

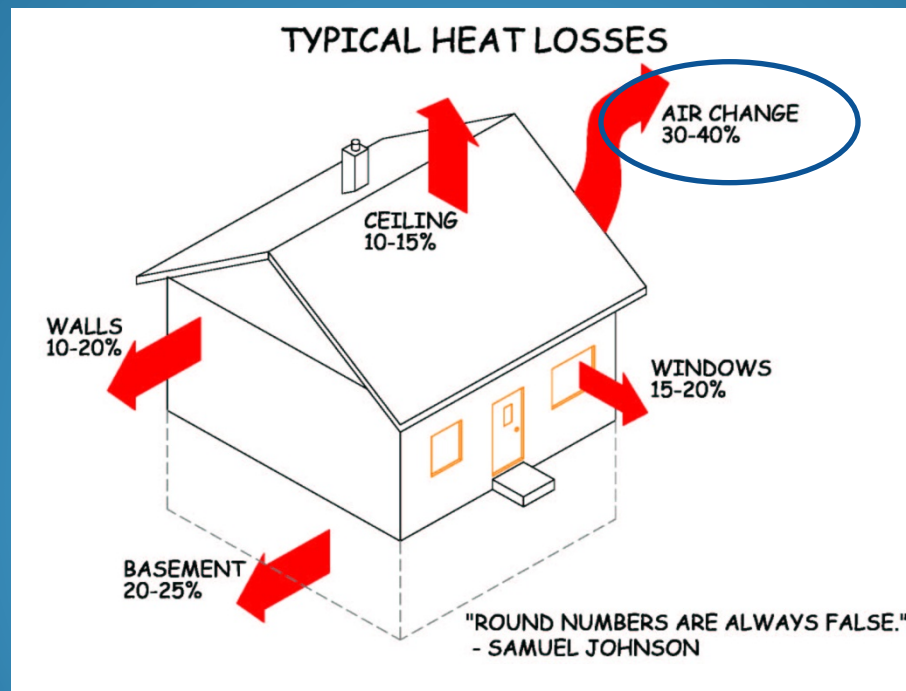
# Impact Of Various Residential Energy Conservation Measures On Airtightness

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Julia Purdy, P. Eng., NRCan

Alex Ferguson, P. Eng.; NRCan



Between 1980 and 2015, NRCan and Its Partners Measured the Airtightness of Approx. **1 Million** Houses ( $\approx 15\%$  of the Total Canadian House Population), And Did Post-Retrofit Testing on About **780,000** Of These.



# What Was Done:

- Airtightness tests were performed in accordance with CGSB 149.10 “Determination of the Airtightness of Building Envelopes Using the Fan Depressurization Technique”.
- 950,000 pre-retrofit tests  
780,000 post-retrofit tests
- Results for the retrofitted houses were then filtered down to houses which received only 1 (one) retrofit measure.
- These were then analyzed.

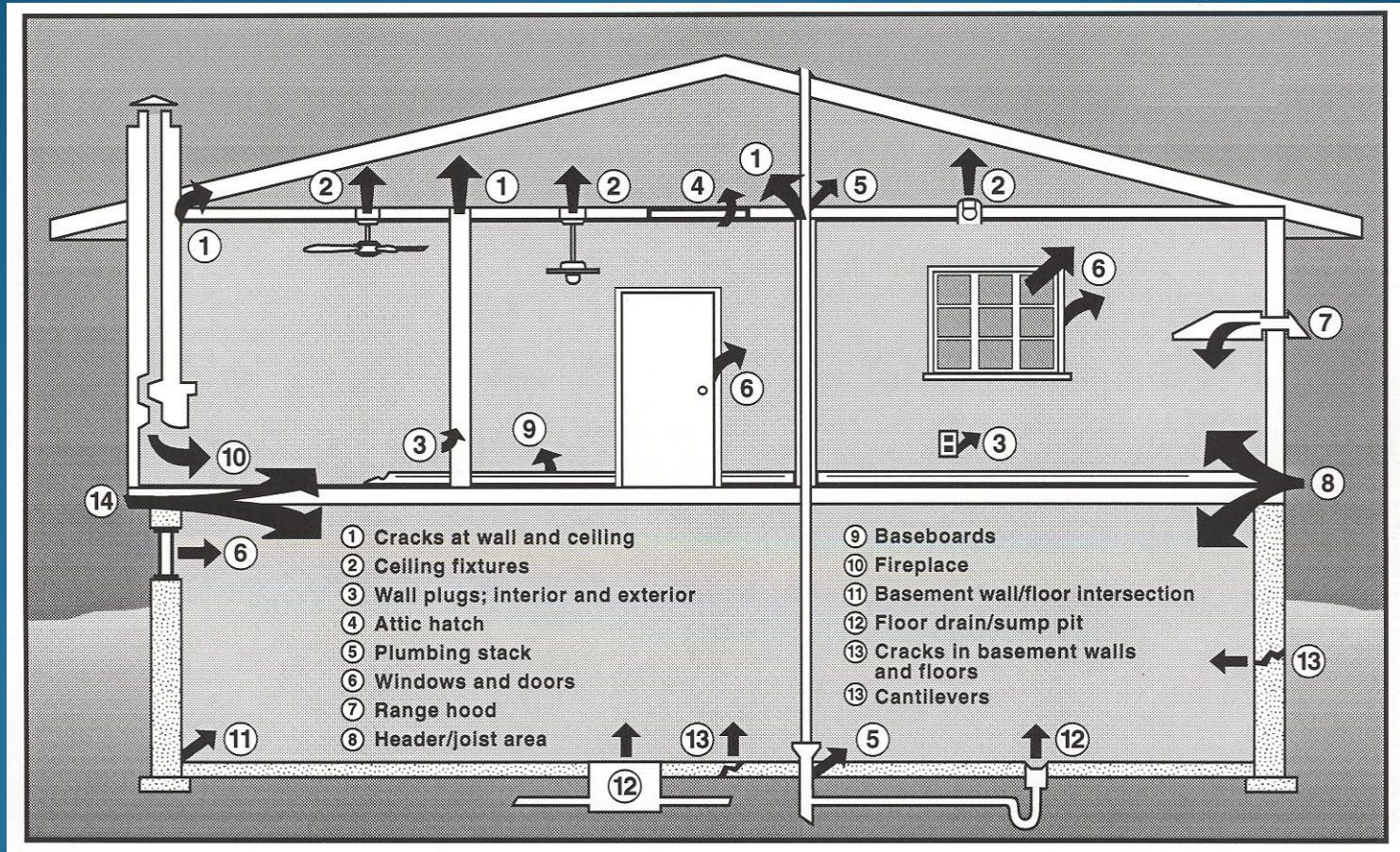
# Types of Retrofit

1. Air leakage sealing (without \$\$\$ incentives)
2. Air leakage sealing (with \$\$\$ incentives)
3. Attics
4. Exterior Walls
5. Foundations
6. Windows and doors
7. HVAC systems

