DOE Low-Rise Multifamily Energy Code Field Studies

Unboxing Compliance: What We've Learned from Three Years of Field Study Data

May 30, 2019

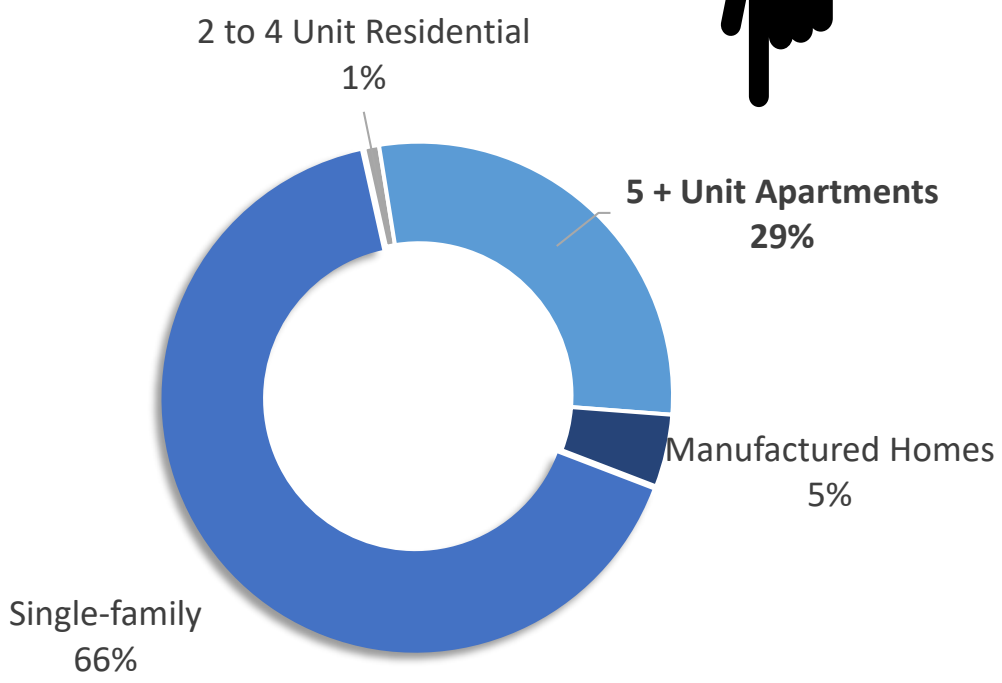
Low-Rise MF Project Team

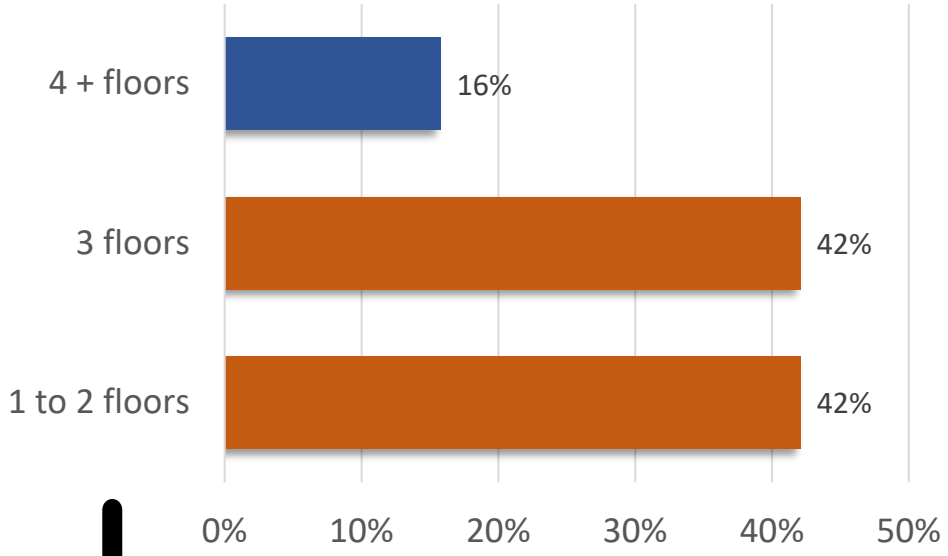
Collective LRMF Field Study Goals

- Estimate regulated energy use in typical low-rise multifamily buildings
- Identify opportunities for energy and cost savings through increased compliance with energy code
- Improve understanding of baseline characteristics of this under-represented building type

Why Low-Rise Multifamily?

Almost 30% of new residential units are in MF buildings





Nearly 85% of new MF buildings are low-rise

Target Population

Includes

- New construction

~3 years

- 1-3 stories, 5+ units
- Mixed occupancy buildings

Excludes

- Single-family
- Townhouses/rowhouses
- Duplexes, triplexes, fourplexes
- Dorms, assisted living, nursing homes, hotels, etc.

Building Types

Garden Style

- Exterior corridors
- Exterior unit entry

Common Entry

- Interior corridors
- Interior unit entry

Baseline and Energy Study Objectives

- Adapt single-family field study protocol to low-rise multifamily
- Collect baseline and energy characteristics
- Model energy efficiency performance

Baseline and Energy Study Activities

Study Design

Logic model, task mapping and literature review

Data Collection Protocol and Tool

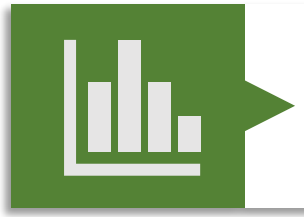
Develop LRMF protocol and data collection tool

Data Collection

Plan review, field visit, and data collection completion

Dataset and Analysis

Baseline characteristics dataset and energy performance modeling



Reporting

LRMF baseline and energy study methodology, baseline dataset

Sample Design

Target Population

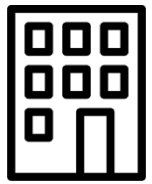
- Source: Dodge Data and Analytics
- Total new LRMF projects over three-year time frame: 2014-2016

