# 2018 Pennsylvania Residential Baseline Study

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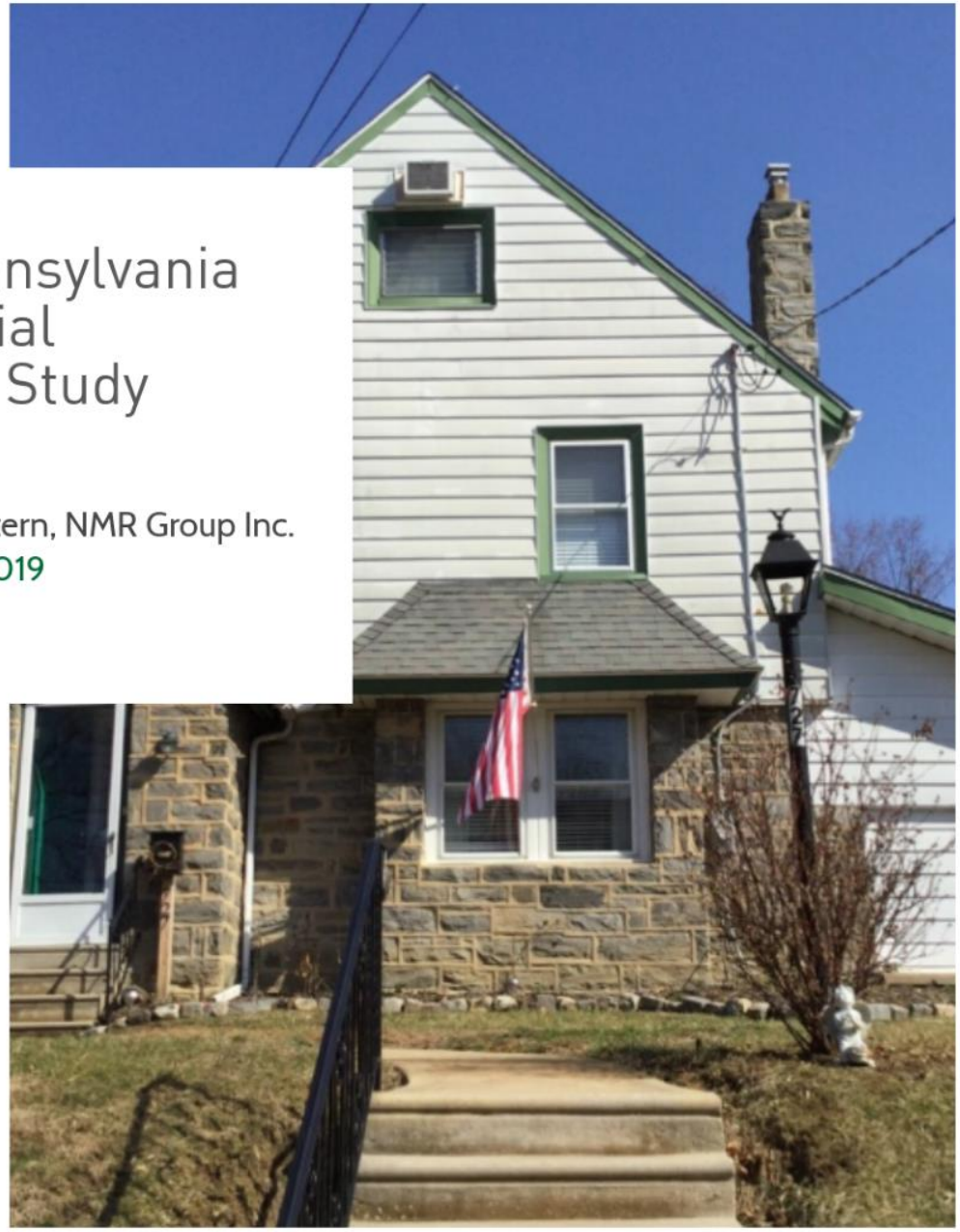

# Agenda

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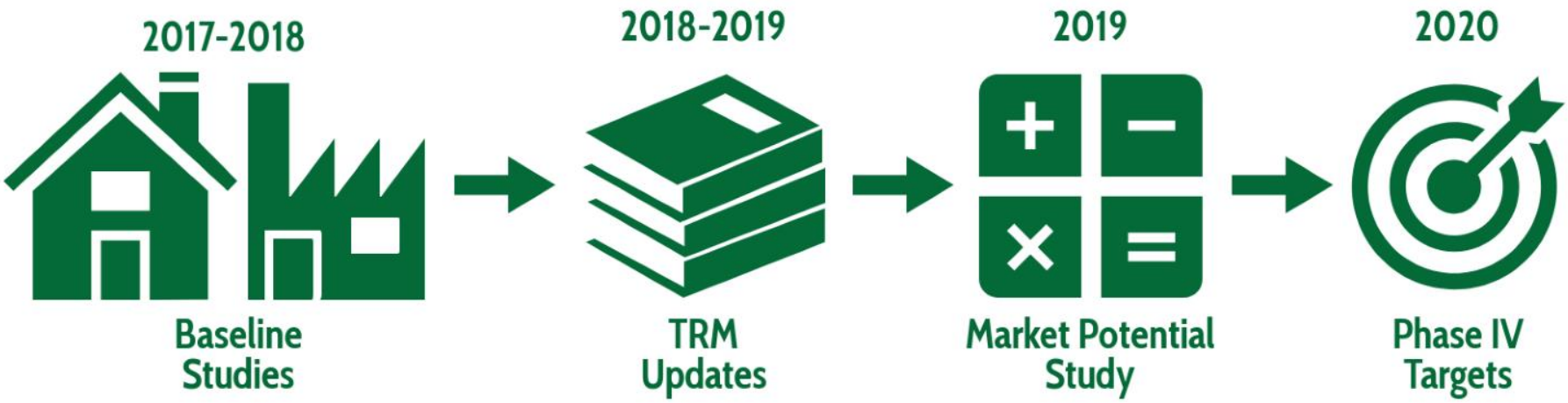
# Introduction

# 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 III (June 1st, 2016 - May 31st, 2021)
  - NMR Group Inc. became the Statewide Evaluator Team Lead in 2016
- Efficiency targets set at the start of each phase