**So, What Did We Learn About the  
Reduction In Air Leakage Due To  
These Individual Retrofits??**



# Where Does Air Leakage Occur In A House?

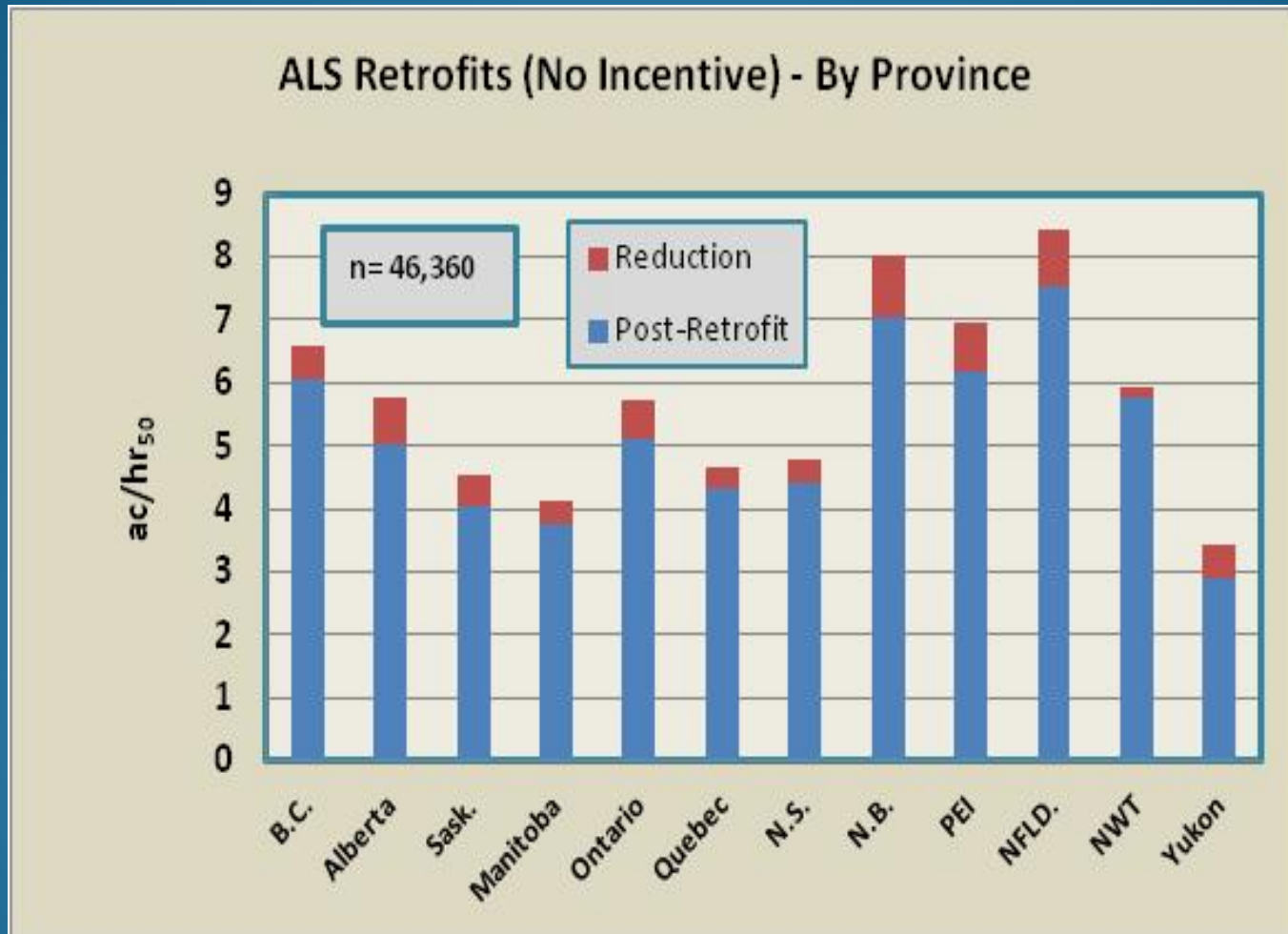


*At Joints, Intersections and Penetrations*



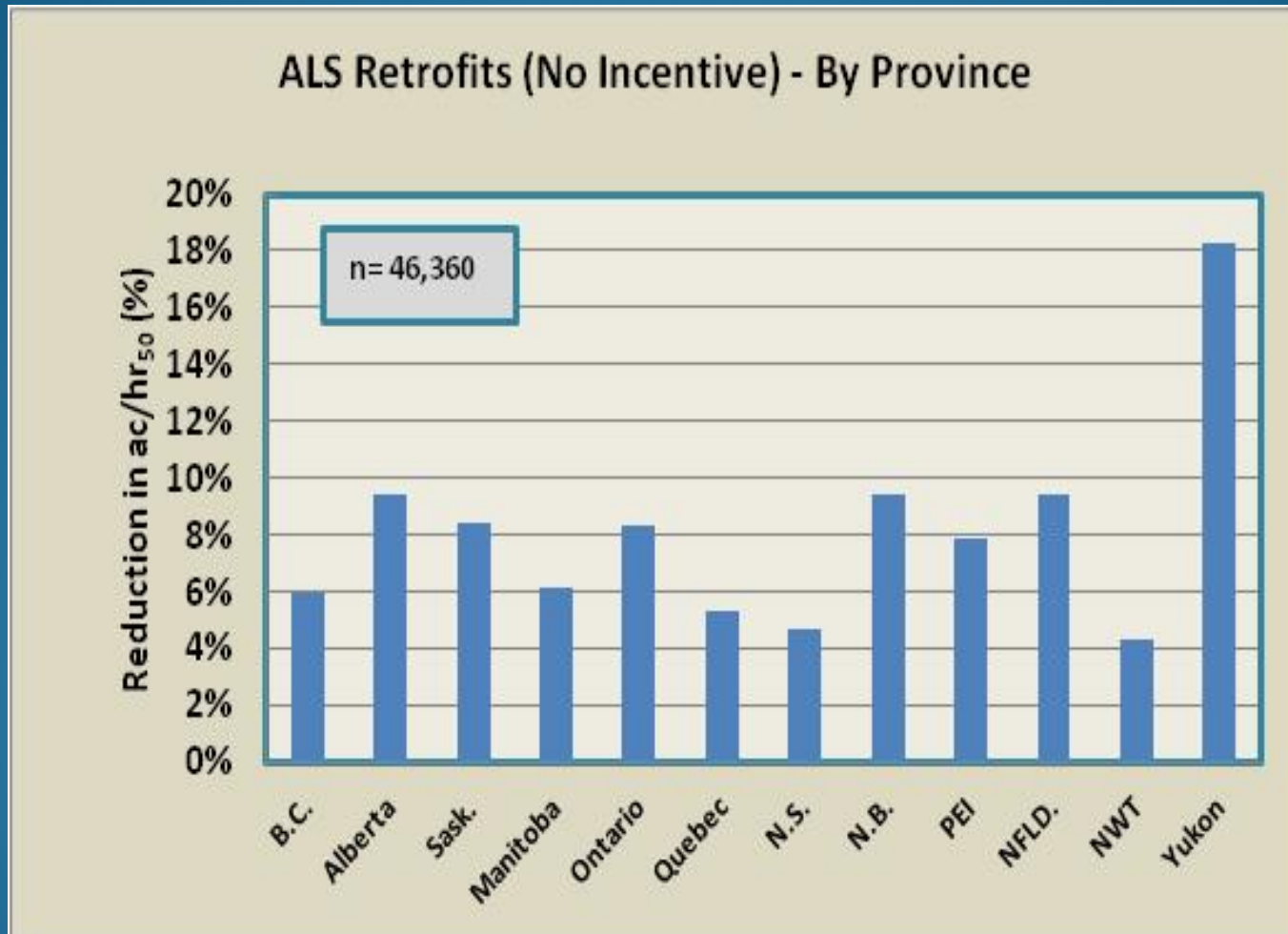
# 1. Air Leakage Sealing (w/o Incentives)

Sample Size = 46,360 Houses



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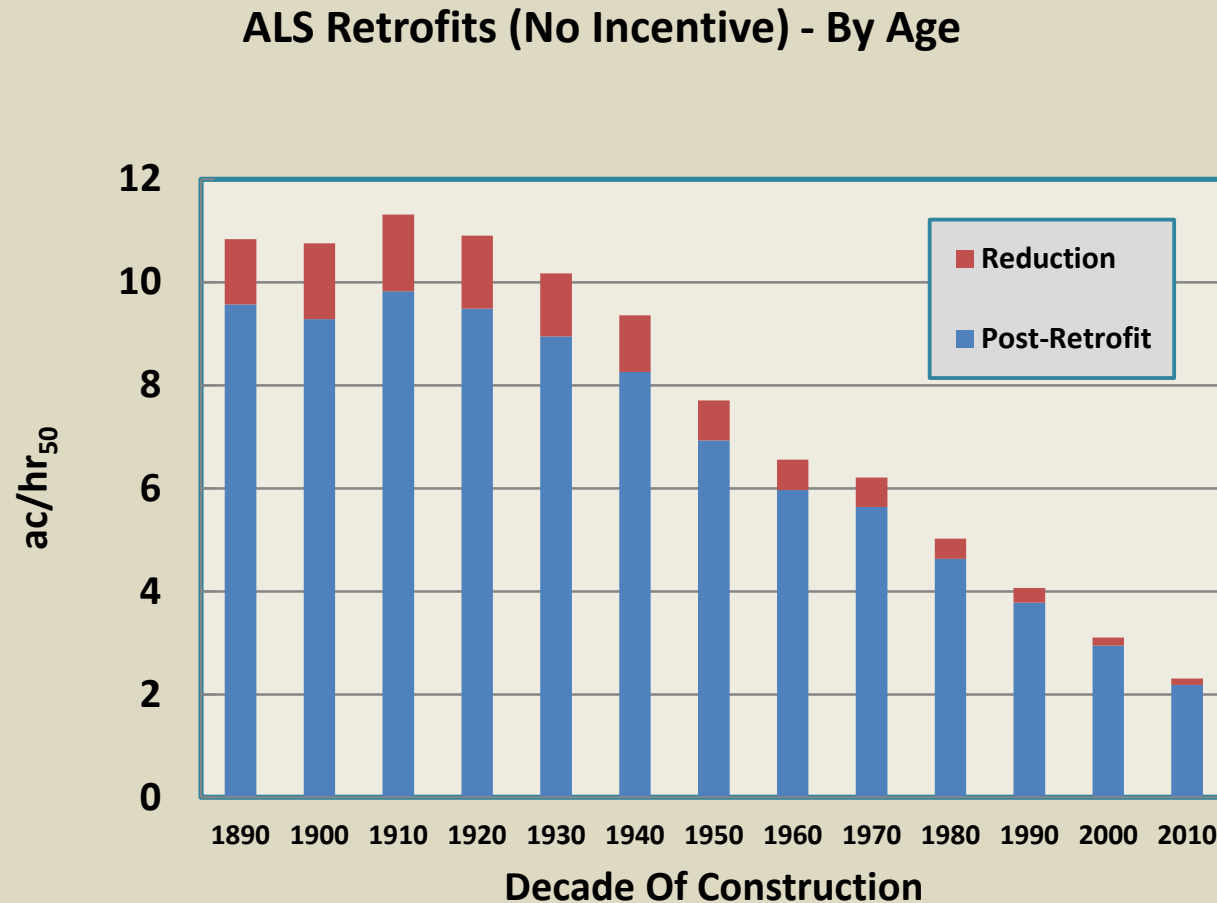
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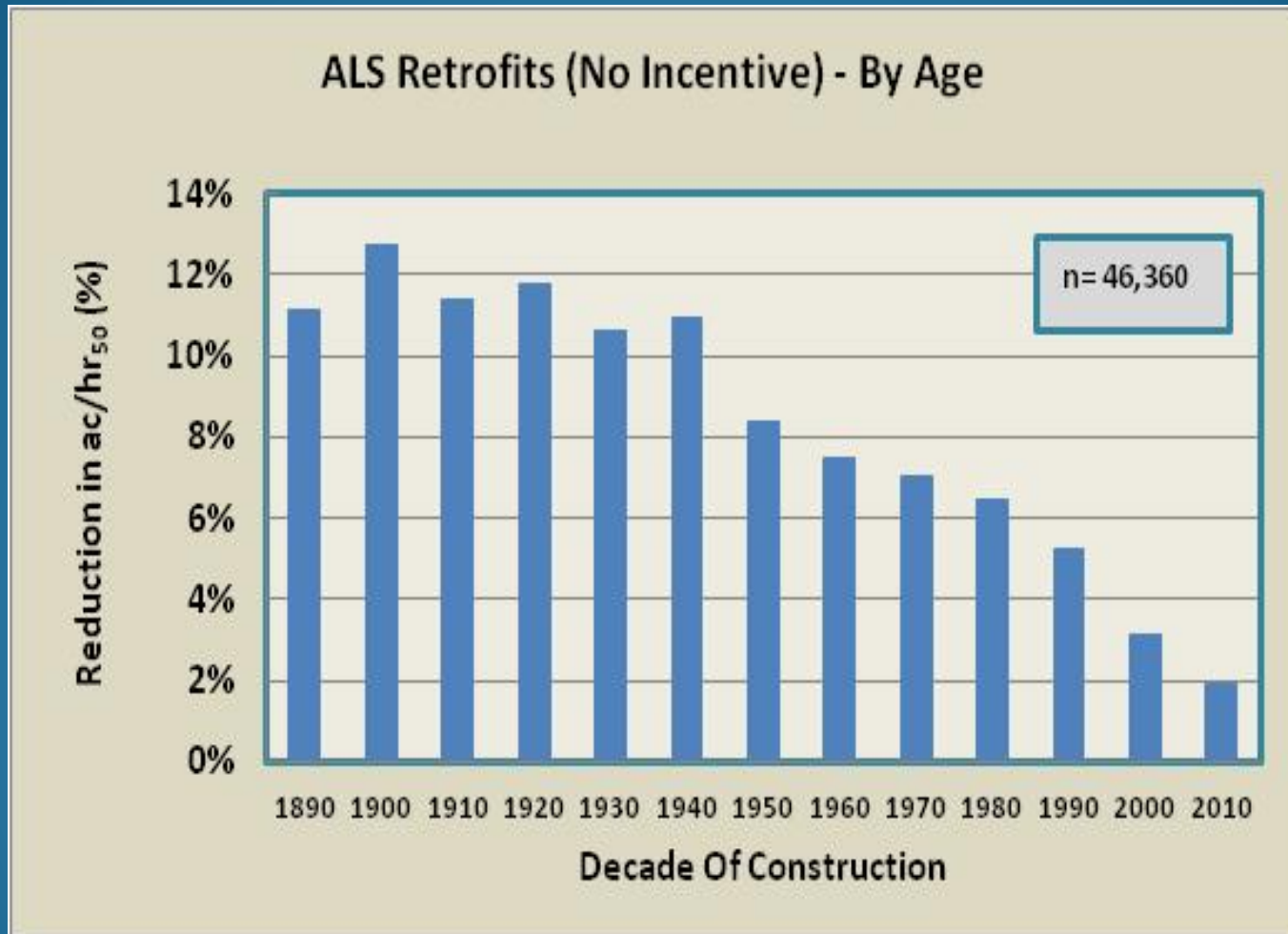
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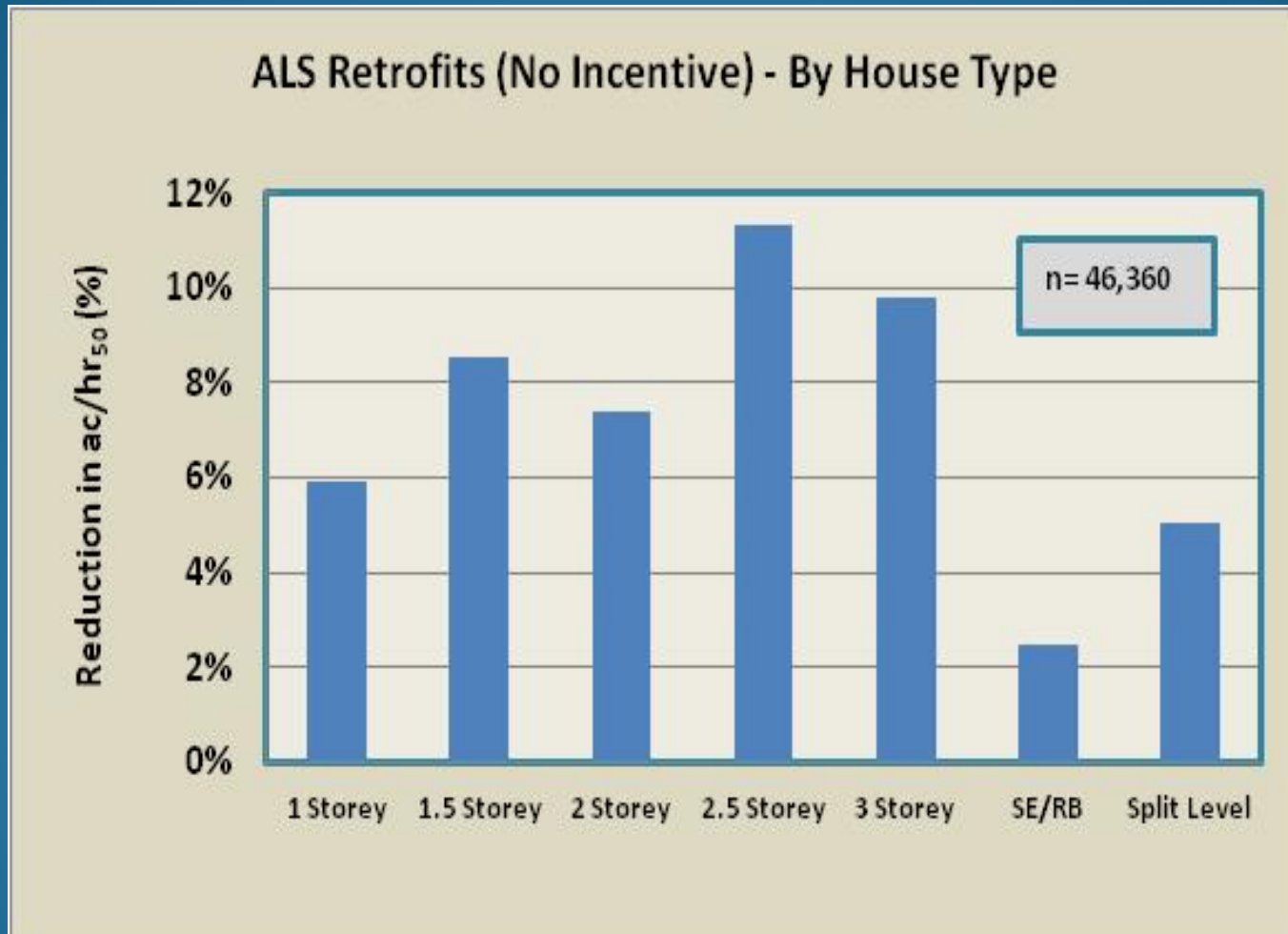
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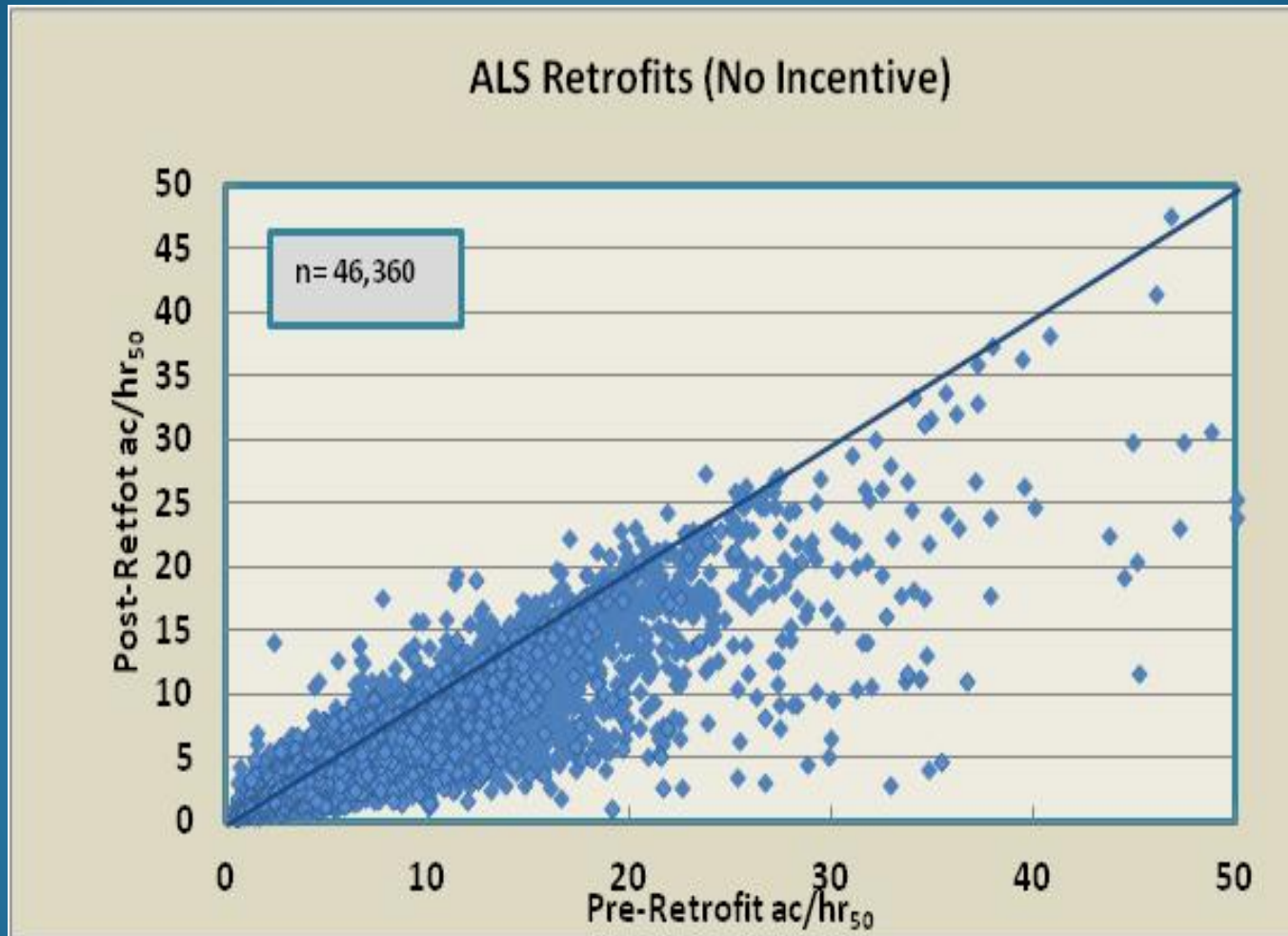
Sample Size = 46,360 Houses