25 buildings per state

~3 units per building

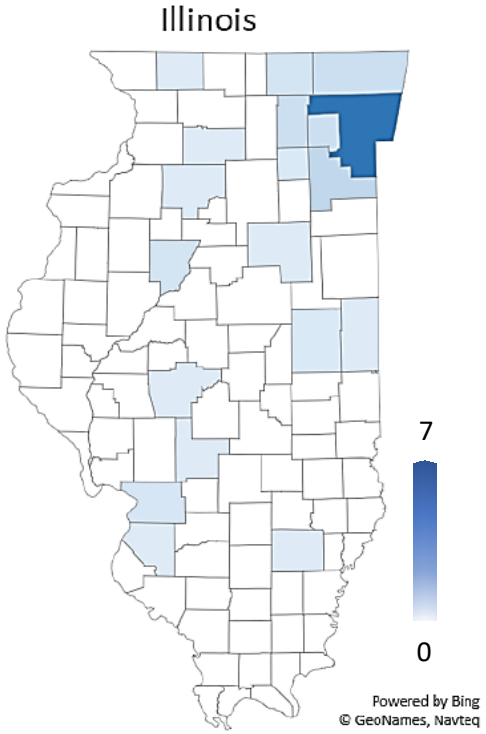
Sample Frame

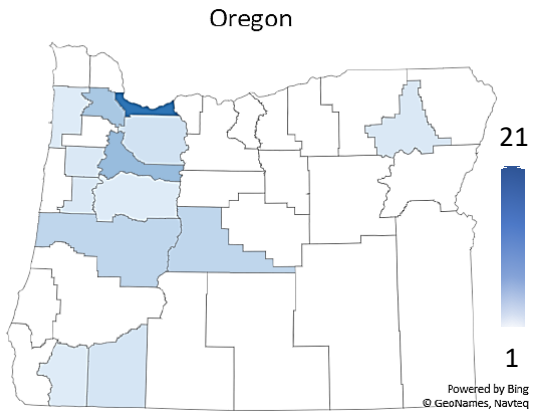
- Obtain building lists from jurisdictions
- Develop randomized recruiting lists