# Evaluation Timeline



# Study Goals

- Characterize the current baseline energy efficiency levels of Pennsylvania's existing residential building stock
- Compare current energy-efficiency levels to the previous Act 129 studies (2012 and 2014)
- Assess the current willingness to pay of electric customers for efficiency upgrades
- Inform a market potential study for Phase IV of Act 129
- Inform updates to the Technical Reference Manual (TRM) for Phase IV of Act 129


# Methods

# Sample Overview

**145**
**Detached Single-family**

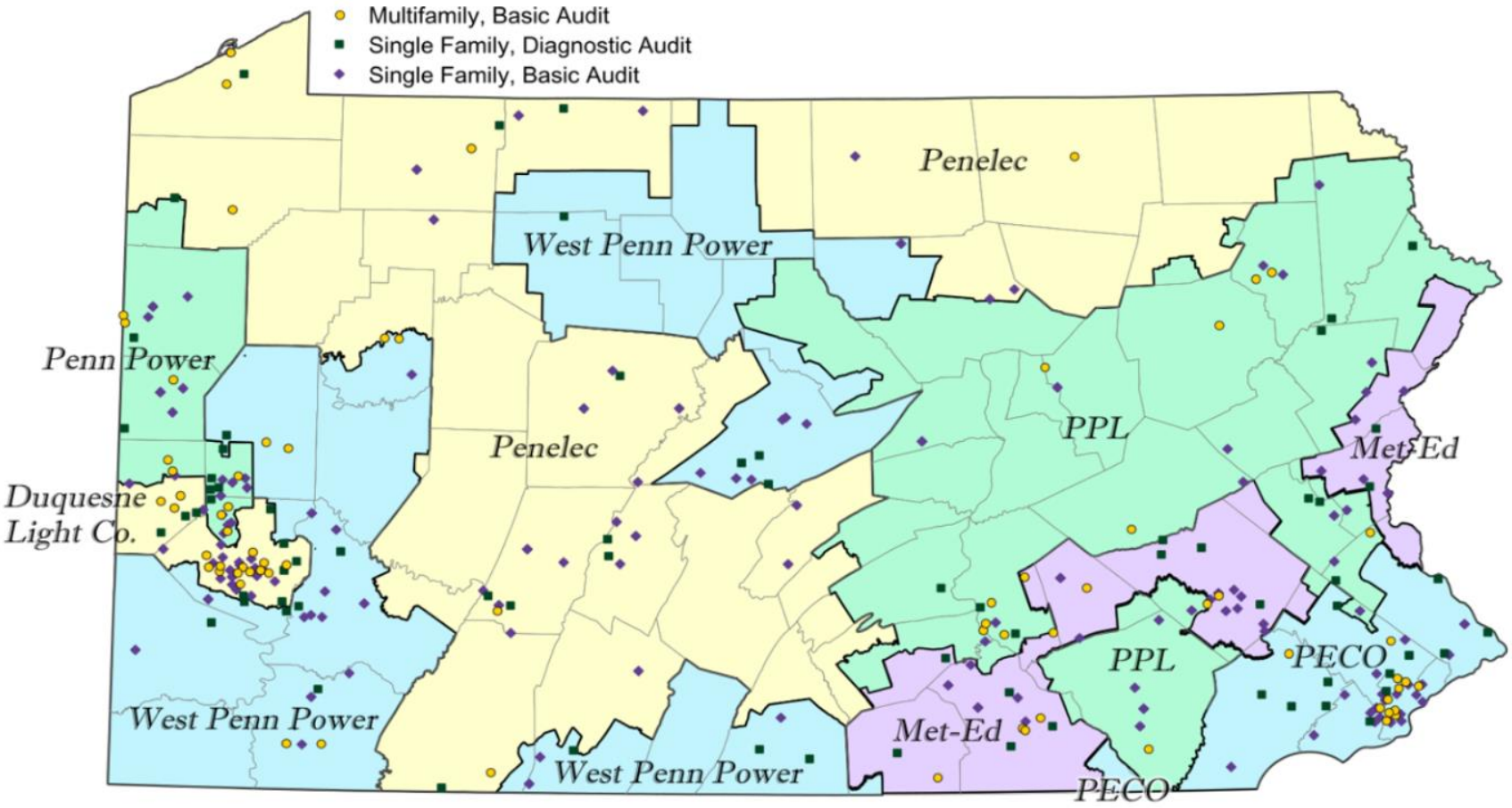
**48**
**Attached Single-family**

**26**
**Manufactured or Mobile**

**70**
**Multifamily homes**

- Target equal count of homes across all seven EDCs
- Targets by home type and and income status based on U.S. Census data
- Sub-sample of 72 homes received full energy modeling (diagnostic audits)

# Sample Location



# Sample Targets

## Sample Composition by EDC

| EDC | Total Single-family | Diagnostic Sub-sample | Multifamily Sample | Full Sample |
|---|---|---|---|---|
| PECO | 34 | 11 | 12 | 46 |
| PPL | 32 | 11 | 12 | 44 |
| Duquesne | 33 | 10 | 18 | 51 |
| FE: Met-Ed | 31 | 10 | 8 | 39 |
| FE: Penelec | 31 | 10 | 7 | 38 |
| FE: Penn Power | 25 | 10 | 7 | 32 |
| FE: West Penn | 33 | 10 | 6 | 39 |
| **Statewide** | **219** | **72** | **70** | **289** |

## Sample Composition by Home Type and Income Status

| Home Type | Proportion | Non-low-income | Low-income | Don't Know/ Refused | Full Sample |
|---|---|---|---|---|---|
| **Detached Single-family** | Target | 43% | 6% | 0% | 49% |
| | Sample | 45% | 5% | 0% | 50% |
| **Attached Single-family** | Target | 13% | 5% | 0% | 17% |
| | Sample | 11% | 5% | 1% | 17% |
| **Manufactured/ Mobile** | Target | 6% | 3% | 0% | 9% |
| | Sample | 6% | 3% | <1% | 9% |
| **Multifamily** | Target | 15% | 9% | 0% | 24% |
| | Sample | 10% | 10% | 4% | 24% |
| **Full Sample** | Target | 76% | 24% | 0% | 100% |
| | Sample | 72% | 23% | 5% | 100% |