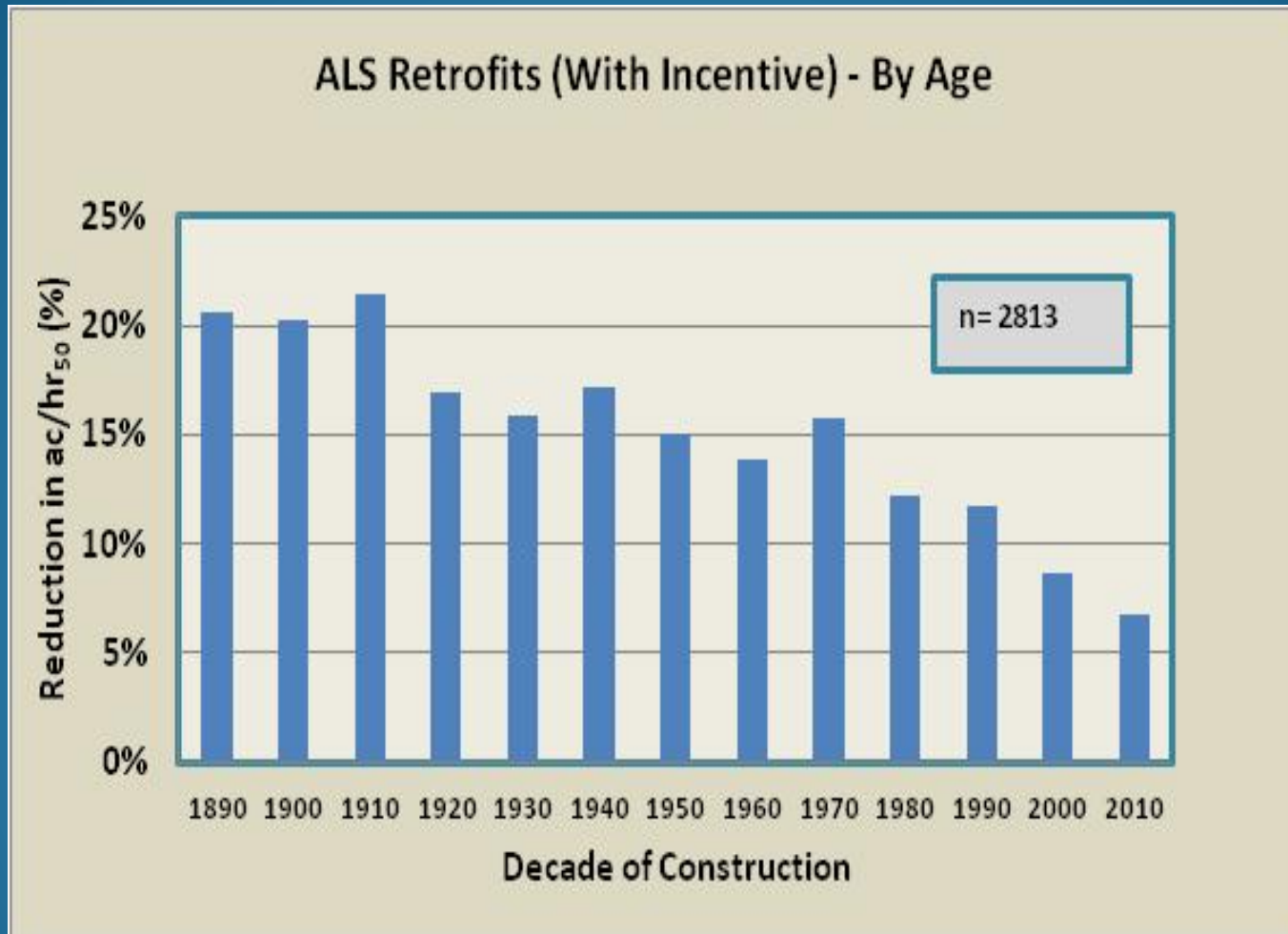
# 1. Air Leakage Sealing (w/o Incentives)