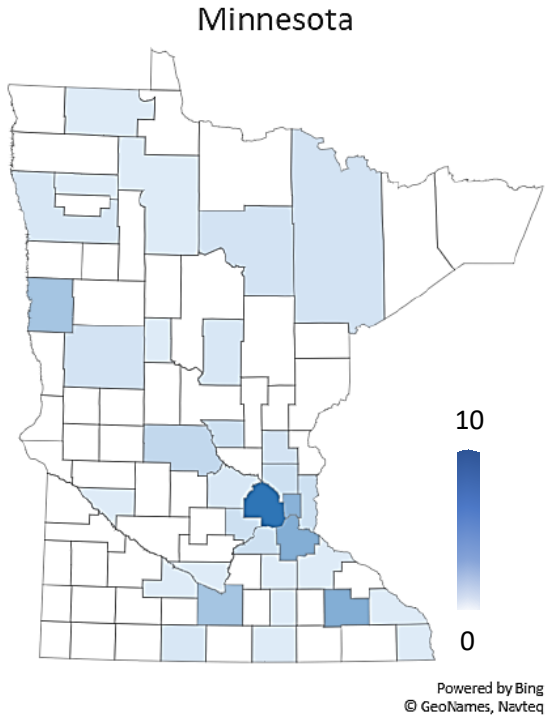


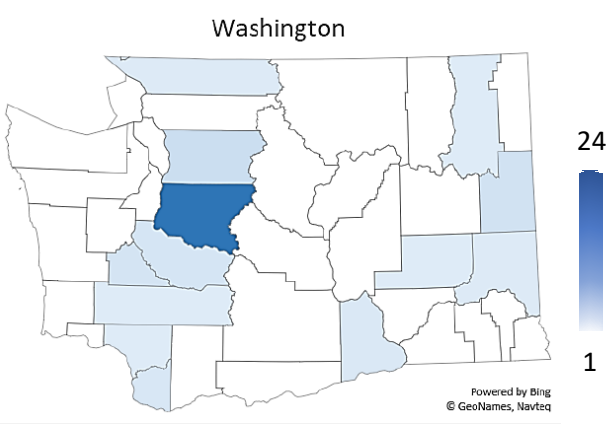
Sampling Unit

- Primary: Building
- Secondary: Dwelling Unit



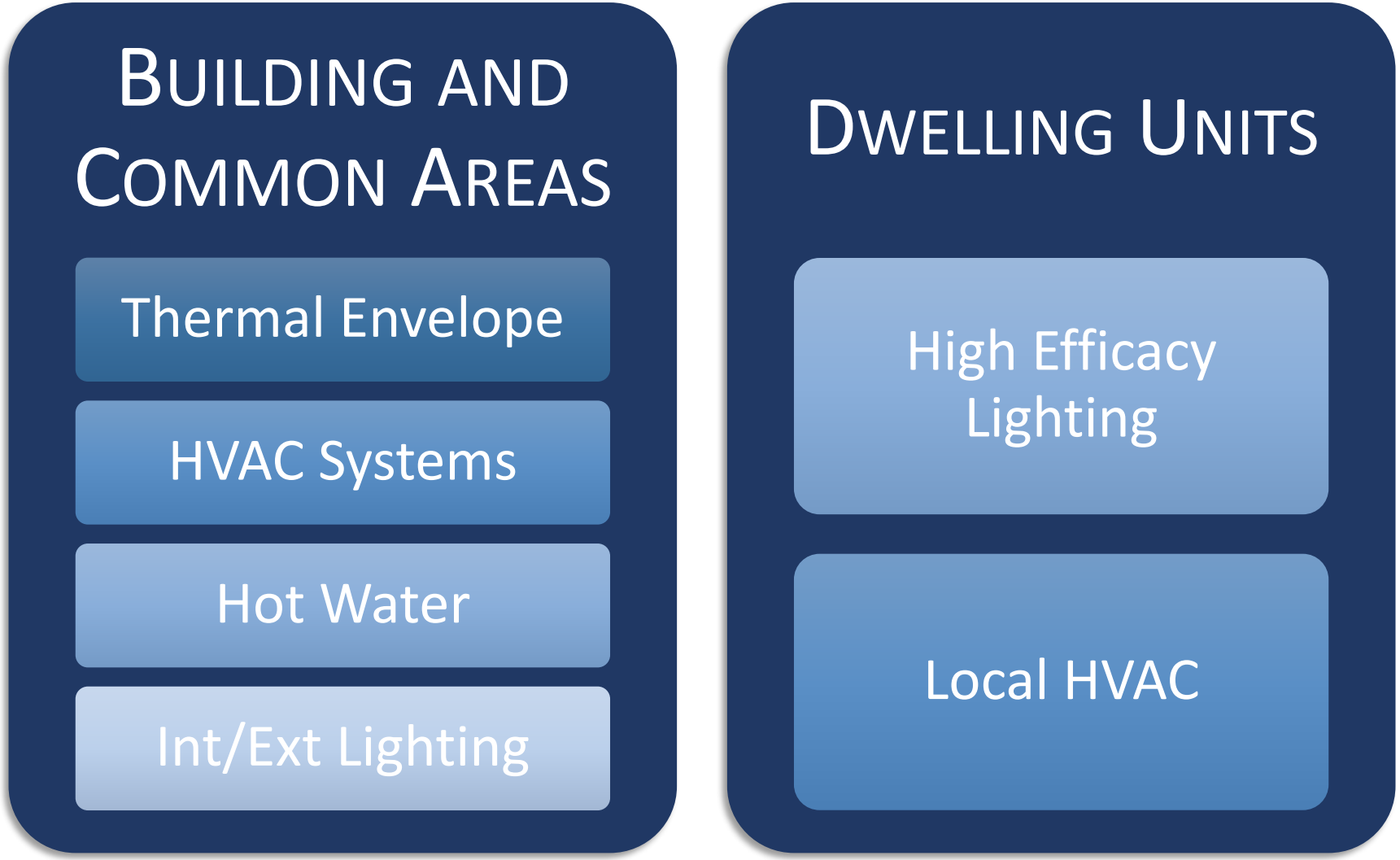






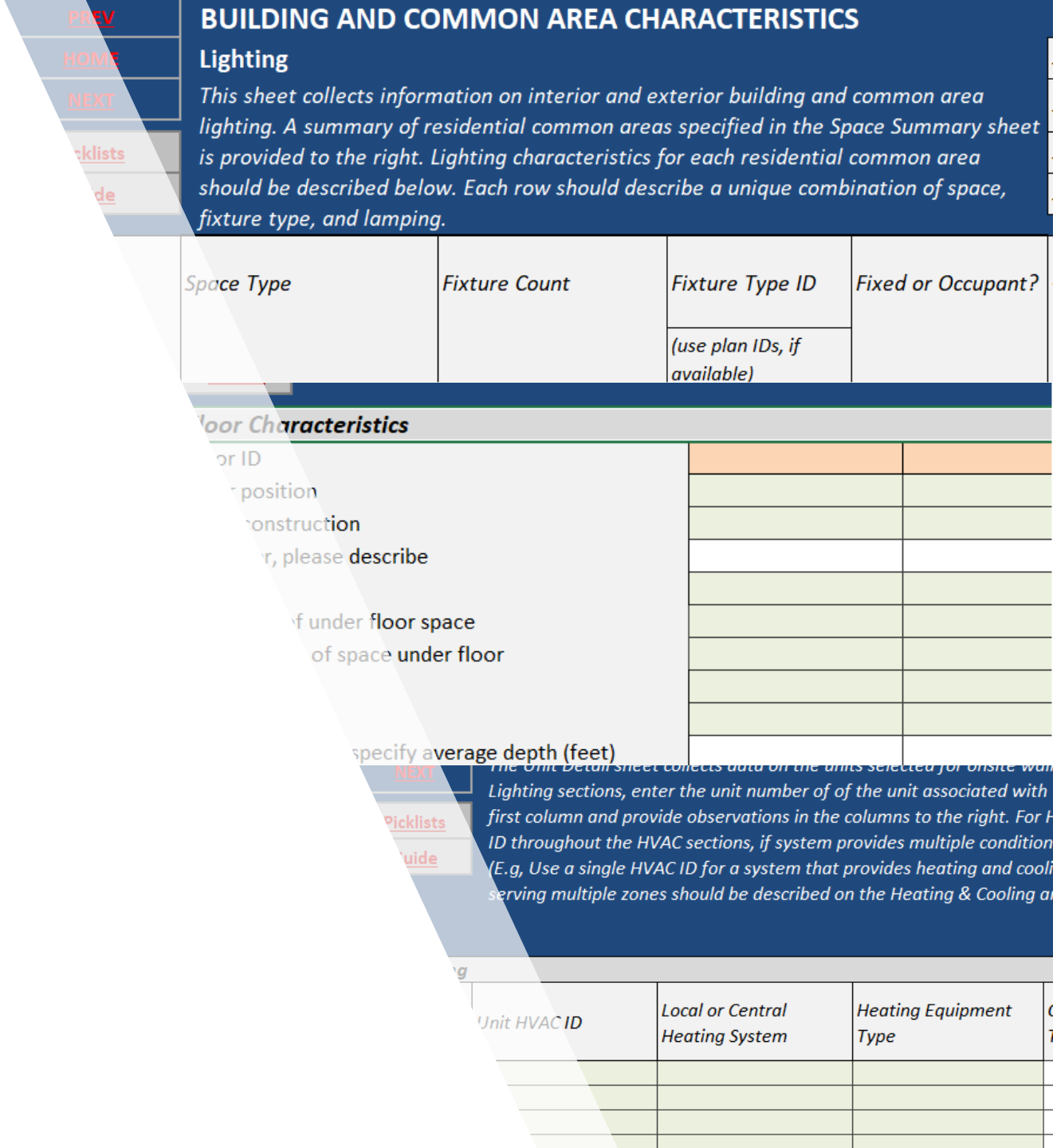
Field Study Geography Distribution

Key Baseline and Energy Characteristics



Data Collection Tool

- Excel
- Table-based
- Includes surveyor guidance
- Picklists where possible
- Built-in quality control



Differences from Single-Family Study

Single Family

Number of SF buildings per state: thousands

Single family surveyed parts of a building (components)

Multifamily

Number of LRMF buildings per state: low hundreds

Multifamily surveyed the entire building

- Not enough LRMF buildings to use a component approach
- Need to learn as much as possible from each building surveyed

Recruiting Challenges

- Extremely small building pool to draw from
- Sample frame came from building permit offices
  - We requested their list of buildings
  - This was varyingly successful
  - When it didn't work, we turned to Dodge data and to non-traditional sources like Zillow to find buildings
- High number of hours spent to get to a "yes"
- Difficult to recruit sites outside Chicago & Chicago suburbs – for example:
  - Springfield clearly had a number of buildings that met our criteria, as identified through Dodge or Zillow
  - Permit office did not have them on lists provided to us, despite multiple requests

Analysis Plan

Summarize Key Characteristics

- Summarize key characteristics
  - Histograms of observed values & tabular description of results
  - Plot by climate zone / state

Provide Collected Data

- Provide collected data
  - Report on all data points collected

Estimate Statewide EUI

- Estimate statewide Energy Use Intensity
  - Estimate statewide weighted average EUI via modeling with EnergyPlus
  - Model prototypes with minimum code requirements to determine baseline
  - Model each building with input parameters as observed

Assess Savings Opportunities

- Assess measure/component savings opportunities
  - Assess impact of bringing non-compliant building components into compliance
  - Calculate savings potential on per-unit basis weighted across state