# Additional Single-Family Targets



## Single-Family Sample Composition - Vintage

| Year Built | Total Single-family (*n=219*) | Diagnostic Sub-sample (*n=72*) | ACS (*N*=3,945,837) |
|---|---|---|---|
| 2010 or later | 5% | 6% | 2% |
| 2000-2009 | 8% | 11% | 9% |
| 1980-1999 | 22% | 32% | 22% |
| 1960-1979 | 21% | 26% | 23% |
| 1940-1959 | 18% | 13% | 21% |
| Before 1940 | 27% | 13% | 23% |

## Single-Family Sample Composition - Heating Fuel

| Heating Fuel | Total Single-family (*n=219*) | Diagnostic Sub-sample (*n=72*) | ACS (*N*=3,978,999) |
|---|---|---|---|
| Natural Gas | 57% | 40% | 52% |
| Electricity | 20% | 42% | 17% |
| Oil or Kerosene | 14% | 10% | 20% |
| Propane or Other Tank Gas | 8% | 8% | 5% |
| Wood | 1% | -- | 4% |
| Coal or Coke | <1% | -- | 2% |
| Solar | -- | -- | <1% |
| Other Fuel | -- | -- | 1% |
| No Fuel Used | -- | -- | <1% |

# Additional Multifamily Targets



## Multifamily Sample Composition - Number of Units

| Number of Units in Building | Multifamily (*n=70*) | ACS (N=974,669) |
|---|---|---|
| 2 to 4 | 19% | 41% |
| 5 to 19 | 33% | 29% |
| 20 to 49 | 24% | 10% |
| 50 + | 24% | 20% |

# Weights



## Full Sample Weights

| Home Type | PECO | PPL | Duquesne | FE: Met-Ed | FE: Penelec | FE: Penn Power | FE: West Penn |
|---|---|---|---|---|---|---|---|
| Detached Single-family | 1.86 | 1.89 | 0.66 | 0.82 | 1.09 | 0.38 | 1.43 |
| Attached Single-family | 2.03 | 3.77 | 0.46 | 1.07 | 1.37 | 0.06 | 0.20 |
| Multifamily | 1.85 | 1.05 | 0.41 | 0.58 | 0.77 | 0.18 | 0.94 |
| Manuf./Mobile | 0.25 | 0.31 | 0.09 | 0.43 | 0.69 | 0.53 | 0.85 |

## Diagnostic Sample Weights

| Primary Heating Fuel Type | Detached Single-family | Attached Single-family | Manufactured/ Mobile |
|---|---|---|---|
| Electric | 0.38 | 0.55 | 0.09 |
| Non-Electric | 1.33 | 2.82 | 0.78 |

# Recruitment

# Results

# General Characterisitcs

Detached Single-family

Attached Single-family

Manufactured or Mobile

Multifamily homes

Statewide

| | Detached Single-family | Attached Single-family | Manufactured or Mobile | Multifamily homes | Statewide |
|---|---|---|---|---|---|
| Average Age | 62 yrs | 65 yrs | 32 yrs | 62 yrs | 65 yrs |
| Avg. Conditioned Floor Area | 2,295 sq.ft. | 1,778 sq.ft. | 1,166 sq.ft. | 1,031 sq.ft. | 1,881 sq.ft. |

# HERS Index Score


Homes, regardless of vintage, are 61% less efficient than a home built to code in 2009. *

Lower = More Efficient

- Home Energy Rating System (HERS) Index created by Residential Energy Services Network (RESNET)
- Score of 100 = Home built to 2006 standards
- Each additional point = 1% decrease in efficiency
- Score of 82 = Home built to 2009 standards
- Score of 54/55 = Home built to 2015 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 | Manufactured/ Mobile | Total |
|---|---|---|---|---|
| *n* | *53* | *10* | *9* | *72* |
| Min | 75.0 | 68.0 | 100.0 | 68.0 |
| Max | 355.0 | 180.0 | 220.0 | 355.0 |
| **Mean** | **134.8** | **110.6** | **150.4** | **132.3** |
| Median | 119.0 | 94.0 | 130.0 | 119.5 |
| Std. Dev. | 52.5 | 36.1 | 42.8 | 50.0 |

## HERS Score by Vintage*

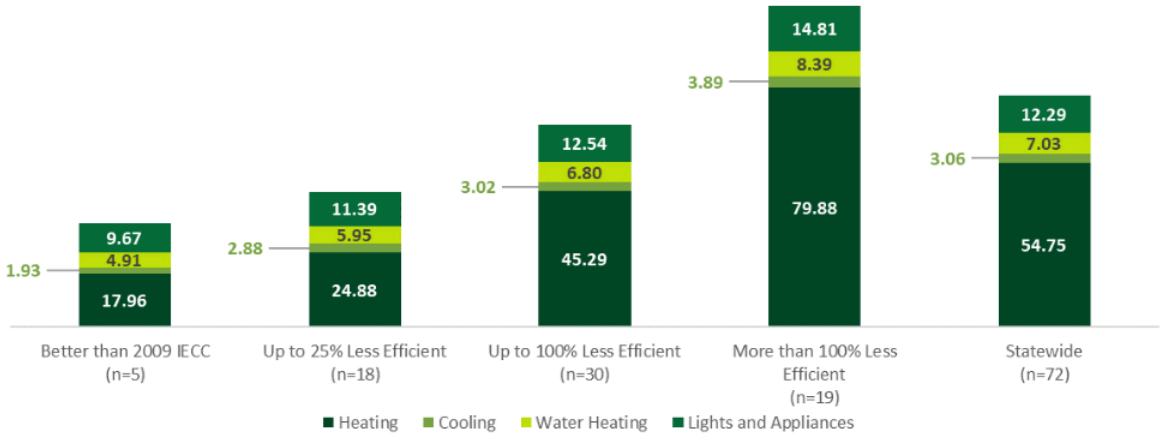
| | Before 1940 | 1940-1959 | 1960-1979 | 1980-1999 | 2000-2009 | 2010 or later | Total |
|---|---|---|---|---|---|---|---|
| *n* | *9* | *9* | *19* | *23* | *8* | *4* | *72* |
| Min | 103.0 | 106.0 | 76.0 | 85.0 | 75.0 | 68.0 | 68.0 |
| Max | 222.0 | 193.0 | 355.0 | 249.0 | 118.0 | 93.0 | 355.0 |
| **Mean** | **159.1** | **138.1** | **147.6** | **133.1** | **90.1** | **85.8** | **132.3** |
| Median | 149.0 | 121.0 | 126.0 | 119.0 | 88.5 | 91.0 | 119.5 |
| Std. Dev. | 41.8 | 32.2 | 64.8 | 44.6 | 13.8 | 11.9 | 50.0 |