**Average Reduction: 7%**



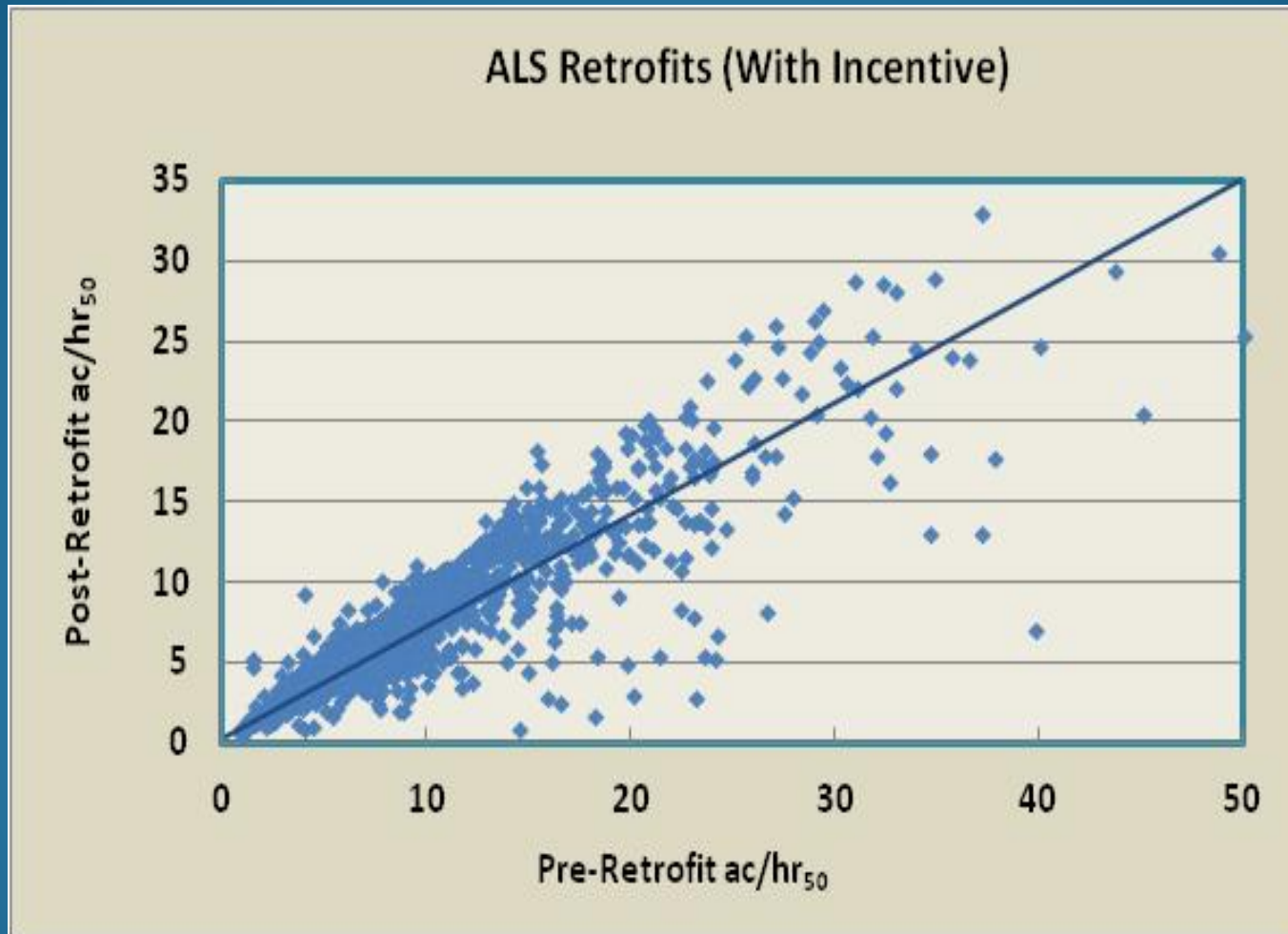
## 2. Air Leakage Sealing (With Incentives)