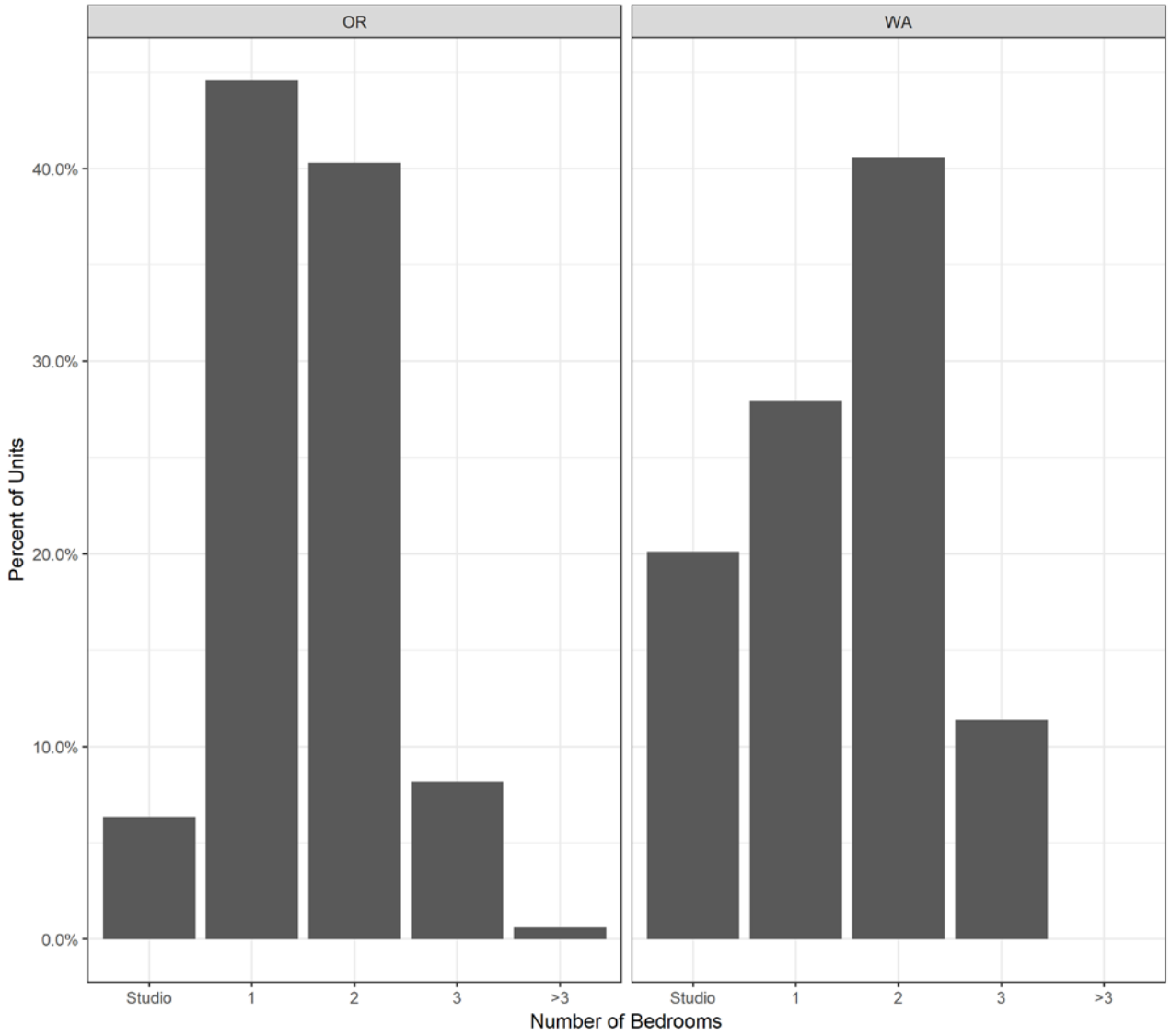
Preliminary Results: Surveyed Building Area

- WA buildings have more units / building on average

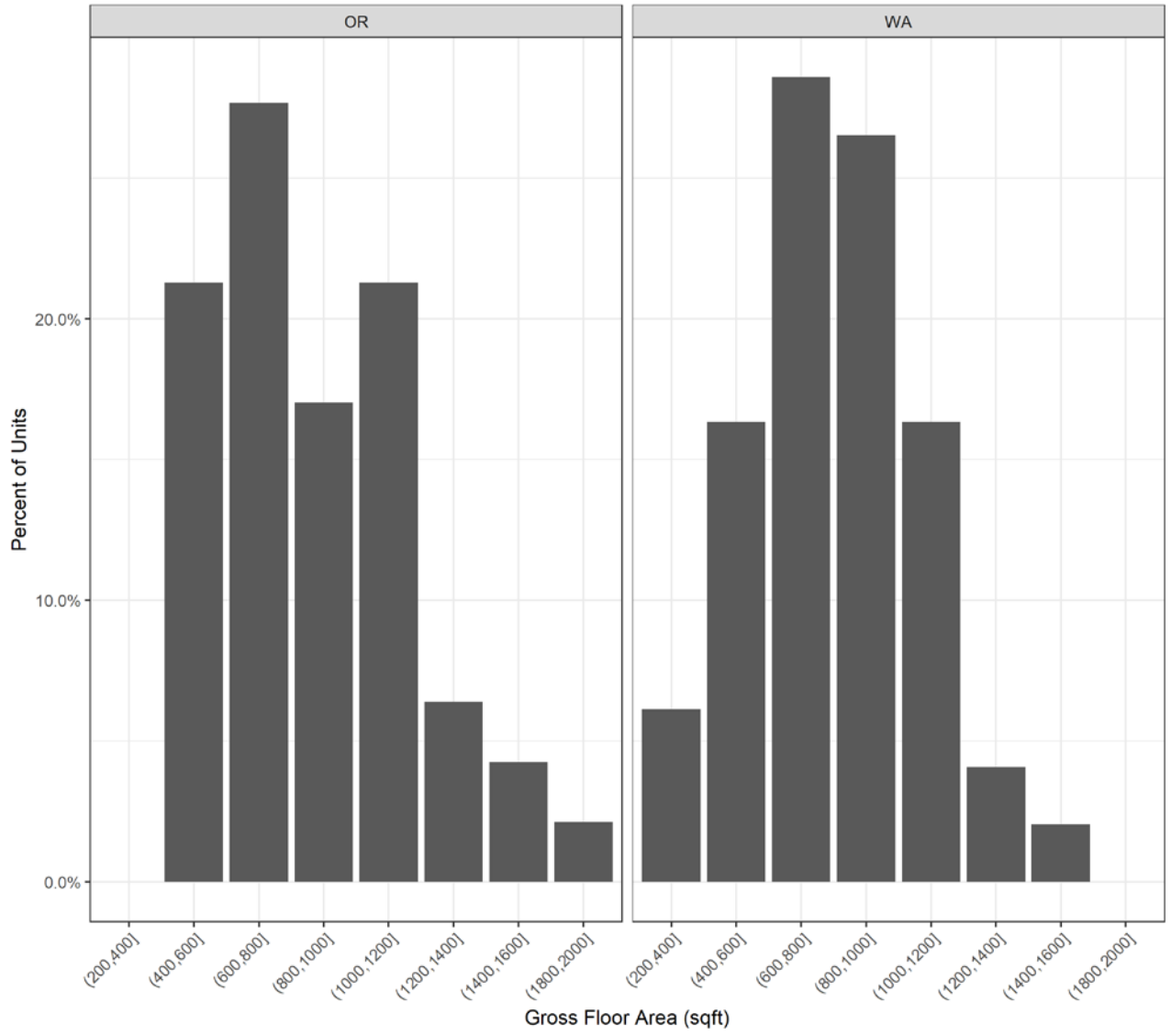
State	Surveyed Buildings (n)	Average Residential Area (cond sqft)	Average # Units
OR	21	22,701	23
WA	25	21,463	29

