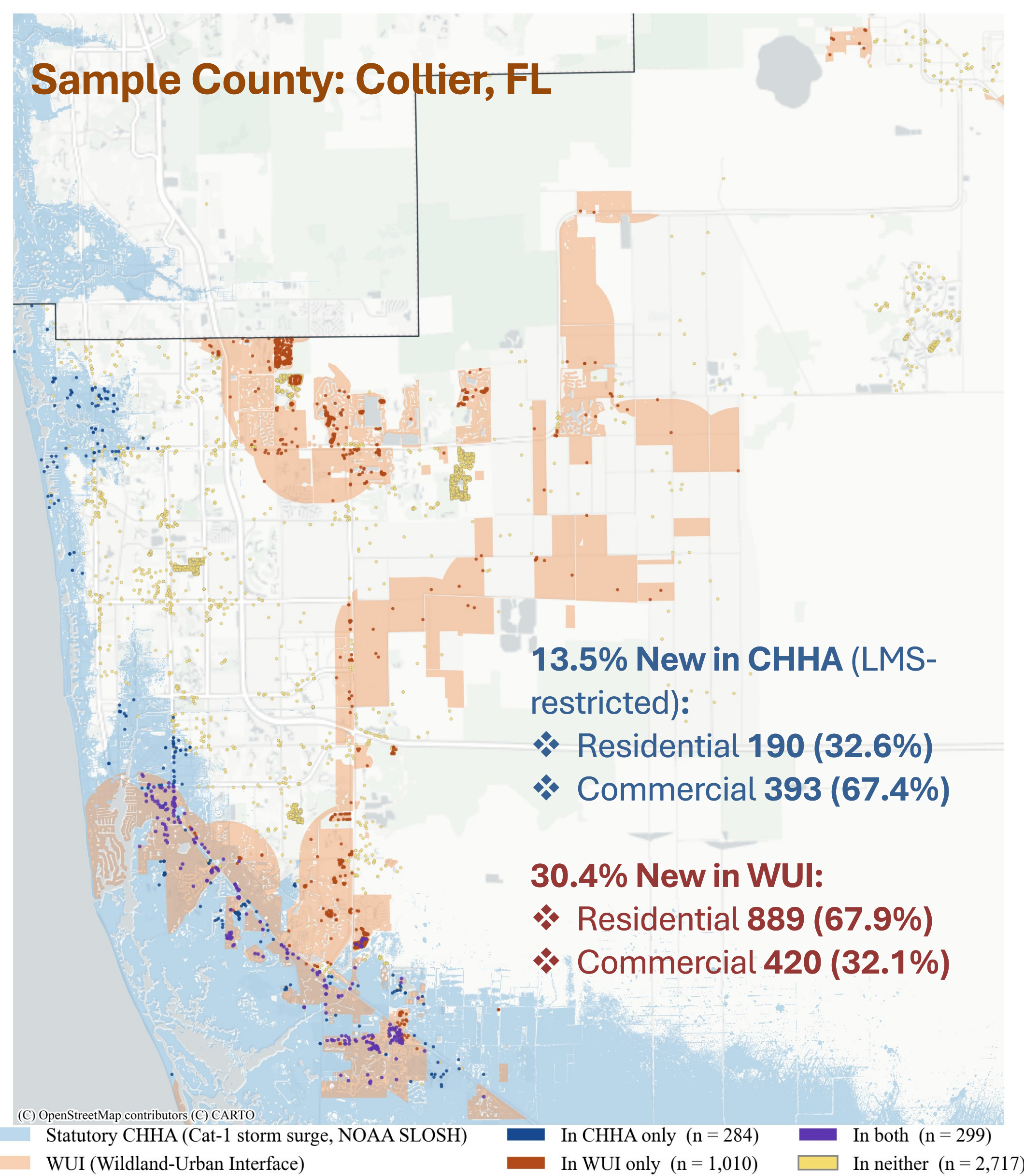


### Problem

- Florida absorbs about 40% of U.S. hurricane landfalls, and every county must maintain a FEMA-mandated mitigation plan (the LMS) to keep federal funding flowing.
- The plan promises protection and unlocks money, but whether its strategies reach actual buildings, and which buildings, rarely gets checked.
- Prior work assesses implementation only in fragments, sampling permits at one stage (Laurian et al. 2004) or scoring plans one by one (Lyles et al. 2016); none follows a strategy through every step to see where it actually breaks down.
- The barrier is not reading the plan, which prior work codes by hand, but linking every strategy to a county's full permit record, building by building, at a scale hand methods cannot reach.