Sample Size = 2,813 Houses



## 2. Air Leakage Sealing (With Incentives)

**Average Reduction: 14%**





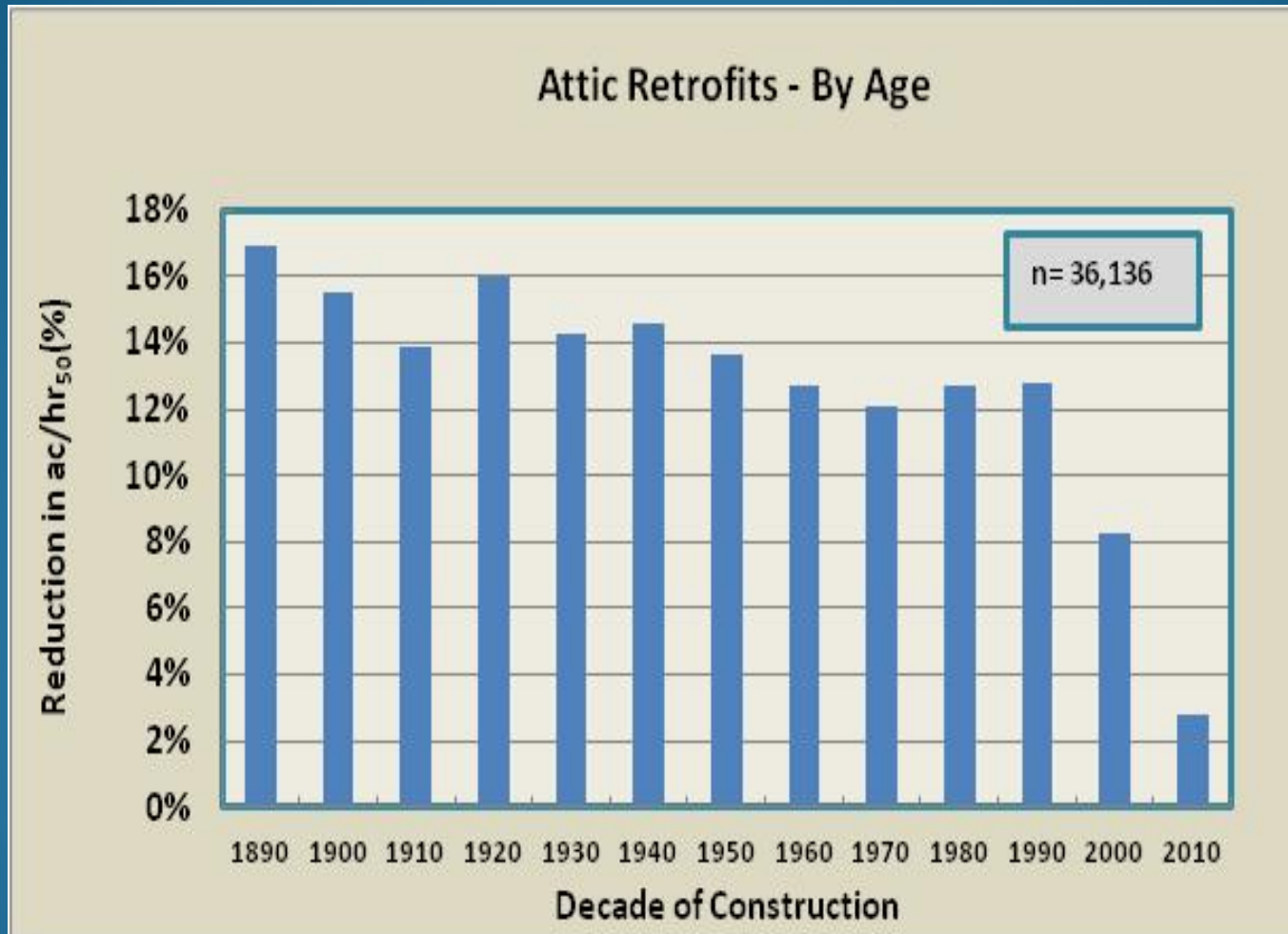
### 3. Attic Retrofits

Sample Size = 36,138 Houses



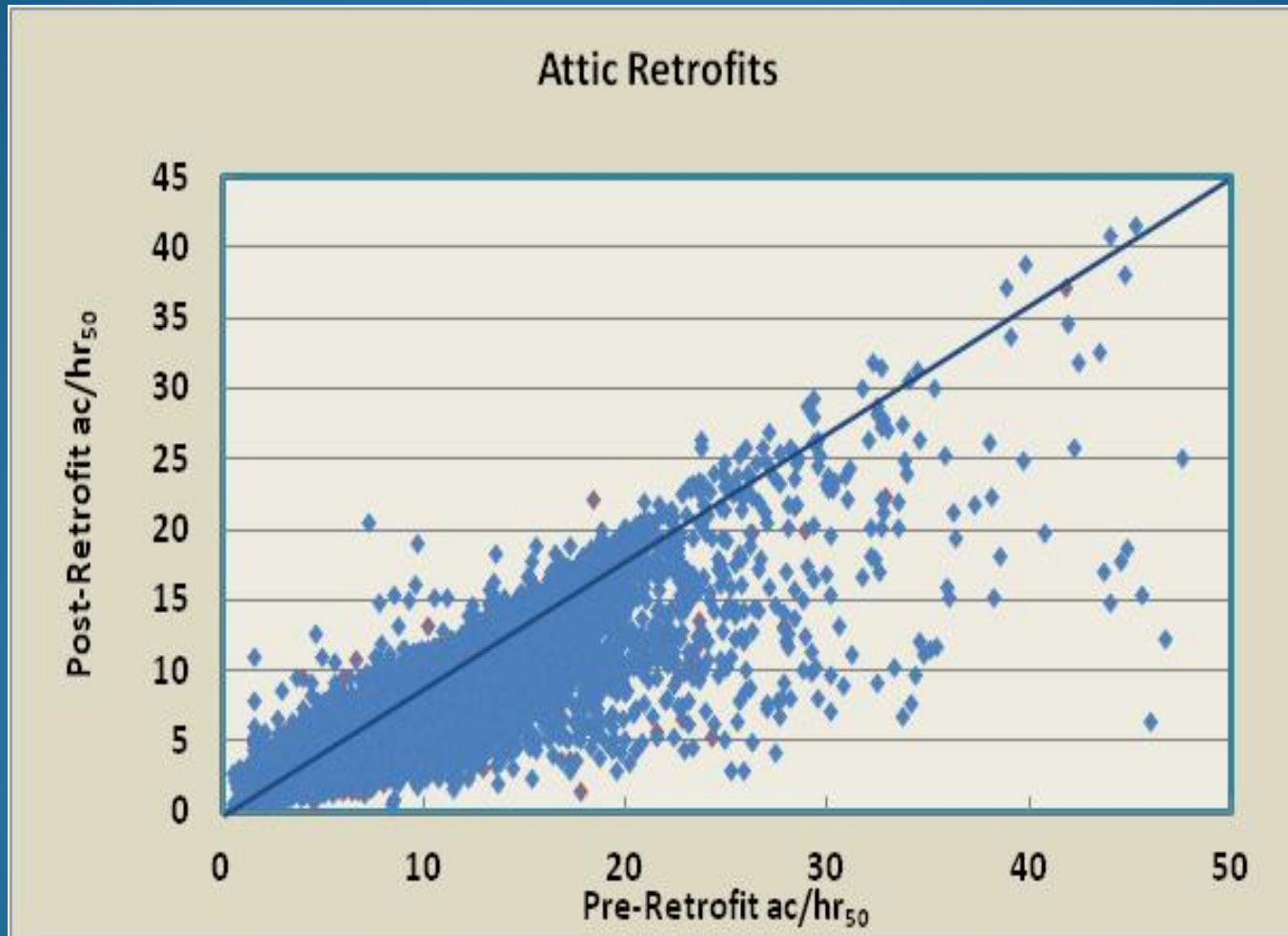
### 3. Attic Retrofits

Sample Size = 36,138 Houses



### 3. Attic Retrofits

**Average Reduction: 13%**





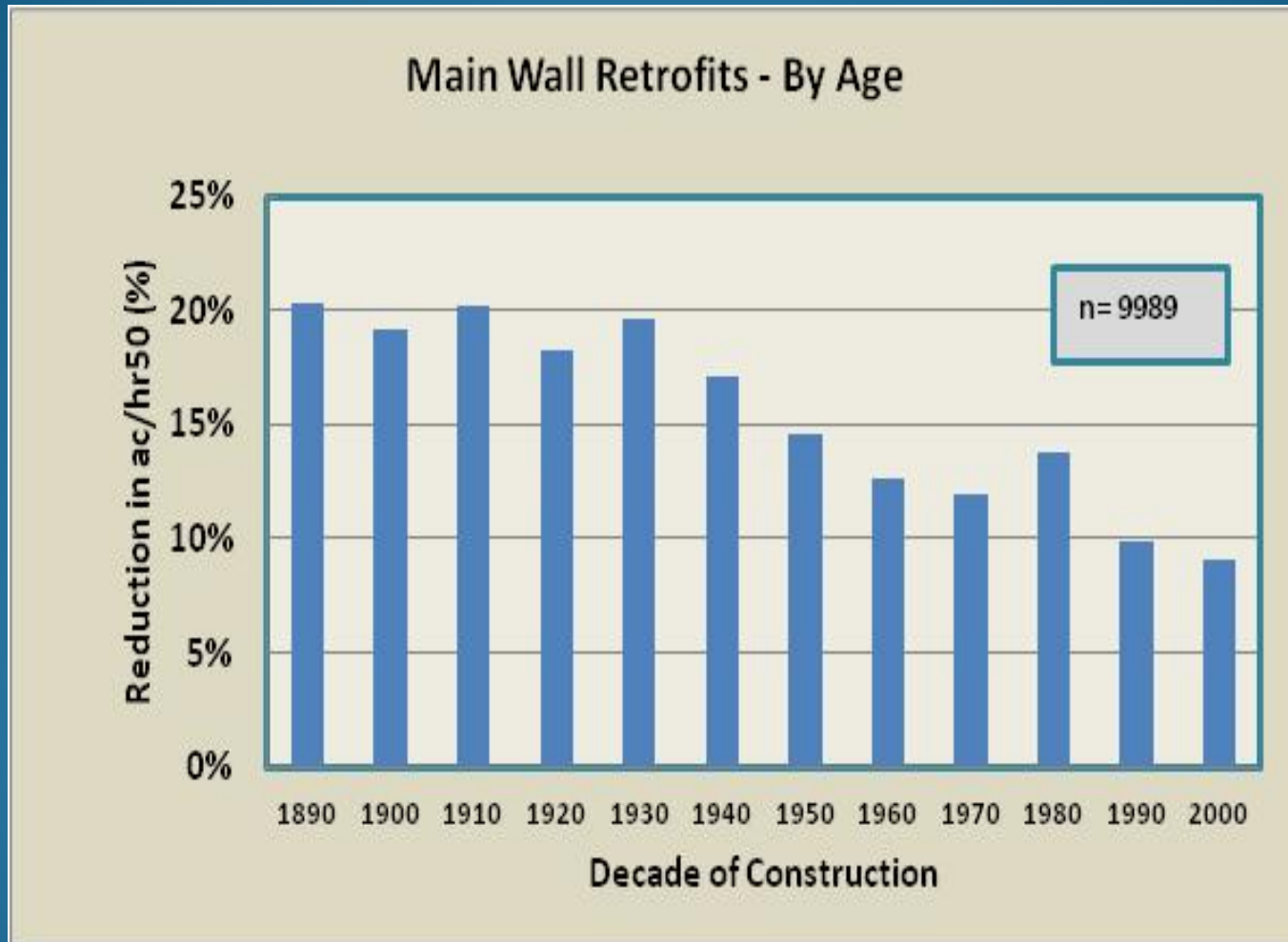
## 4. Exterior Wall Retrofits

Sample Size = 9,989 Houses



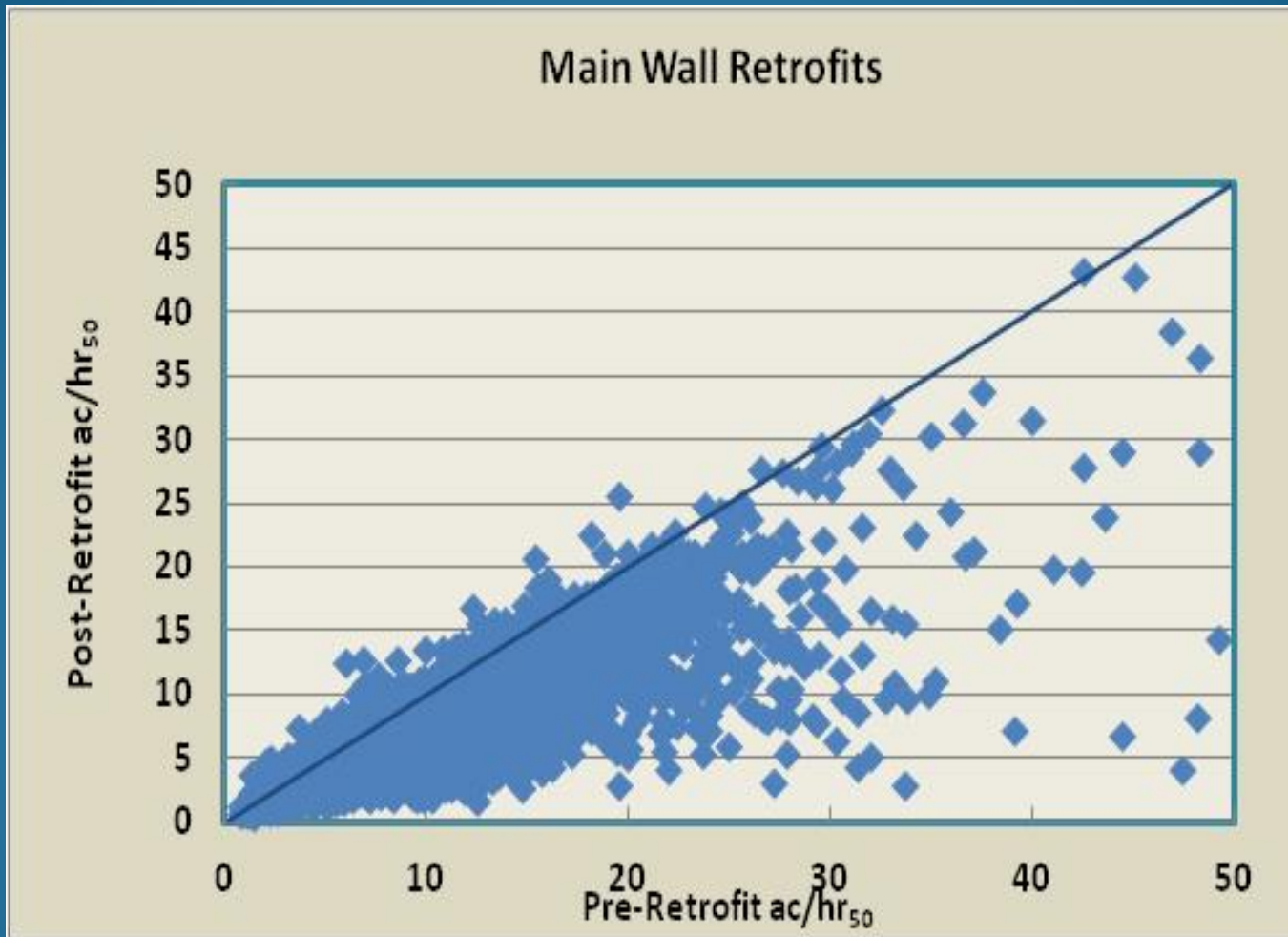
## 4. Exterior Wall Retrofits

Sample Size = 9,989 Houses



## 4. Exterior Wall Retrofits

**Average Reduction = 15%**





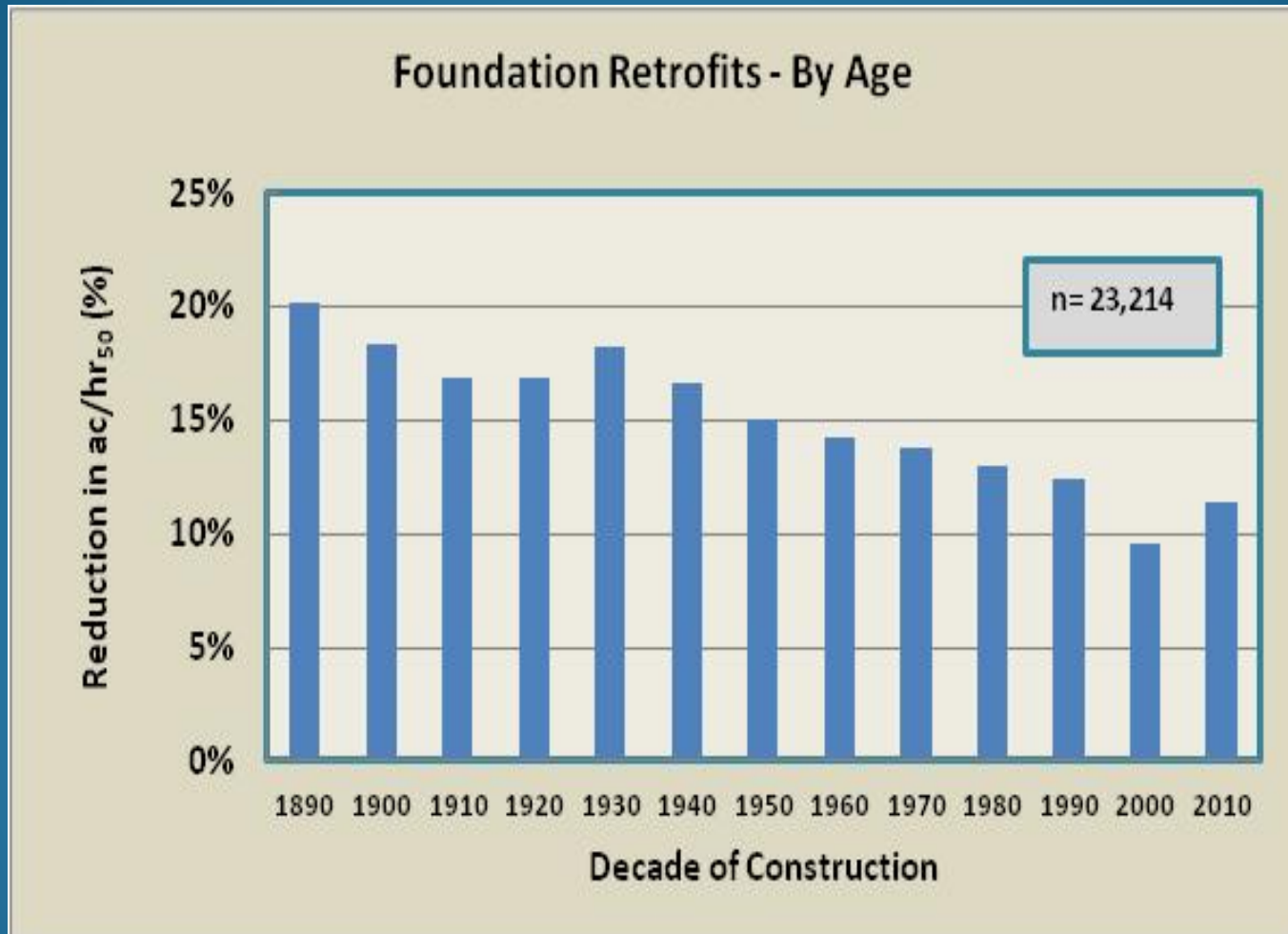