Preliminary Results: Number of Units

- Higher percentage of Studios in WA, whereas OR has more 1-bedrooms

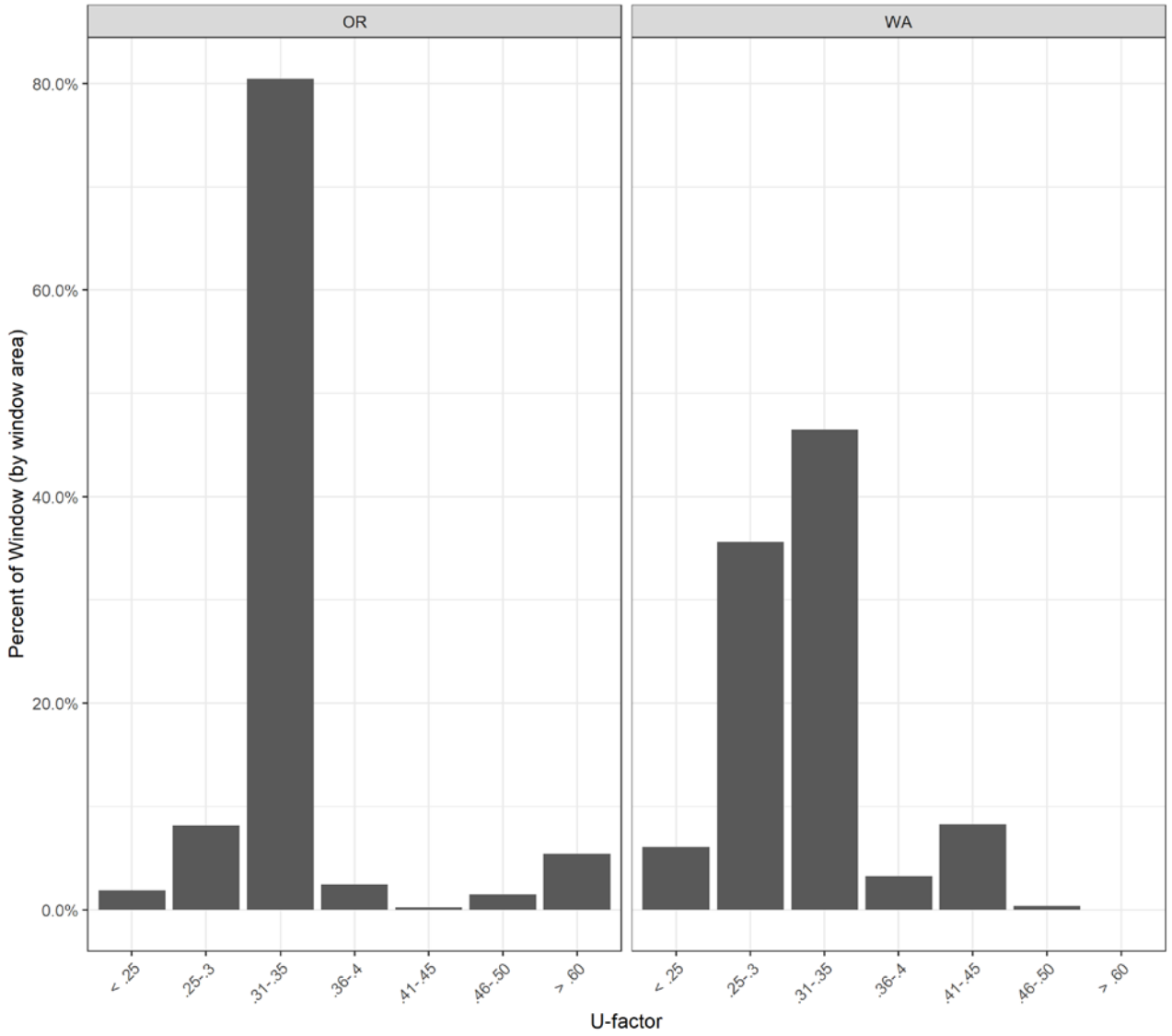


Preliminary Results: Distribution of Unit Sizes



Preliminary Results: Windows U-Factor

- WSEC requires 0.30 U-factor, ORSC requires 0.35 U-factor
- OR glazing > 0.46 are primarily patio/entry doors



