^{a,b} | 80% | 86% ^{a,b} | 89% ^{a,b} |
| Dehumidifier | 87% | 93% | 80% | 90% | 92% | 91% | 80% |
| Room AC | 42% | 27% | 17% | 18% | 43% | 57% | 31% |

^a Significantly different from the PECO sample at the 95% confidence level.

^b Significantly different from the PPL sample at the 95% confidence level.

^c Significantly different from the Duquesne Light sample at the 95% confidence level.

^d Significantly different from the FE: Met-Ed sample at the 95% confidence level.

^e Significantly different from the FE: Penelec sample at the 95% confidence level.

^f Significantly different from the FE: Penn Power sample at the 95% confidence level.

¹ Includes LED, CFL, and fluorescent bulbs.

Comparisons by EDC

| | PECO | PPL | Duquesne Light | FE: Met-Ed | FE: Penelec | FE: Penn Power | FE: West Penn |
|--|-------------------------|---------------------------|------------------------|---------------------------|-------------------------|------------------------------|---------------------------|
| Shell (Average R-value) | | | | | | | |
| Flat Ceiling | 26.3 | 28.5 | 23.5 | 26.2 | 28 | 29.8^c | 25.2 |
| Vaulted Ceiling | 18 | 29 | 14.6 | 23.7 | 26 | 28.3 | 22.7 |
| Ambient Walls | 12.6^c | 12.9^c | 9.2 | 13.5^c | 14.6^c | 15.6^{-a,b,c} | 11.3^f |
| Frame Floor to UC Bsmt/ECS | 1.1 | 11.3^{a,c} | 0.0⁵ | 17.0^{a,c} | 7.5 | 5.0^d | 2.7^{b,d} |
| Conditioned Foundation Walls | 8.1 | 5.4 | 5.2 | 11.7^{b,c} | 4.7^d | 11.5^{b,c,e} | 6.4^d |
| Mechanical Equipment Efficiency | | | | | | | |
| Heating (AFUE) | 86.4^c | 86.9^c | 90.6 | 91.1^{a,b} | 88.1^d | 92.7^{a,b,e} | 89.4 |
| Cooling (SEER2) ² | 13.8^c | 15.0^c | 13.1 | 14.1^c | 14.1 | 13.0^{b,d} | 13.3^{b,4} |
| Water Heating (UEF) ³ | 0.84^c | 0.90^c | 0.69 | 0.90^c | 0.85^c | 0.83 | 0.79^{b,c} |

^a Significantly different from the PECO sample at the 95% confidence level.

^b Significantly different from the PPL sample at the 95% confidence level.

^c Significantly different from the Duquesne Light sample at the 95% confidence level.

^d Significantly different from the FE: Met-Ed sample at the 95% confidence level.

^e Significantly different from the FE: Penelec sample at the 95% confidence level.

^f Significantly different from the FE: Penn Power sample at the 95% confidence level.

¹ Includes LED, CFL, and fluorescent bulbs.

² Includes all systems with SEER2 and SEER ratings converted to SEER2.

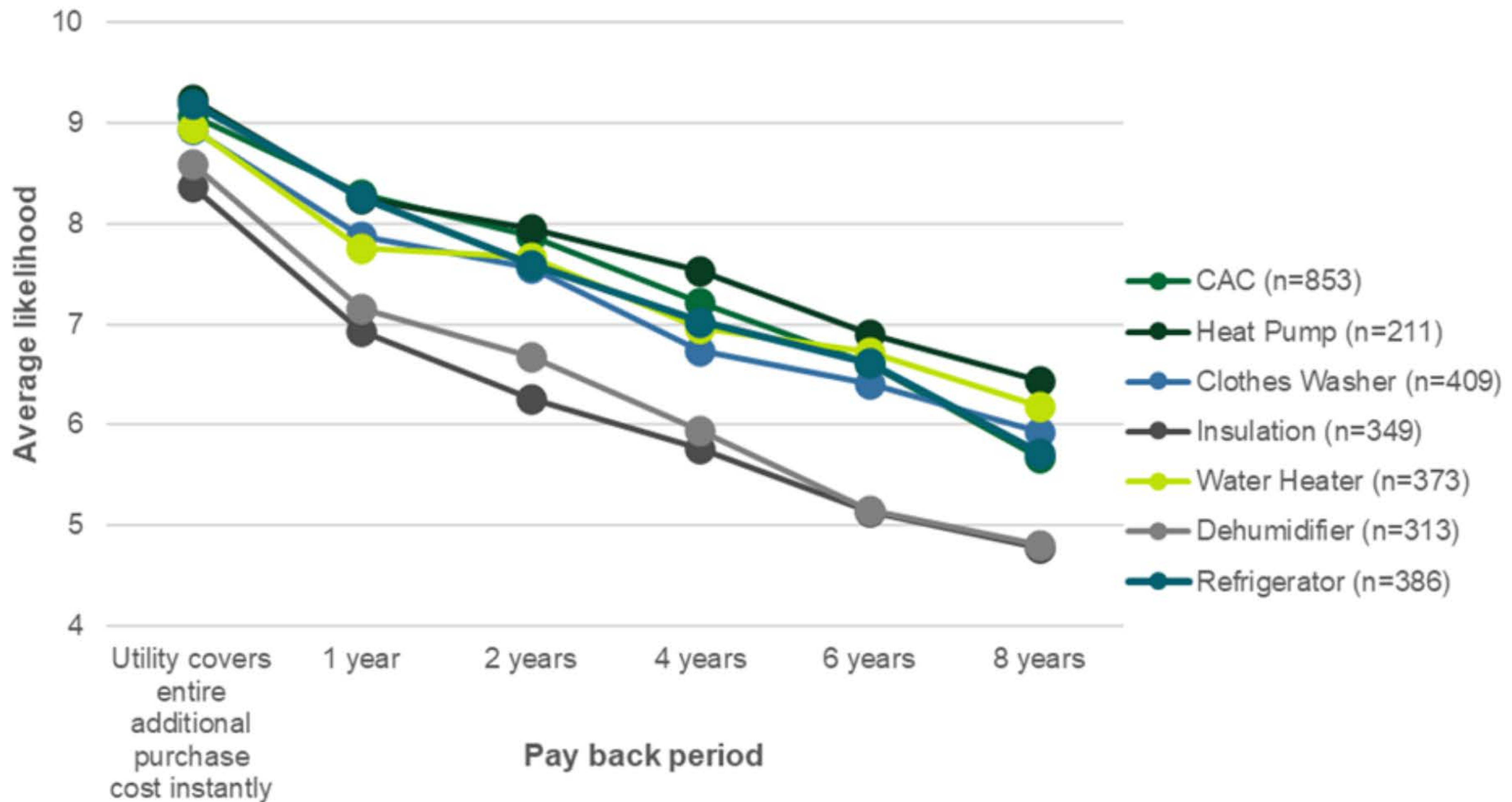
³ Includes all systems with UEF ratings and EF ratings converted to UEF.

⁴ The statewide value in SEER is 13.7. SEER to SEER2 conversions can be found in Table 199 in Appendix G.

⁵ None of the 13 homes with unconditioned basements in Duquesne Light territory had insulation present. It should be noted that 70% of unconditioned basements were uninsulated, statewide. See Appendix D.3 for additional EDC-specific framed floor details.

Willingness to Pay

Heat pumps, central air conditioners, refrigerators, and water heaters had the highest purchase likelihoods



Thank You!

Questions?

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