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

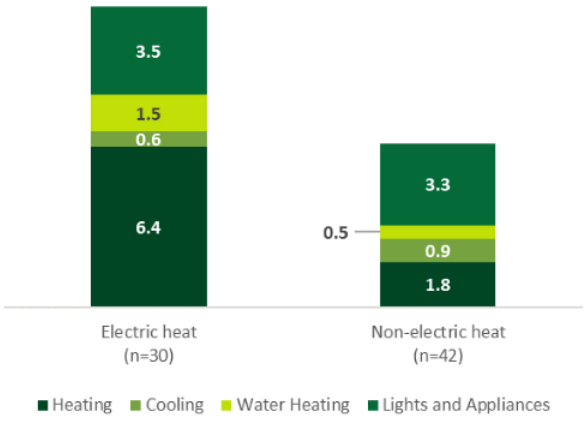
# Energy Use Intensity



## EUI (Btu/sq.ft./yr)*




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




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

# Air Infiltration


Homes have 63% more (worse) air infiltration than a home built to code in 2009. *

Lower = More Efficient

- Measured in Air Changes per Hour with a pressure gradient of 50 pascals (ACH50)
- Results from blower door tests
- 7 ACH50 = 2009 standard
- 3 ACH50 = 2015 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 | Manufactured/ Mobile | Total |
|---|---|---|---|---|
| *n* | *53* | *10* | *9* | *72* |
| Min | 2.1 | 4.4 | 4.9 | 2.1 |
| Max | 25.9 | 31.9 | 46.5 | 46.5 |
| **Mean** | **9.6** | **11.7** | **18.1** | **11.4** |
| Median | 8.4 | 8.3 | 16.2 | 9.4 |
| Std. Dev. | 5.0 | 9.2 | 11.8 | 7.3 |

## ACH50 by Vintage*

| | Before 1940 | 1940-1959 | 1960-1979 | 1980-1999 | 2000-2009 | 2010 or later | Total |
|---|---|---|---|---|---|---|---|
| *n* | *9* | *9* | *19* | *23* | *8* | *4* | *72* |
| Min | 11.7 | 5.1 | 2.7 | 3.1 | 2.5 | 2.1 | 2.1 |
| Max | 31.9 | 12.0 | 46.5 | 19.5 | 10.8 | 7.1 | 46.5 |
| **Mean** | **18.7** | **8.7** | **13.6** | **9.6** | **5.7** | **5.1** | **11.4** |
| Median | 17.3 | 8.4 | 11.1 | 7.9 | 4.3 | 5.5 | 9.4 |
| Std. Dev. | 6.6 | 2.6 | 9.7 | 4.6 | 3.0 | 2.1 | 7.3 |

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

# Duct Leakage


Duct systems have 83% more (worse) leakage than those in a home built to code in 2009.*

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 standard



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

# Duct Leakage to Outside



## Duct Leakage to Outside by Home Type*

| | Detached Single-family | Attached Single-family | Manufactured/ Mobile | Total |
|---|---|---|---|---|
| *n* | *52* | *8* | *7* | *67* |
| Min | 0.0 | 0.0 | 9.2 | 0.0 |
| Max | 43.4 | 32.6 | 30.6 | 43.4 |
| **Mean** | **14.7** | **11.1** | **20.5** | **14.6** |
| Median | 15.5 | 6.5 | 20.4 | 16.0 |
| Std. Dev. | 9.5 | 11.4 | 7.5 | 9.7 |

## Duct Leakage to Outside by Vintage*

| | Before 1940 | 1940-1959 | 1960-1979 | 1980-1999 | 2000-2009 | 2010 or later | Total |
|---|---|---|---|---|---|---|---|
| *n* | *9* | *11* | *15* | *19* | *9* | *4* | *67* |
| Min | 4.9 | 0.0 | 0.6 | 1.8 | 0.0 | 1.8 | 0.0 |
| Max | 37.1 | 43.4 | 24.0 | 30.6 | 20.4 | 27.0 | 43.4 |
| **Mean** | **20.0** | **14.1** | **15.1** | **17.5** | **7.6** | **9.2** | **14.6** |
| Median | 20.2 | 9.8 | 17.6 | 20.0 | 8.8 | 4.0 | 16.0 |
| Std. Dev. | 11.7 | 13.0 | 7.0 | 7.2 | 6.8 | 11.9 | 9.7 |

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

# Insulation Levels

(Full sample)


Walls, ceilings, and floors are between 48% and 87% less efficient than a home built to code in 2009.

Higher = 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.
- 75% of floors, 34% of walls, and 17% of ceilings have *no* insulation
- 2009 standards*:
  - Ceilings: R-38
  - Walls: R-20
  - Floors: R-30 (or R-19 if it fills cavity)
- 2015 standards*:
  - Ceilings: R-49
  - Walls: R-20
  - Floors: R-30 (or R-19 if it fills cavity)

*Standards only apply to new construction.