## 5. Foundation Retrofits

Sample Size = 23,214 Houses



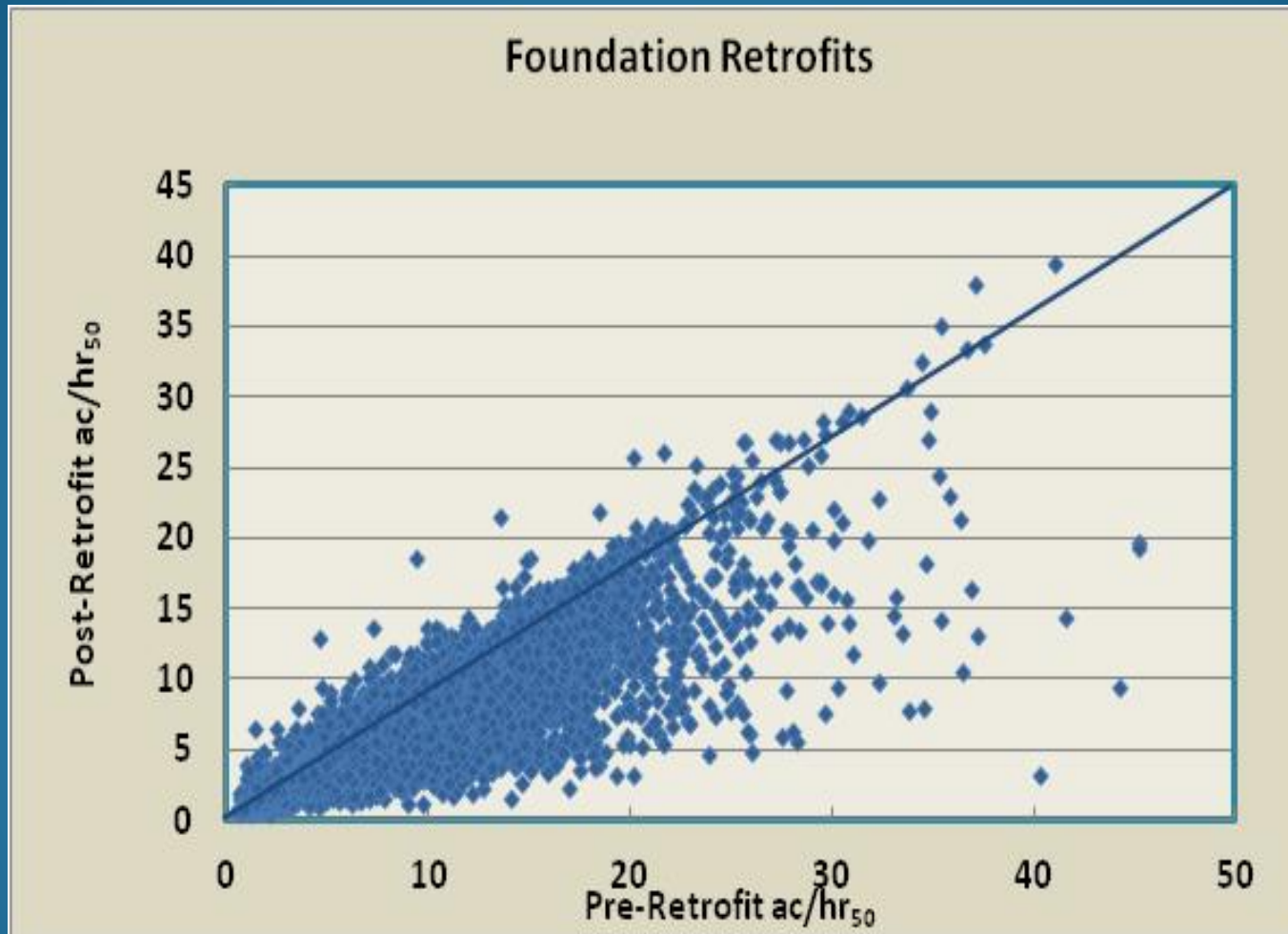
## 5. Foundation Retrofits

Sample Size = 23,214 Houses



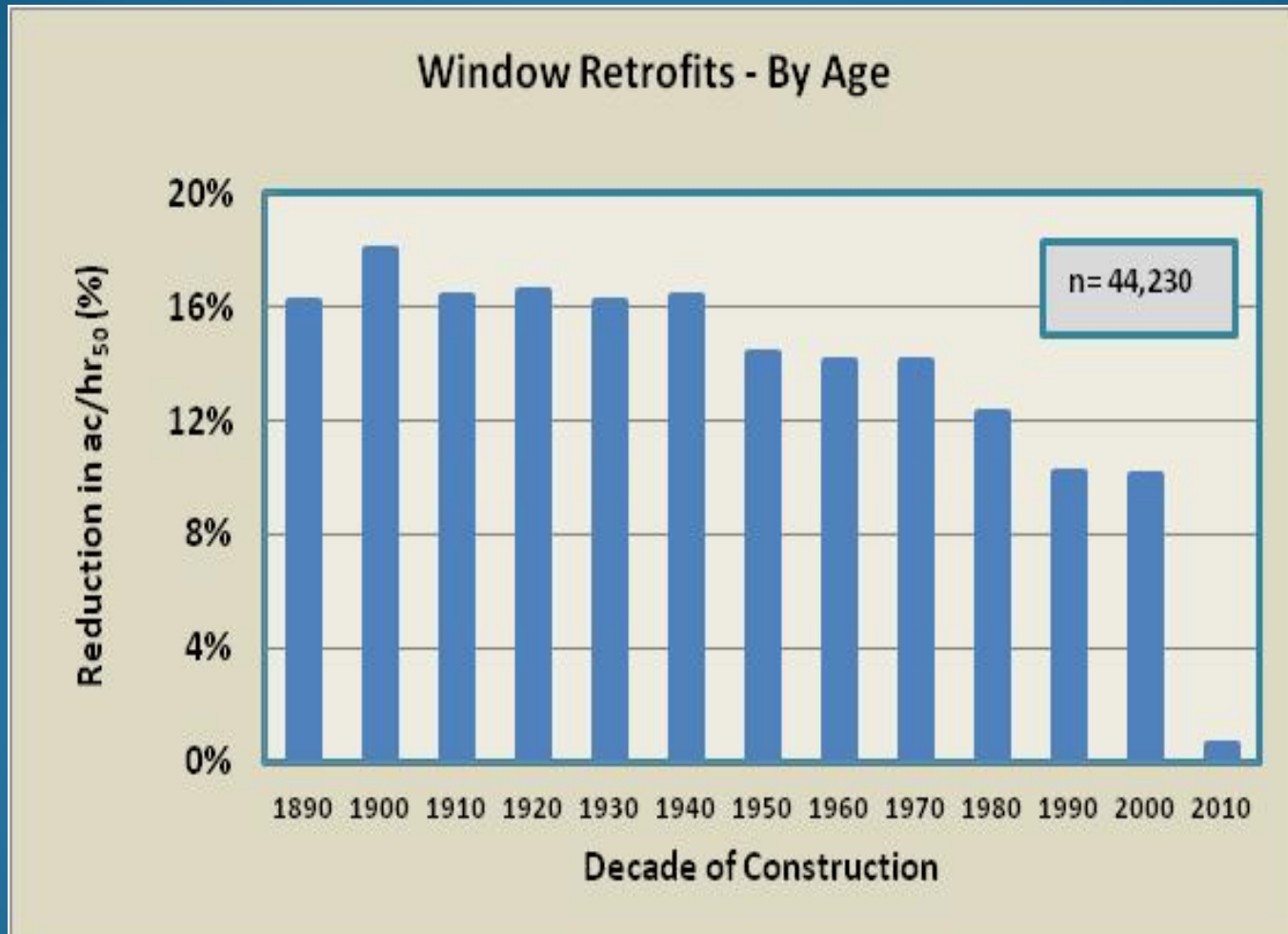
## 5. Foundation Retrofits

**Average Reduction = 14%**



## 6. Window Retrofits

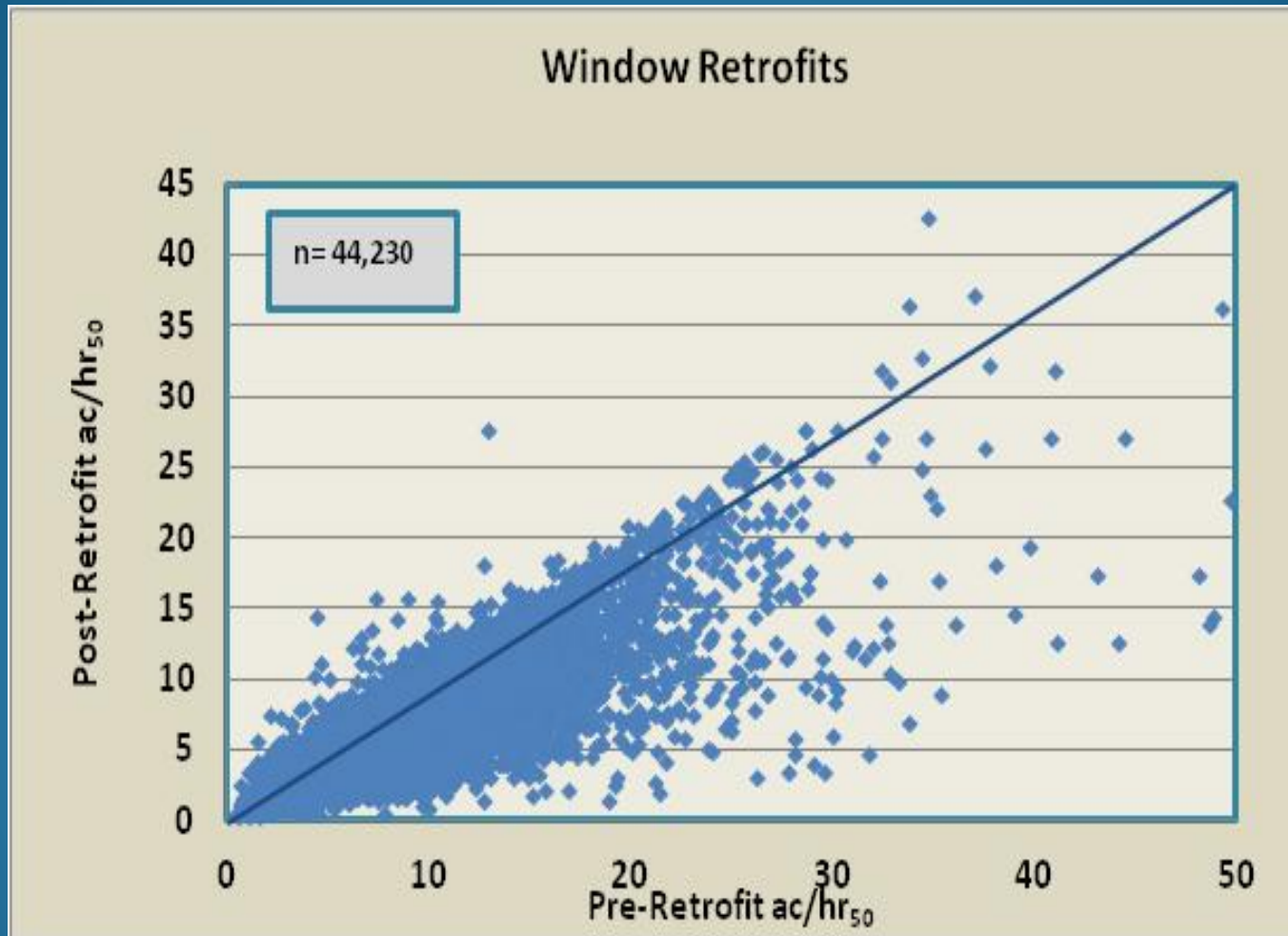
Sample Size = 44,230 Houses





## 6. Foundation Retrofits

**Average Reduction = 13%**



## 7. HVAC Retrofits

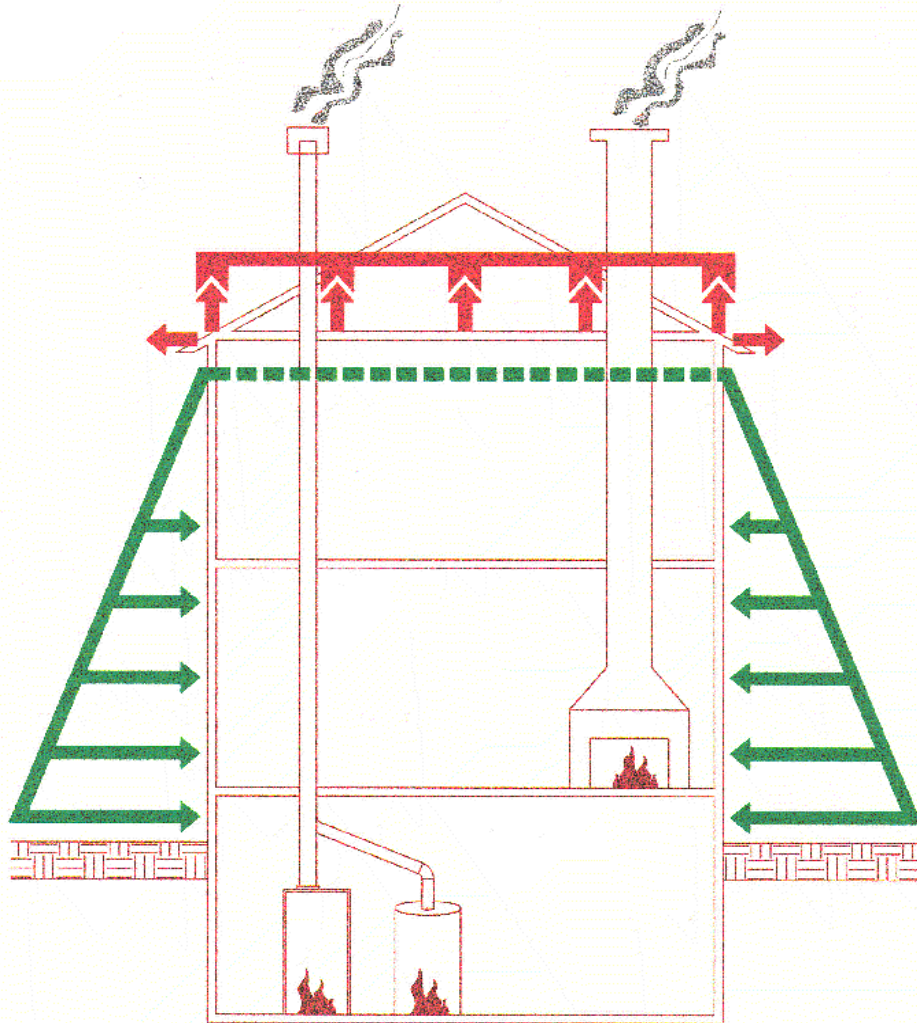
Sample Size = 19,431 Houses



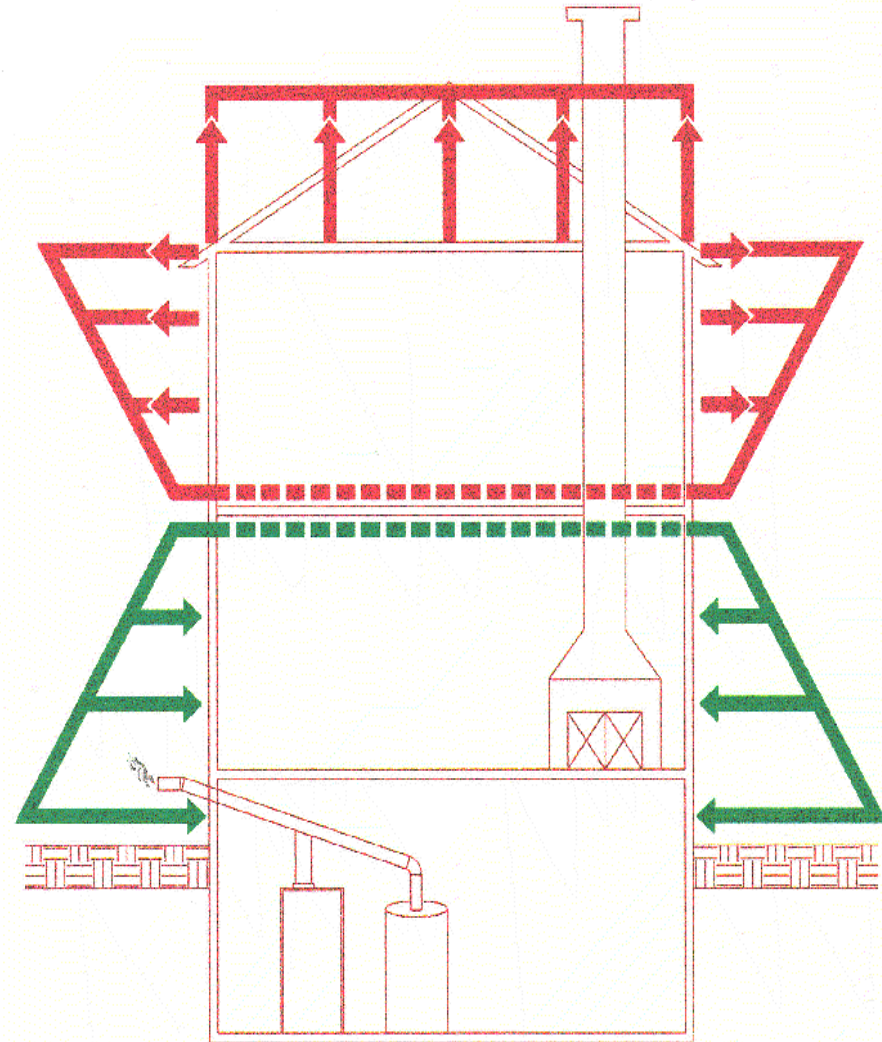


# Mechanical System Retrofits

With Naturally Aspirated  
Appliances

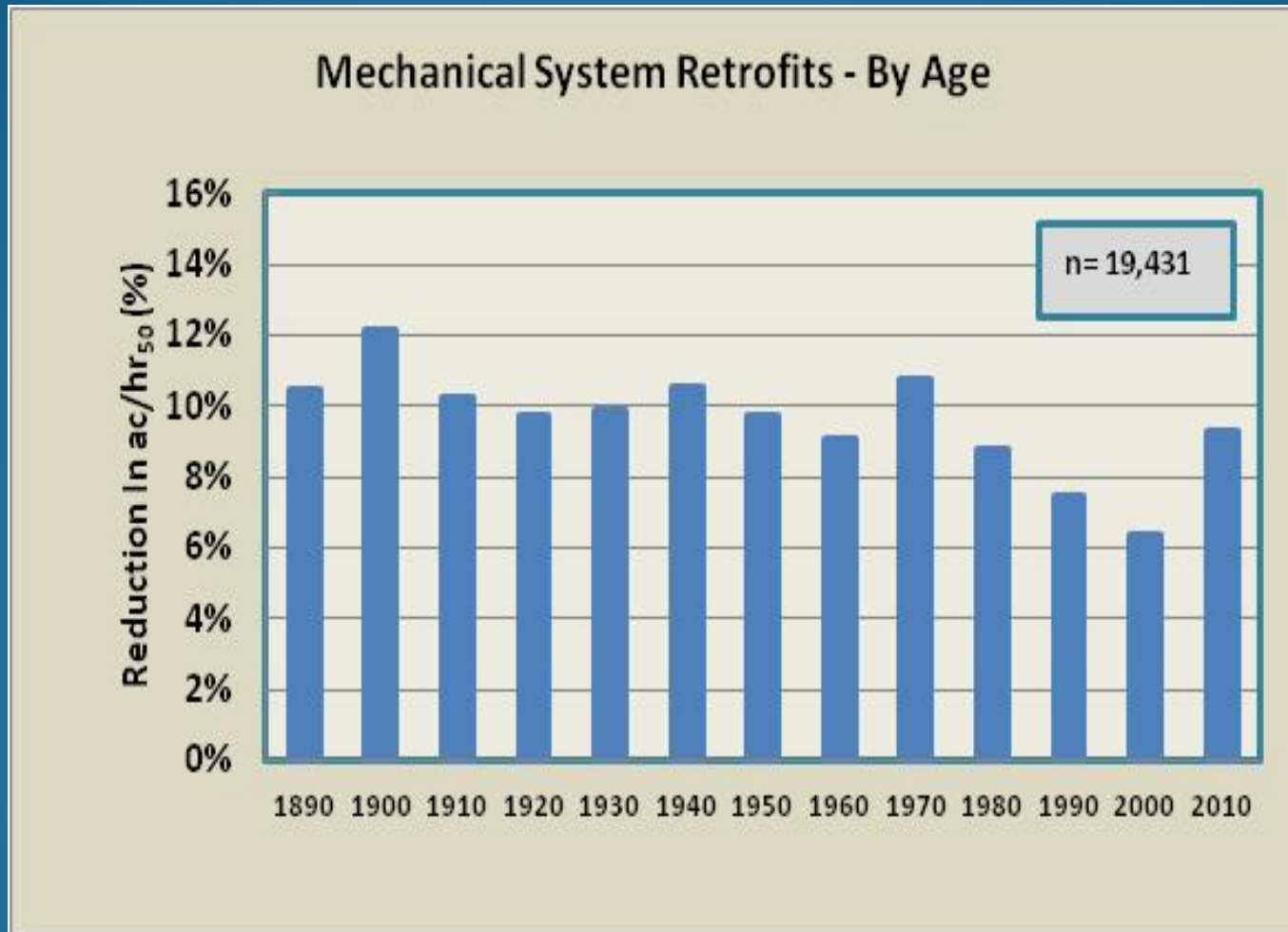


With No Naturally Aspirated  