Air Tightness Testing - Preliminary Results

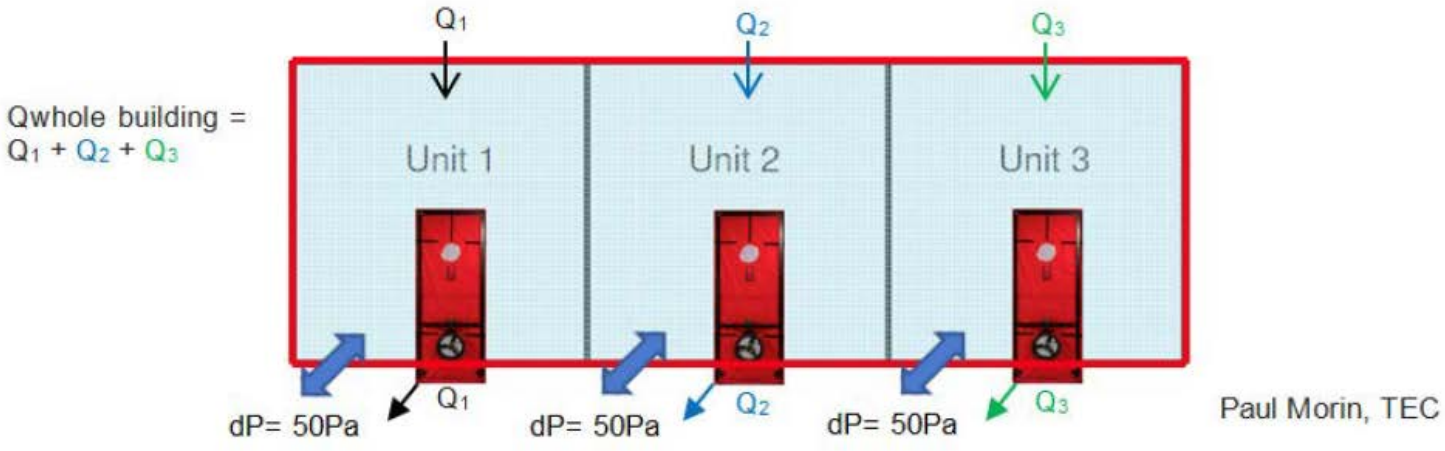
Air Tightness Testing Goals

Research Goals

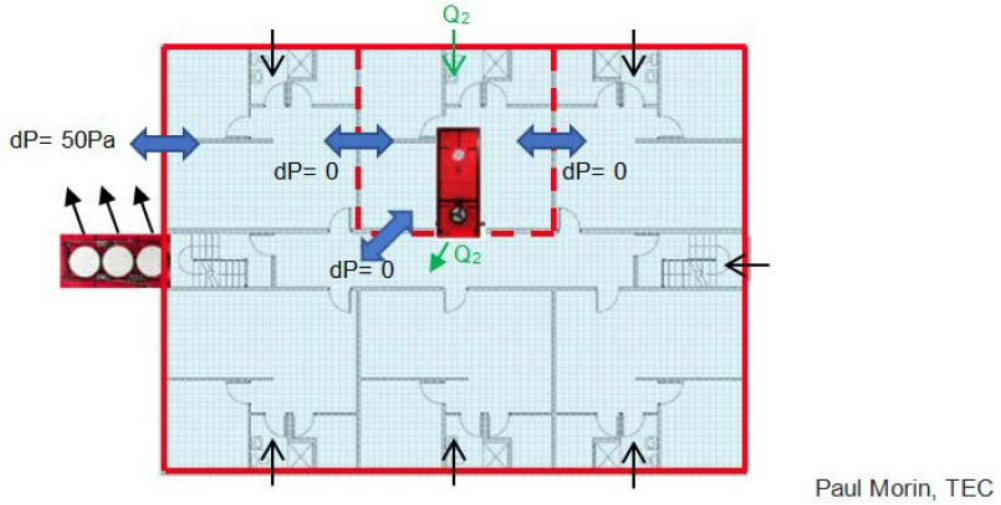
- Determine whether a relationship between different air tightness tests exists for the two building types and, if so, how strong it is and what variables affect its predictive power for energy use.
- Provide an envelope air leakage test protocol(s) that would be appropriate and practical to determine energy code compliance for multifamily buildings.
- Provide guidance for the development of code language to address envelope tightness in model energy codes aimed at the low-rise multifamily sector.
- Assess the energy impact of air tightness testing using the testing protocols used in this study.

Building Testing Methodology

- Three types of tests
  - Whole Building Exterior Leakage
  - Individual Unit Exterior Leakage
  - Individual Unit Interior and Exterior Leakage