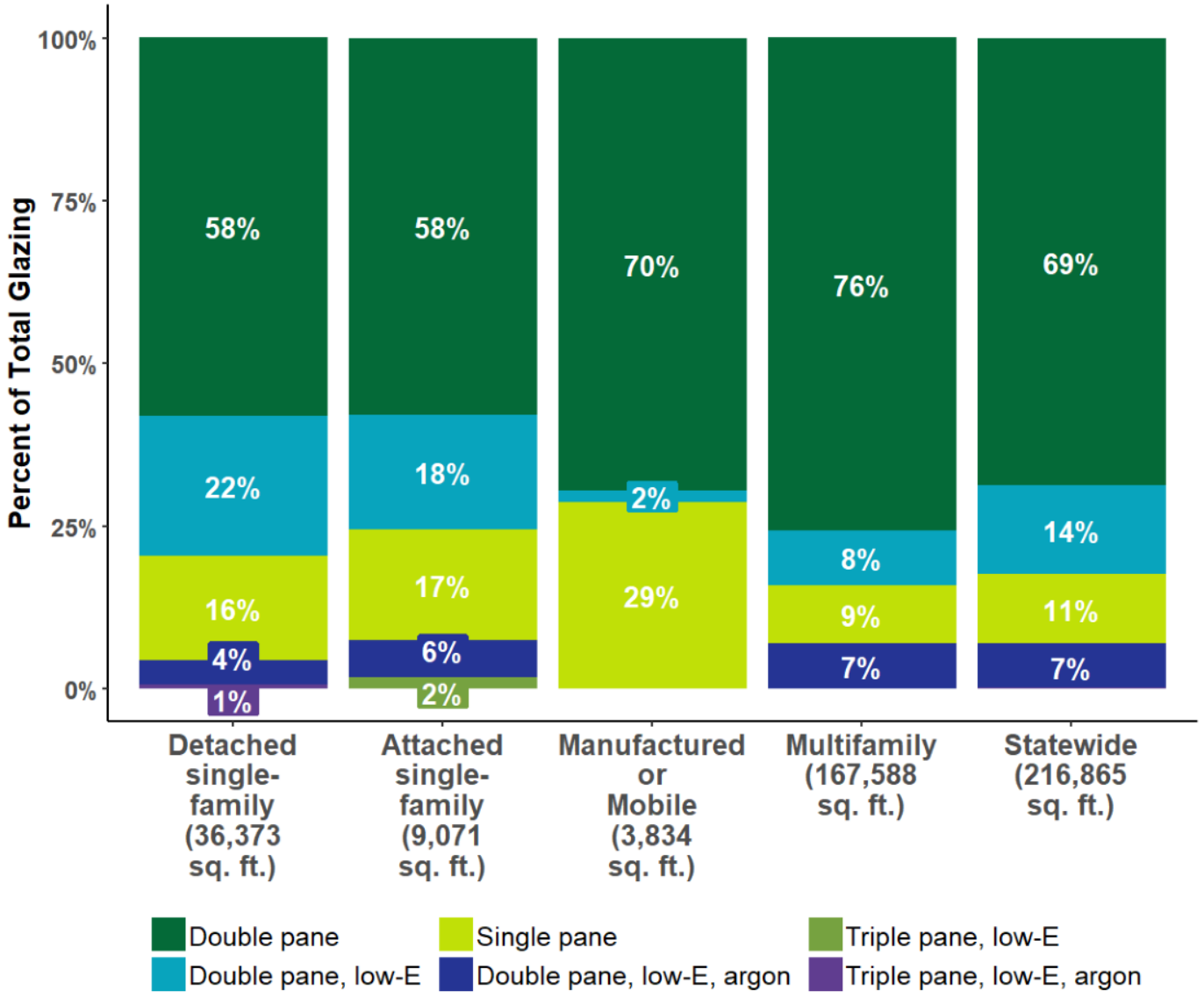
# Insulation Installation Grade


## Statewide Insulation Grade by Measure (Diagnostic Only)*

| Grade | Walls | Flat Ceilings | Vaulted Ceilings | Floors |
|---|---|---|---|---|
| *n* | *72* | *69* | *30* | *34* |
| I | 6% | 18% | 2% | 5% |
| II | 46% | 49% | 53% | 15% |
| III | 33% | 28% | 33% | 44% |
| No Cavity Insulation | 16% | 5% | 11% | 36% |

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

# Windows


Percent of Total Glazing
100%
75%
50%
25%
0%
58%
22%
16%
4%
1%
58%
18%
17%
6%
2%
70%
2%
29%
76%
8%
9%
7%
69%
14%
11%
7%
Detached single-family (36,373 sq. ft.)
Attached single-family (9,071 sq. ft.)
Manufactured or Mobile (3,834 sq. ft.)
Multifamily (167,588 sq. ft.)
Statewide (216,865 sq. ft.)
Double pane
Double pane, low-E
Single pane
Double pane, low-E, argon
Triple pane, low-E
Triple pane, low-E, argon

# Primary Heating

*32% of heating systems were ENERGY STAR qualified .*



## Fuel

- Natural Gas: 54%
- Electricity: 23%
- Fuel Oil: 15%
- Propane: 5%
- Wood/Pellet" 2%

## Type

- Furnace: 43%
- Boiler: 32%
- ASHP: 10%
- Elec. Baseboard: 9%
- Other: 6%

## Efficiency

- Furnace: 87.9 Annual Fuel Utilization Efficiency (AFUE)
- Boiler: 83.0 AFUE
- Heat Pump: 8.7 Heating Seasonal Performance Factor (HSPF)

# Primary Cooling

*24% of permanent cooling systems and 33% of room ACs were ENERGY STAR qualified.*



## Fuel

- Electric

## Type

- Room AC: 37%
- Central AC: 35%
- ASHP: 12%
- Ductless HP: 4%
- Other: 4%
- None: 8%

## Efficiency

- Room AC: 10.2 Energy Efficiency Ratio (EER)
- Central AC: 12.0 Seasonal Energy Efficiency Ratio (SEER)
- Ductless/ASHP: 14.9 SEER

# Water Heating

*15% of water heaters were ENERGY STAR qualified.*



## Fuel

- Natural Gas: 55%
- Electric: 35%
- Propane: 5%
- Oil: 5%

## Type

- Storage: 87%
- Indirect: 4%
- Instantaneous: 4%
- Tankless coil: 3%
- Heat pump: 2%

## Efficiency

- Storage (Fossil): 0.61 Uniform Energy Factor (UEF)
- Storage (Electric): 0.90 UEF
- Indirect: 0.81 Energy Factor (EF)
- Instaneous: 0.94 UEF
- Tankless coil: 0.50 EF
- Heat pump: 2.80 UEF

# Faucets and Showerheads

*57% of faucets and 4% of showerheads are low-flow.*



| | Kitchen | Bathroom | Utility | All Faucets | Showerheads |
|---|---|---|---|---|---|
| Avg. Quantity | 1.0 | 2.0 | 0.4 | 3.4 | 1.5 |
| Avg. Flow Rate | 2.0 gpm | 1.8 gpm | 2.2 gpm | 1.8 gpm | 2.3 gpm |

# Thermostats



## Thermostat Penetration

| Type | Detached Single-family | Attached Single-family | Manufactured/ Mobile | Multifamily | Statewide[1] |
|---|---|---|---|---|---|
| *n* | *143* | *47* | *25* | *65* | *280* |
| Manual | 45% | 64% | 52% | 40% | 50% |
| Programmable | 49% | 32% | 44% | 38% | 43% |
| Wi-fi | 3% | 4% | -- | 2% | 2% |
| Smart | 4% | 2% | -- | -- | 2% |
| None | 1% | -- | 4% | 20% | 5% |

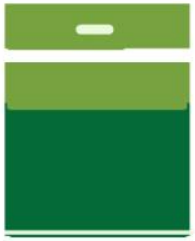
[1] Since some homes have more than one thermostat, column totals can sum to more than 100%.