**Gap:** this implementation chain has remained a black box for lack of a method to open it, which an LLM-based pipeline now makes tractable.

#### New construction in Collier (2014–2024) · CHHA + WUI exposure



### A five-stage LLM-assisted pipeline

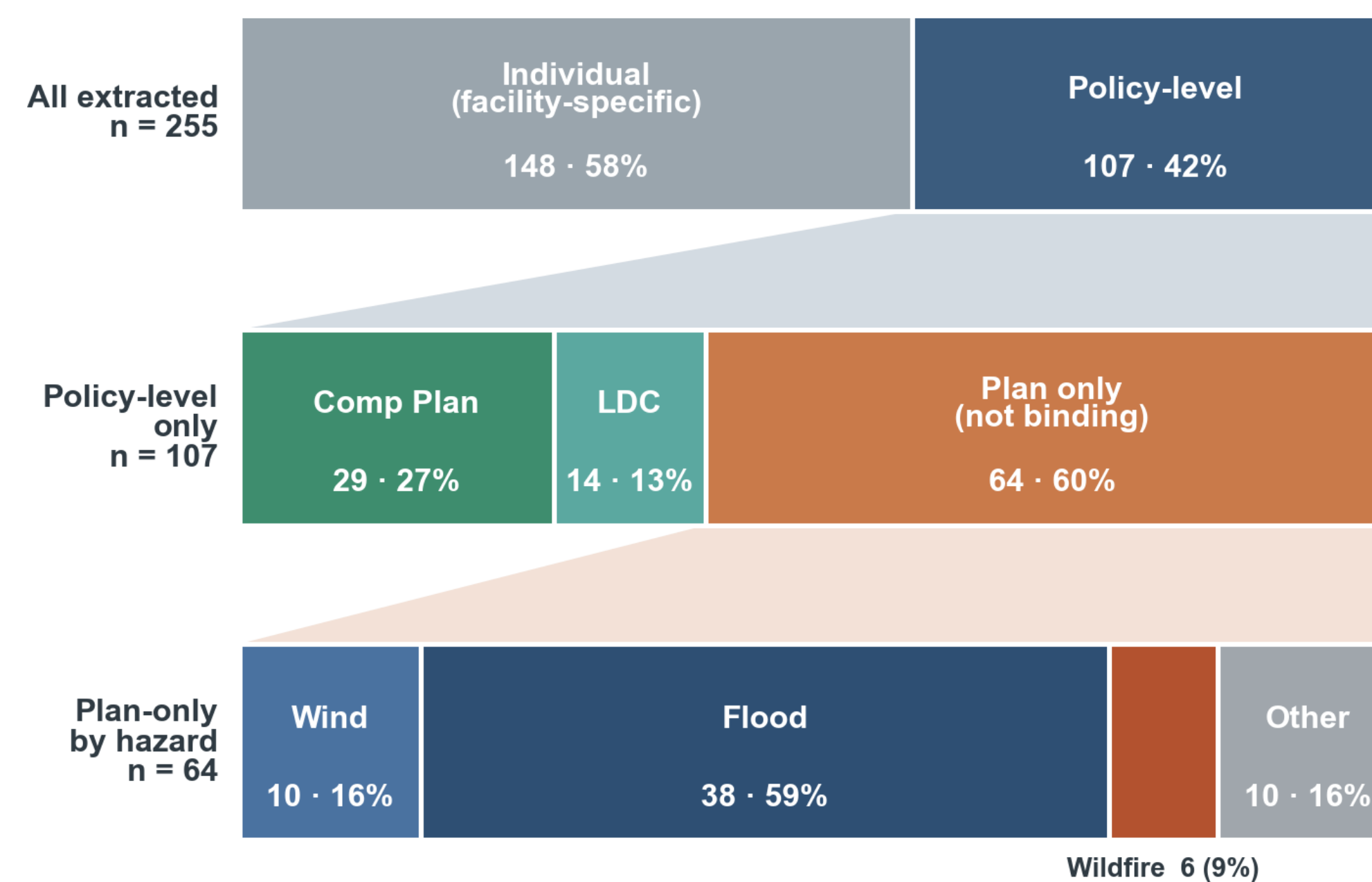
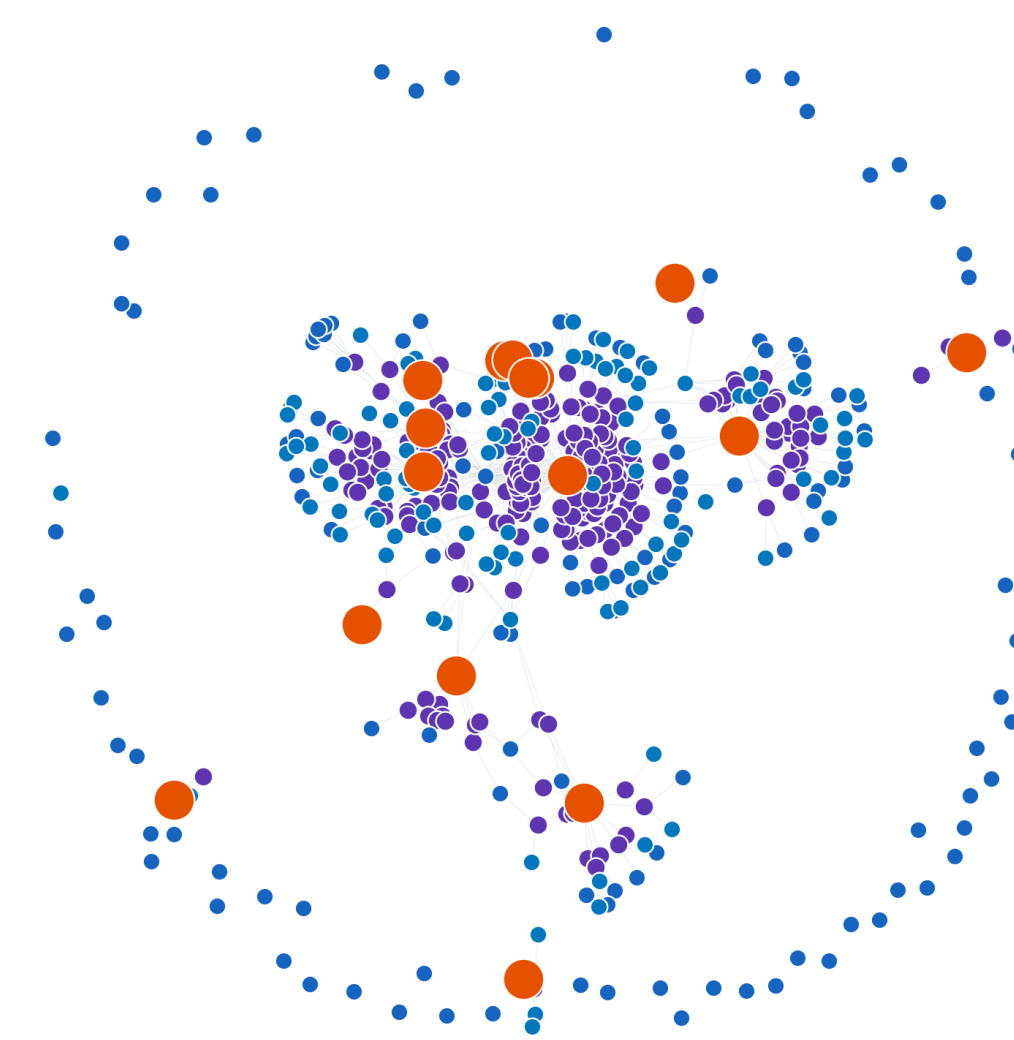
Same code, prompts, and model on any Florida county's LMS plan. Case study in **Collier County**

#### 1 STAGE 1: Read the plan

An LLM converts the 634-page LMS into a typed knowledge graph; every strategy stays anchored to its verbatim source text.

- ✓ 255 strategies
- ✓ 464 nodes, 662 edges
- ✓ 100% verbatim-traceable

#### Knowledge graph



#### 2 STAGE 2: Test legal binding

Each strategy is checked against the Comprehensive Plan and Land Development Code: adopted into binding law, or recommendation only?