Garden Style - Whole Building Exterior Leakage

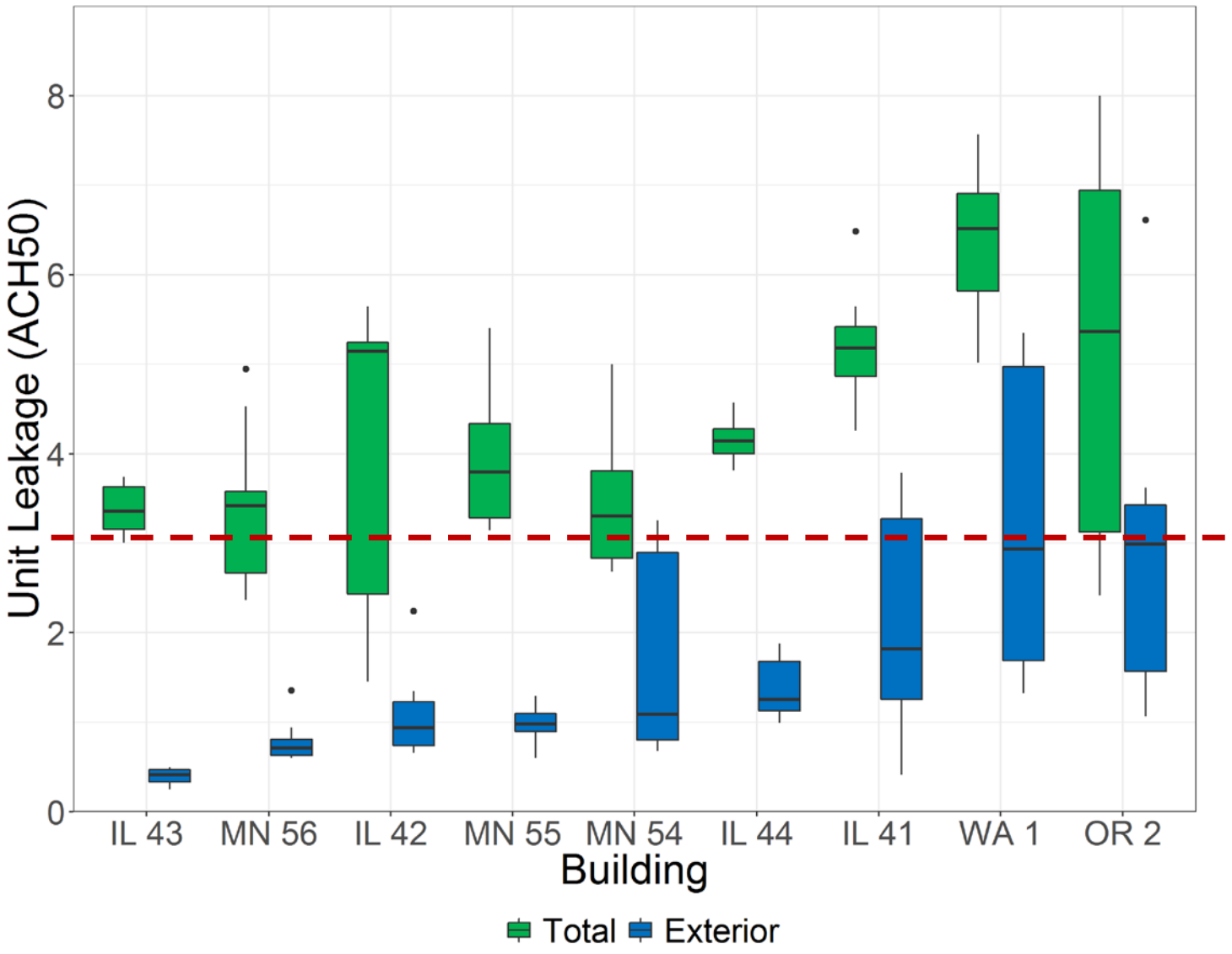


Common Entry - Whole Building Exterior Leakage

Preliminary Results Air Tightness Testing: Common Entry Buildings

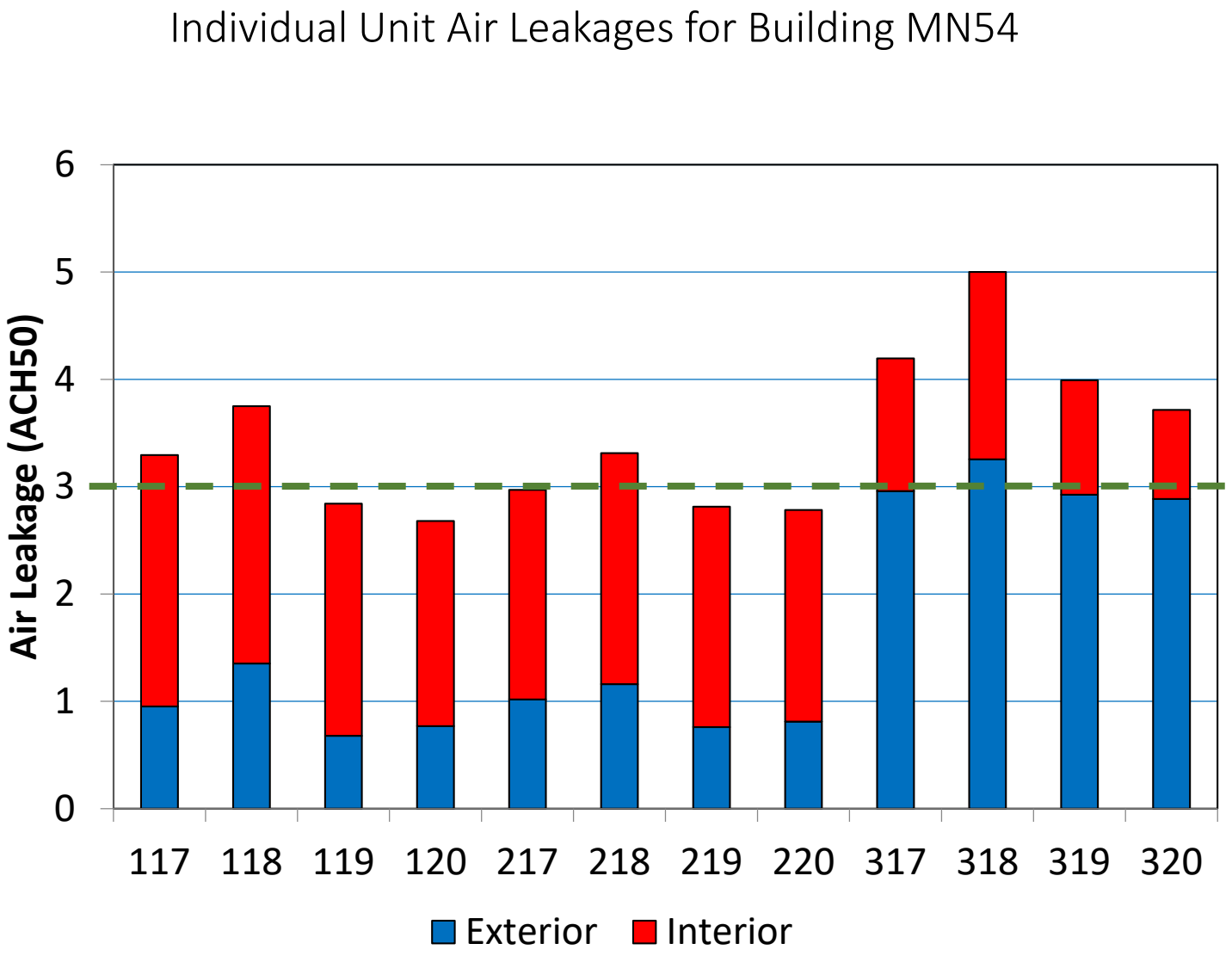
- The whole building exterior leakage ranged from 0.41 to 3.26 ACH_{50} with an average of 1.75 ACH_{50}.
- For five of the nine buildings, the leakage met the IECC requirement of ≤ 3 ACH_{50}.