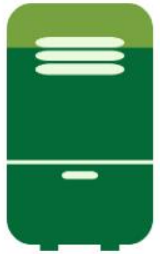
## Thermostat Saturation

| Type | Detached Single-family | Attached Single-family | Manufactured/ Mobile | Multifamily | Statewide |
|---|---|---|---|---|---|
| *n* | *184* | *54* | *24* | *53* | *315* |
| Manual | 47% | 65% | 54% | 49% | 53% |
| Programmable | 46% | 30% | 46% | 49% | 42% |
| Wi-Fi | 3% | 4% | -- | 2% | 3% |
| Smart | 4% | 2% | -- | -- | 2% |

# Residential Appliances







| | Refrigerators | Freezers | Dishwashers | Clothes Washers | Clothes Dryers | Dehumidifiers |
|---|---|---|---|---|---|---|
| % ENERGY STAR | 31% | 10% | 56% | 40% | 6% | 83% |
| Avg. Age | 12 yrs | 14 yrs | 10 yrs | 9 yrs | 12 yrs | 8 yrs |

# Lighting Penetration

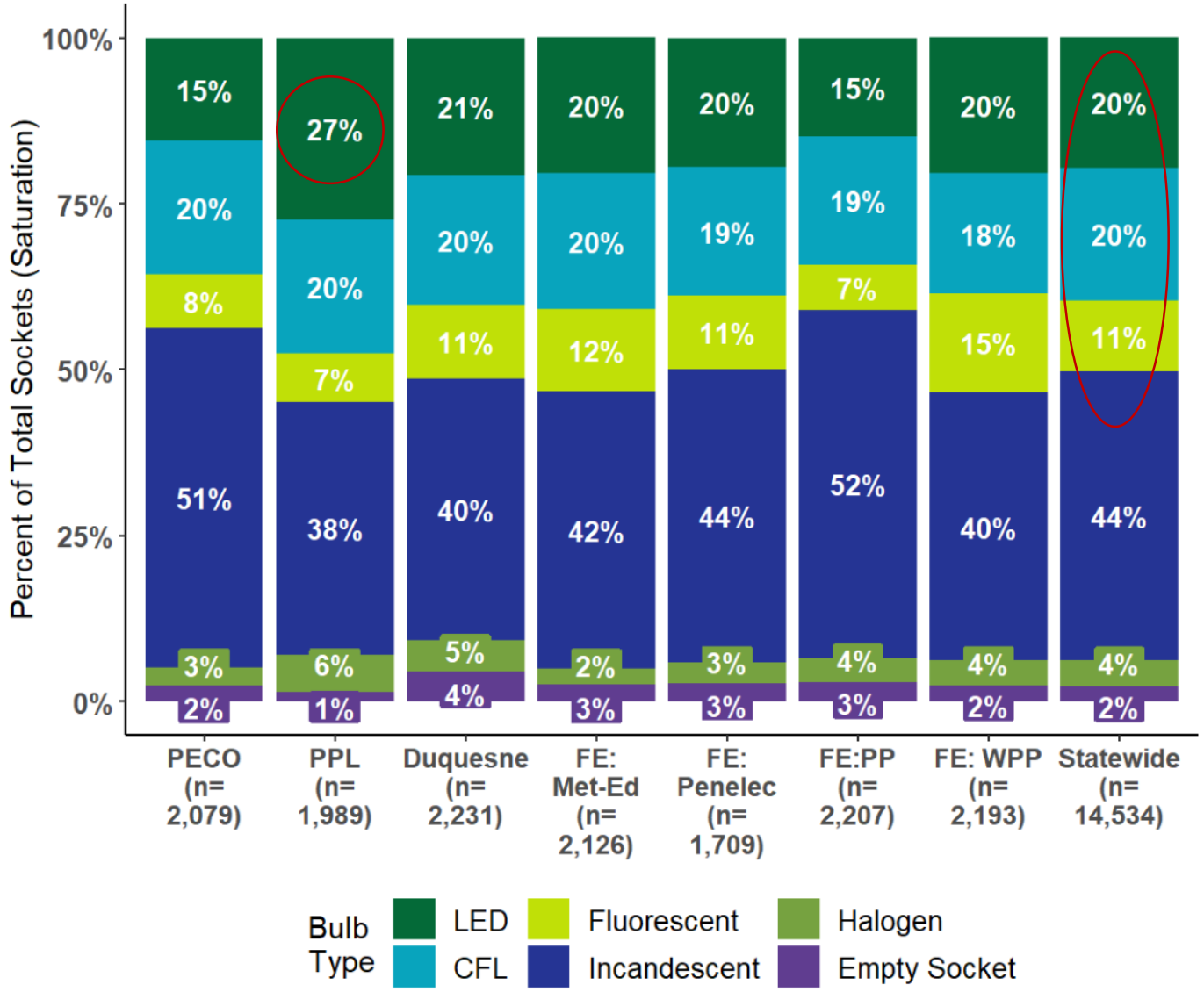
- Penetration: the amount of homes that have at least one of a given bulb type
- FE: Met-Ed and PPL homes are significantly more likely to have at least one LED than PECO homes.

## Bulb Type Penetration

| Bulb Type | PECO | PPL | Duquesne | FE: Met-Ed | FE: Penelec | FE: Penn Power | FE: West Penn | Statewide |
|---|---|---|---|---|---|---|---|---|
| *n* | *46* | *44* | *51* | *39* | *38* | *32* | *39* | *289* |
| LED | **65%** | **82%**[a] | 73% | **90%**[a] | 71% | 81% | 74% | 75% |
| CFL | 89% | 80% | 84% | 95% | 95% | 84% | 95% | 89% |
| Fluorescent | 65% | 64% | 67% | 74% | 76% | 63% | 82% | 74% |
| Incandescent | 85% | 91% | 92% | 95% | 92% | 97% | 95% | 91% |
| Halogen | 44% | 43% | 47% | 44% | 40% | 53% | 51% | 46% |

[a] Significantly different from PECO at the 95% confidence level.