- ✓ 148 facility-specific entries excluded
- ✓ 43 of 107 policy strategies bind (40%)
- ✓ wind 55% / flood 37% / wildfire 25%

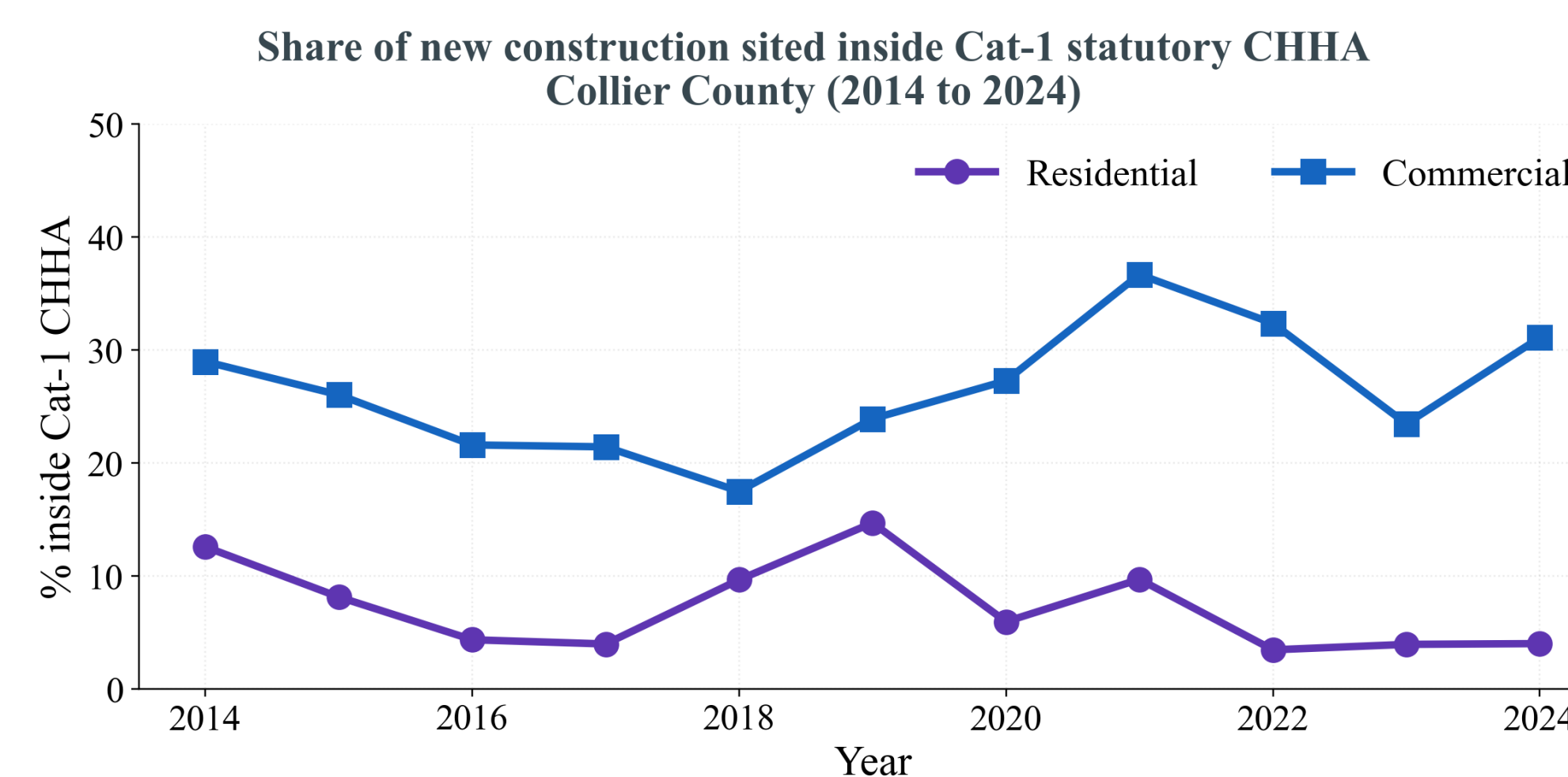
#### Enforcement channels



#### 3 STAGE 3: Find the enforcement channel

Each binding strategy is assigned to an enforcement channel; four of six channel types leave traces in county permits.