Total and Exterior Leakage for Common Entry Buildings



Preliminary Results Air Tightness Testing: Common Entry Buildings

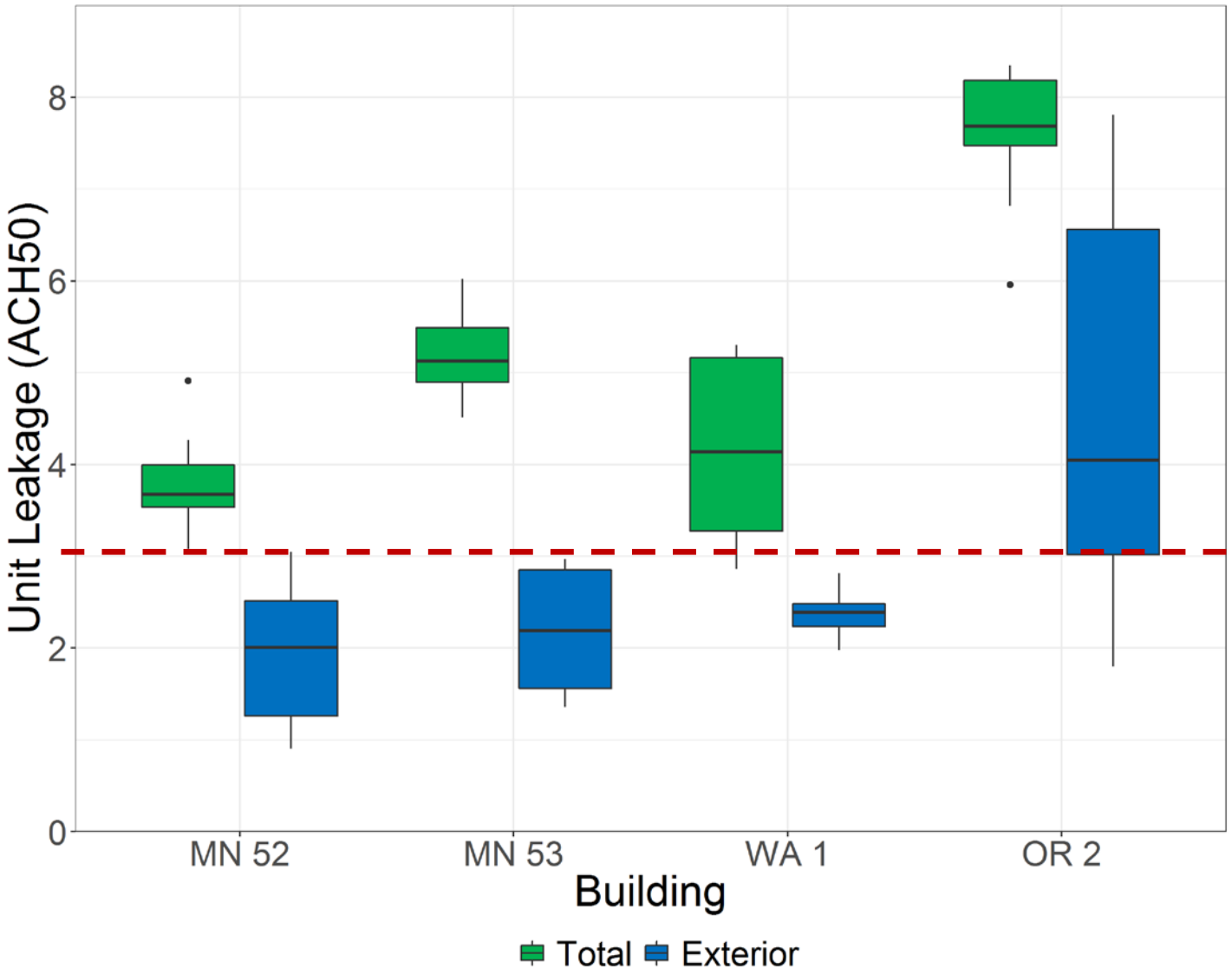
- This chart shows the measured leakage of all 12 units in a common entry building.
- Each bar represents a unit's total leakage divided between exterior and inter-unit.



Preliminary Results Air Tightness Testing: Garden Style Buildings

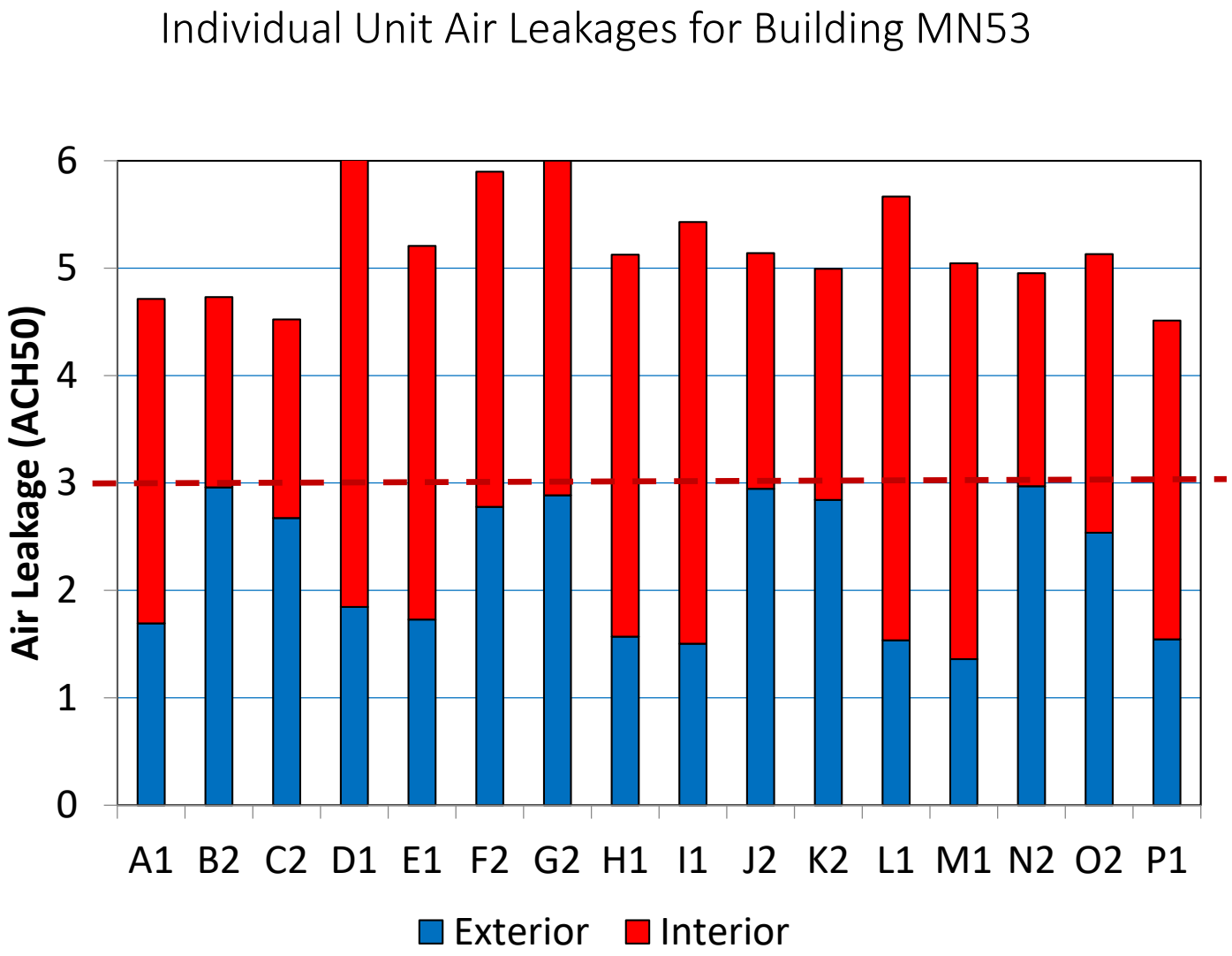
- The whole building exterior leakage ranged from 2.0 to 4.7 ACH_{50} with an average of 2.8 ACH_{50}.
- For three of the four buildings, the leakage met the IECC requirement of ≤ 3 ACH_{50}.

Total and Exterior Leakage (ACH_{50}) for Garden Style Buildings



Preliminary Results Air Tightness Testing: Garden Style Buildings

- This chart shows the measured leakage of all 16 units in a garden style building.
- Each bar represents a unit's total leakage divided between exterior and inter-unit.



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Final Report available
4th Quarter 2019