Appliances



## 7. HVAC Retrofits

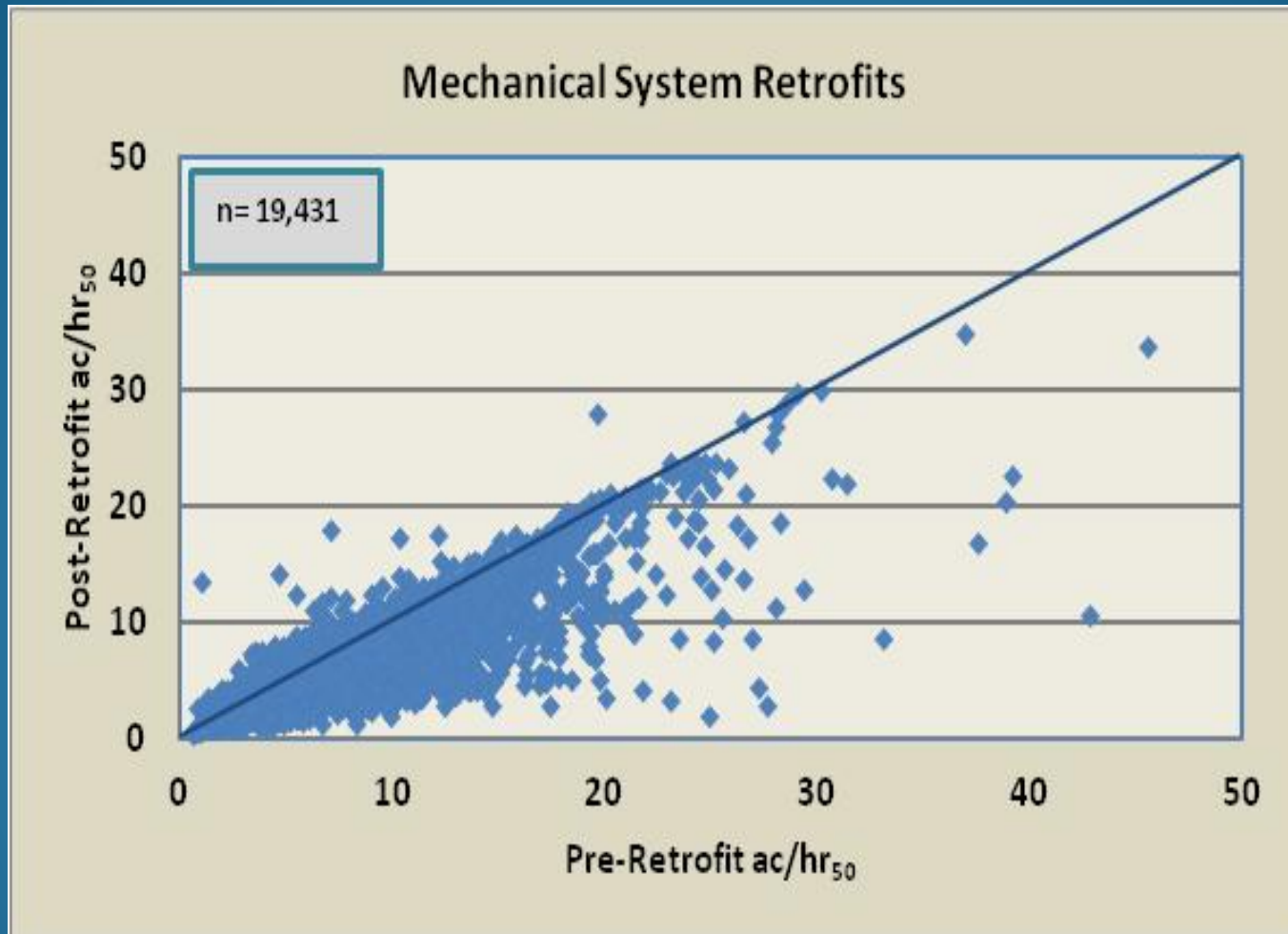
Sample Size = 19,431 Houses



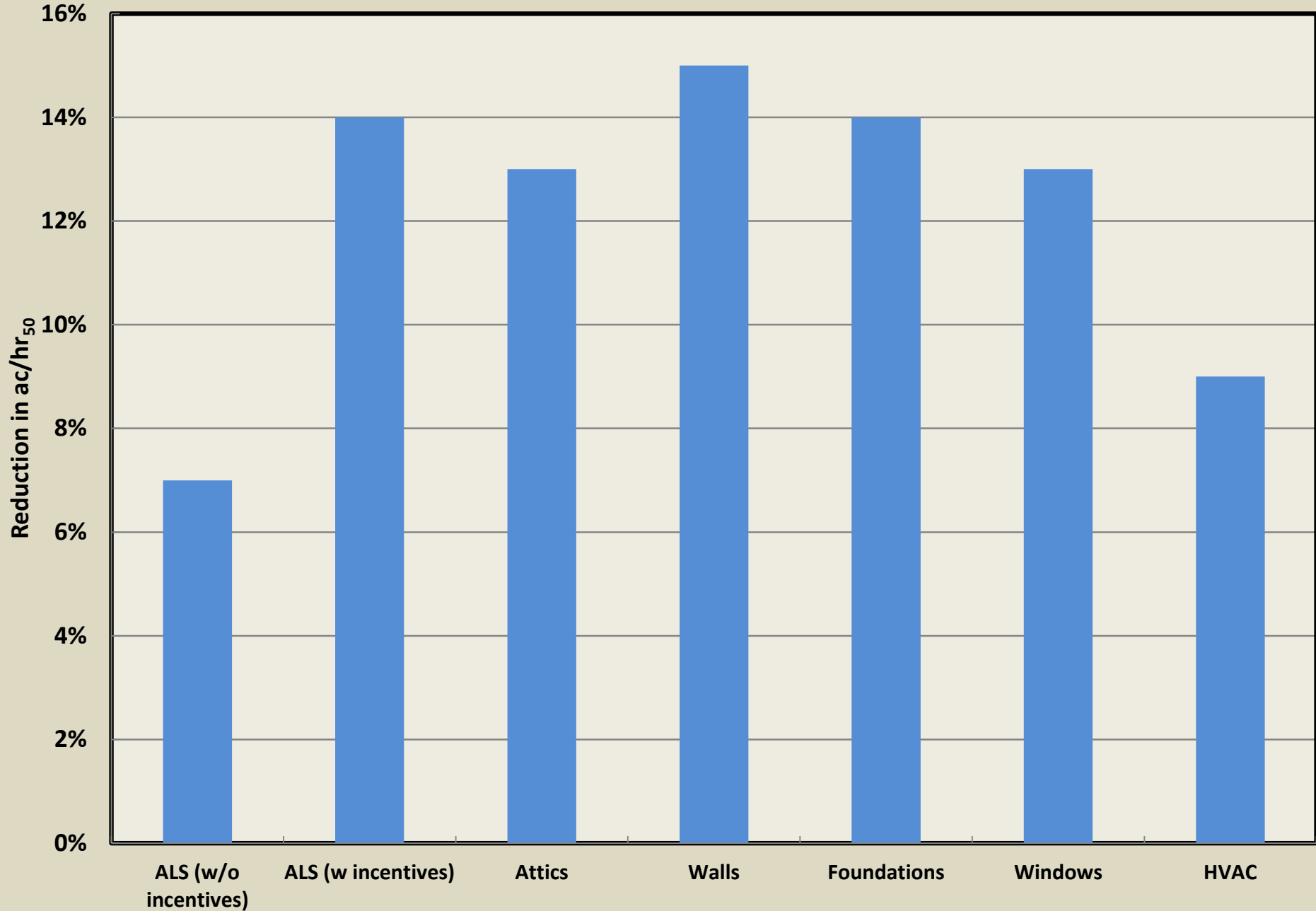


## 7. HVAC System Retrofits

**Average Reduction = 9%**



# Summary of Airtightness Results



## Typical Retrofit Costs (From Various Contractor Sources)

Supplemental Attic Air Leakage Sealing (ALS) : \$300 to \$400

Attic Insulation Removal & Supplemental ALS: \$3,000 to \$4,000

Foundation Air Leakage Sealing: \$800 to \$1,000

Whole House Air Leakage Sealing: \$1,000 to \$1,500

Exterior Wall Insulation/ALS (blowing in dense-pack cellulose:  
\$30/m<sup>2</sup> (\$3/ft<sup>2</sup>)

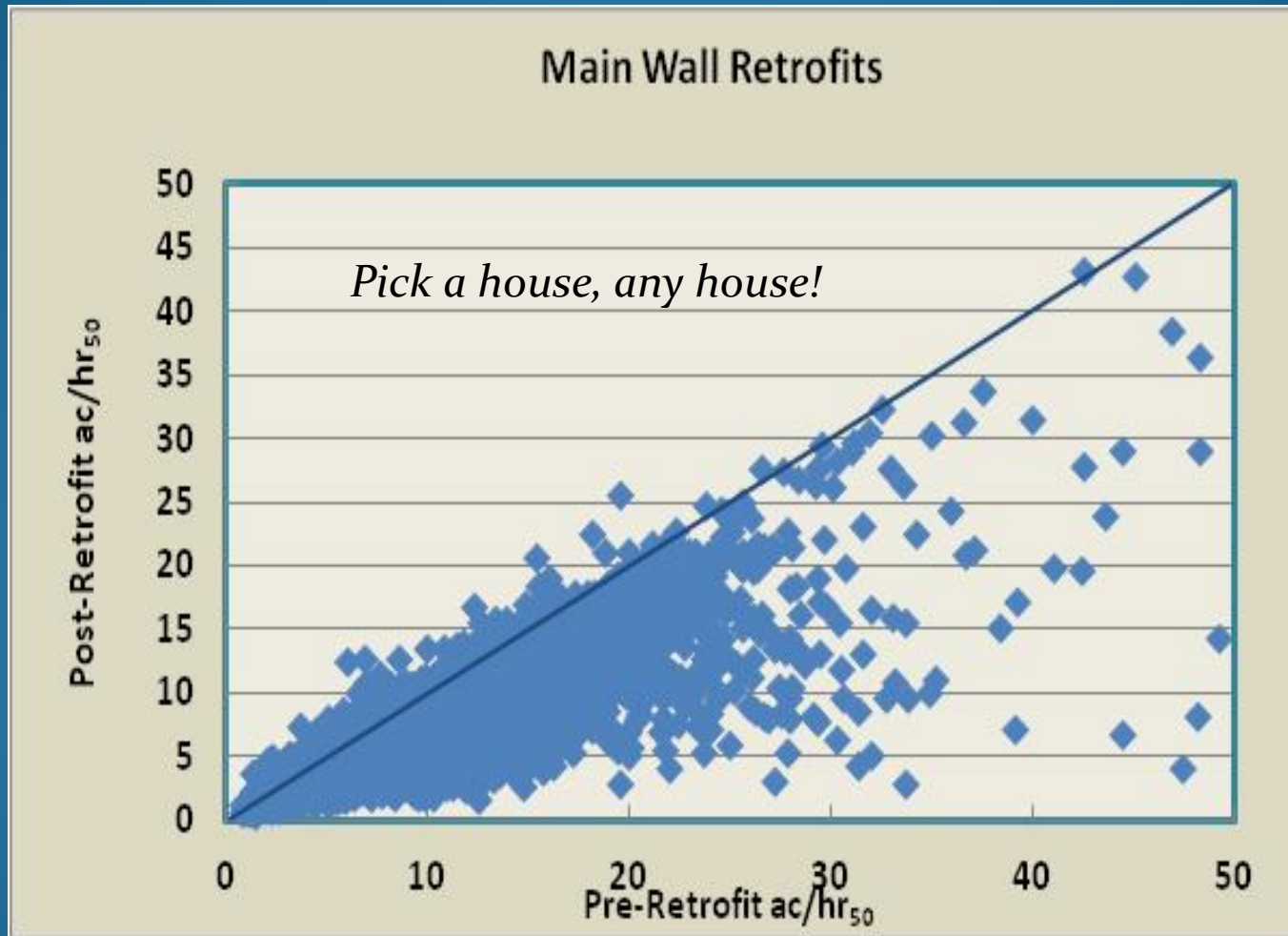
# So, What Did We Learn From All This?

1. All of the retrofits reduced air leakage (by 7% to 15%, on average), depending on the retrofit measure.
2. For all measures, other than ALS (w/o incentives) and HVAC systems), average reductions were consistently in the range of 13% to 15%.
3. Reductions depended on:
  - Age
  - Type of House
  - Location



# So, What Did We Learn From All This?

4. Results for individual houses varied wildly.



# So, What Did We Learn From All This?

5. Secondary benefits of retrofits which reduce air leakage may outweigh the energy savings.



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*And Many Thanks To NRCan for Supporting This Work!*