# Lighting Saturation



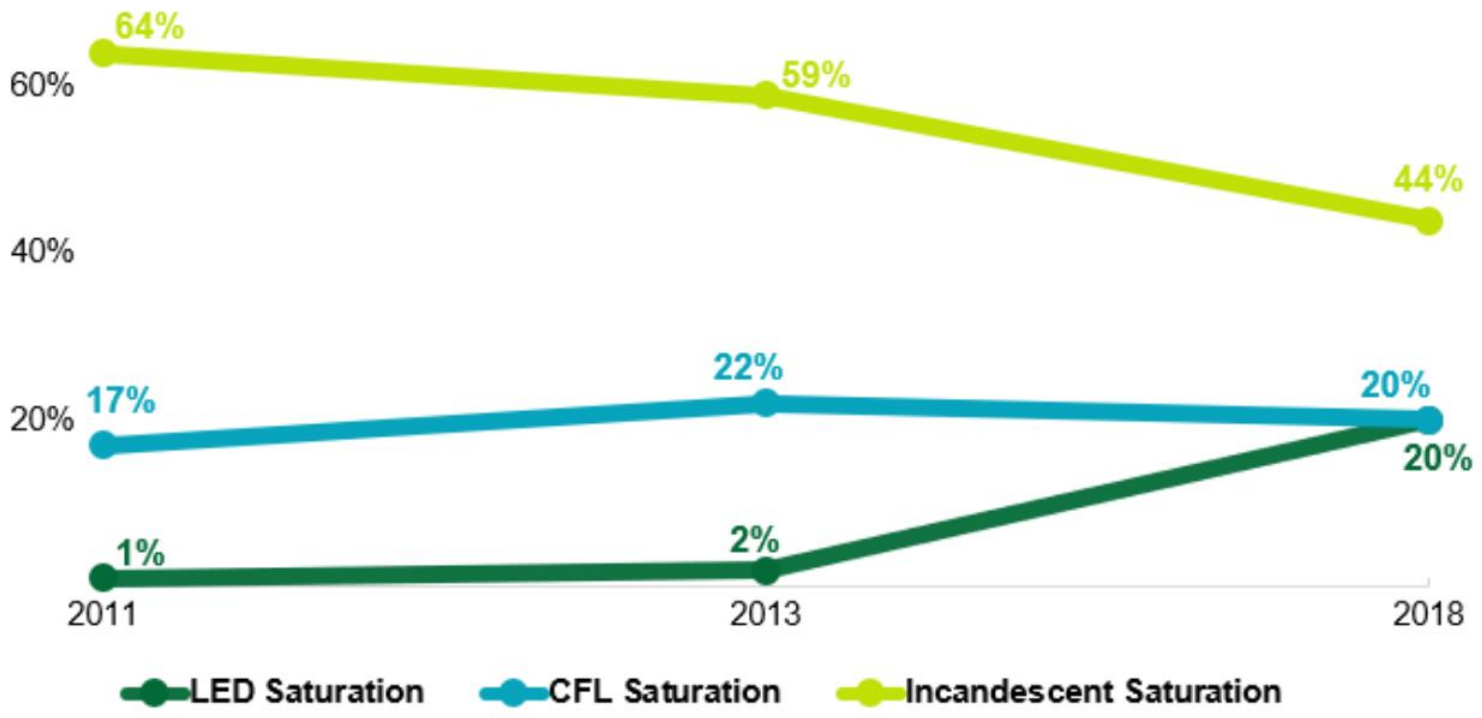
# Comparisons Over Time

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

[a] Significantly different from the 2012 sample at the 95% confidence level.
[b] Significantly different from the 2014 sample at the 95% confidence level.

# Comparison of Lighting

*LEDs are replacing inefficient bulbs.*



# Comparisons by Income

| | Low-Income *(Sites=66)* | Non-Low-Income *(Sites=208)* |
|---|---|---|
| **Lighting** | | |
| Efficient Lighting Saturation* | **57%** | **48%[a]** |
| CFL Saturation | 21% | 19% |
| LED Saturation | **25%** | **19%[a]** |
| **Appliances (Percent ENERGY STAR)** | | |
| Refrigerator | 38% | 32% |
| Freezer | **--** | **15%[a]** |
| Clothes Washer | 39% | 42% |
| Clothes Dryer | 8% | 6% |
| Dishwasher | 50% | 38% |
| Dehumidifier | 83% | 80% |
| Room AC | 22% | 33% |
| **Shell (Average R-value)** | | |
| Flat Ceiling | **17.6** | **22.3[a]** |
| Cathedral Ceiling | 16.8 | 18.0 |
| Ambient Walls | 8.2 | 10.1 |
| Frame Floor to UC Bsmt/ECS | 5.6 | 4.8 |
| Conditioned Foundation Walls | 4.7 | 5.9 |
| **Mechanical Equipment Efficiency** | | |
| Heating Equipment (AFUE)[1] | **83.8** | **87.0[a]** |
| Cooling Equipment (SEER)[2] | 13.1 | 12.9 |
| Water Heating Equipment (UEF)[3] | 0.88 | 0.78 |

# Comparisons by EDC

| | PECO | PPL | Duquesne | FE: Met-Ed | FE: Penelec | FE: Penn Power | FE: West Penn |
|---|---|---|---|---|---|---|---|
| **Lighting** | | | | | | | |
| LED Saturation | **15%** | **27%**[a] | **21%**[a,b] | **20%**[a,b] | **20%**[a,b] | **15%**[b,c,d,e] | **20%**[a,b,f] |
| CFL Saturation | 20% | 20% | 20% | 20% | 19% | 19% | 18% |
| Total Efficient Bulb Saturation[1] | **43%** | **54%**[a] | **52%**[a] | **53%**[a] | **50%**[a,b,d] | **41%**[b,c,d,e] | **53%**[a,e,f] |
| LED Penetration | **65%** | **82%**[a] | **73%** | **90%**[a,c] | **71%**[d] | 81% | **74%**[d] |
| **Appliances (Percent ENERGY STAR)** | | | | | | | |
| Refrigerator | **26%** | **32%** | **25%** | **34%** | **28%** | **51%**[abcde] | **35%**[f] |
| Freezer | -- | 9% | 13% | -- | 17% | 11% | **29%**[ad] |
| Clothes Washer | **39%** | **36%** | **27%** | **50%**[c] | **16%**[abd] | **44%**[e] | **53%**[ce] |
| Clothes Dryer | **8%** | 3% | **2%** | **2%** | **2%** | --[a] | **12%**[adef] |
| Dishwasher | **50%** | 46% | 31% | **48%** | **50%** | **26%**[ad] | **23%**[ad] |
| Dehumidifier | 78%* | 91% | 67% | 82% | 100% | 69% | 77% |
| Room AC | 28% | 24% | 26% | 35% | **41%** | 50% | **25%**[e] |

[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 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.
[†] Sample size too low for significance testing.
[1] Includes LED, CFL, and fluorescent bulbs.
[2] Includes all systems with AFUE ratings
[3] Includes all systems with SEER ratings
[4] Includes all systems with UEF ratings and EF ratings converted to UEF.

# Comparisons by EDC

| | PECO | PPL | Duquesne | FE: Met-Ed | FE: Penelec | FE: Penn Power | FE: West Penn |
|---|---|---|---|---|---|---|---|
| **Shell (Average R-value)** | | | | | | | |
| Flat Ceiling | **15.2** | **23.9**[a] | **17.6**[b] | **21.9**[a] | **15.9**[b] | **27.2**[a,c,e] | **24.9**[a,c,e] |
| Cathedral Ceiling | 18.2 | **22.3** | 17.7 | 16.1 | **12.4**[b] | 20.8 | 19.2 |
| Ambient Walls | **6.1** | **11.1**[a] | **7.3**[b] | **9.7**[a] | **9.0**[a] | **12.2**[a,c,e] | **11.6**[a,c] |
| Frame Floor to UC Bsmt/ECS | 3.9 | **7.0** | **1.9**[b] | **8.3**[c] | 4.1 | 1.4† | 6.6 |
| Conditioned Foundation Walls | **1.7** | **5.9**[a] | **2.5** | **6.6**[a,c] | **8.6**[a,c] | **6.5**[a] | **7.9**[a,c] |
| **Mechanical Equipment Efficiency** | | | | | | | |
| Heating (AFUE)[2] | 84.2 | 85.3 | 87.8 | 86.4 | 85.0 | 88.9 | 89.2 |
| Cooling (SEER)[3] | 12.3 | 13.5 | 12.6 | 12.9 | 14.0 | 12.7 | 13.1 |
| Water Heating (UEF)[4] | 0.70 | 0.95 | 0.69 | 0.76 | 0.82 | 0.79 | 0.81 |

[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 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.
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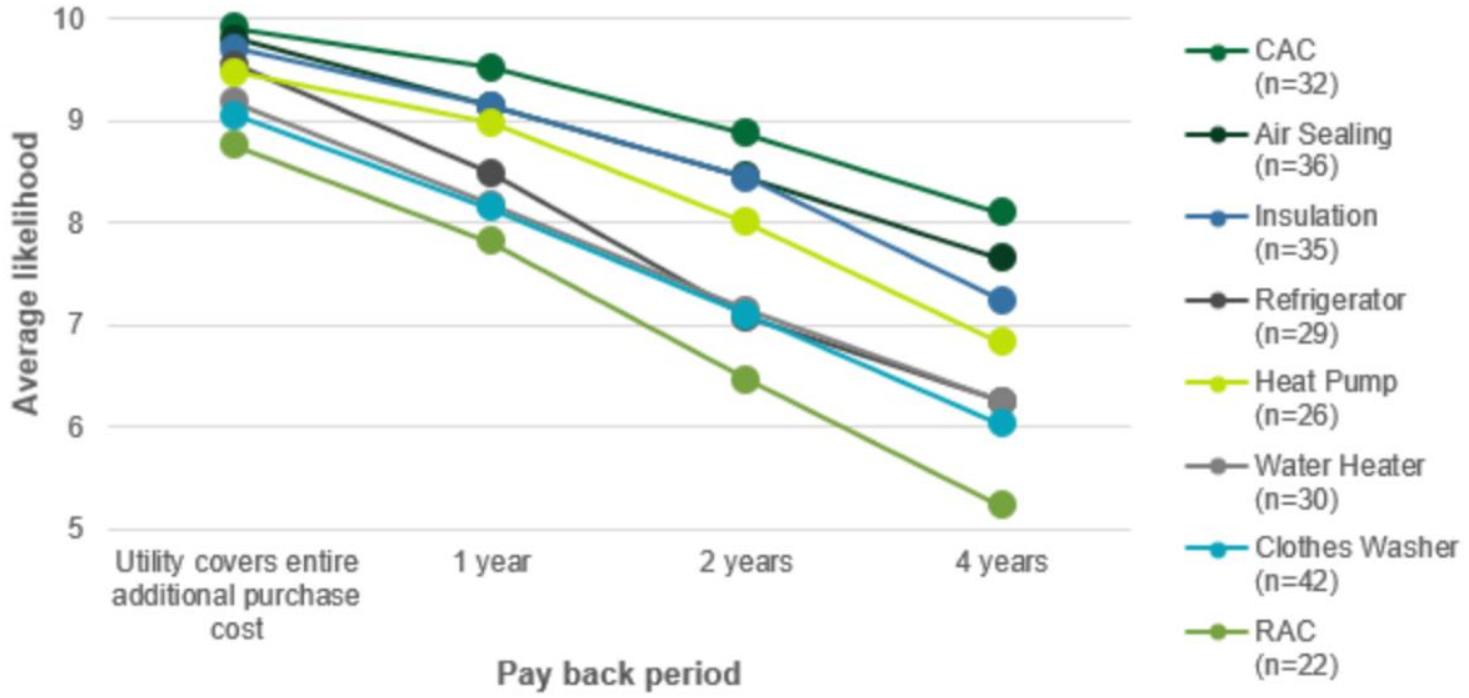
[1] Includes LED, CFL, and fluorescent bulbs.
[2] Includes all systems with AFUE ratings
[3] Includes all systems with SEER ratings
[4] Includes all systems with UEF ratings and EF ratings converted to UEF.

# Willingness to Pay

*Respondents care most about an upgrade's performance, energy bill savings, and lower maintenance costs*



# Thank You!

Questions?

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41 EMPLOYEE OWNERS

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