- ✓ 84% of binding strategies are permit-observable
- ✓ FBC carries wind, NFIP carries flood
- ✓ Wildfire runs through state programs, invisible to permits



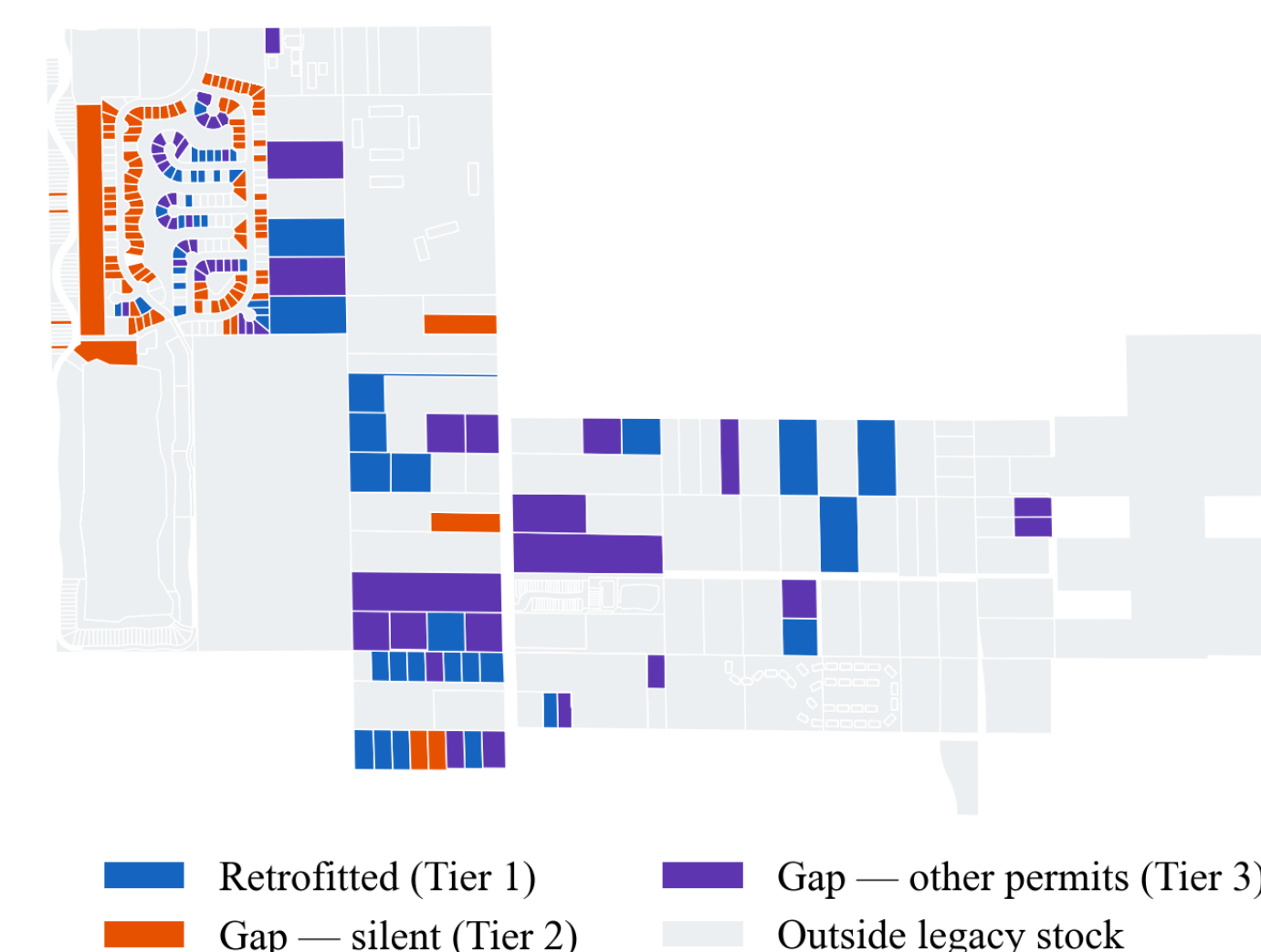
#### 4 STAGE 4: Check the ground: new construction

Binding strategies' target zones are overlaid on 365K parcels: are new buildings sited where the plan says to restrict?

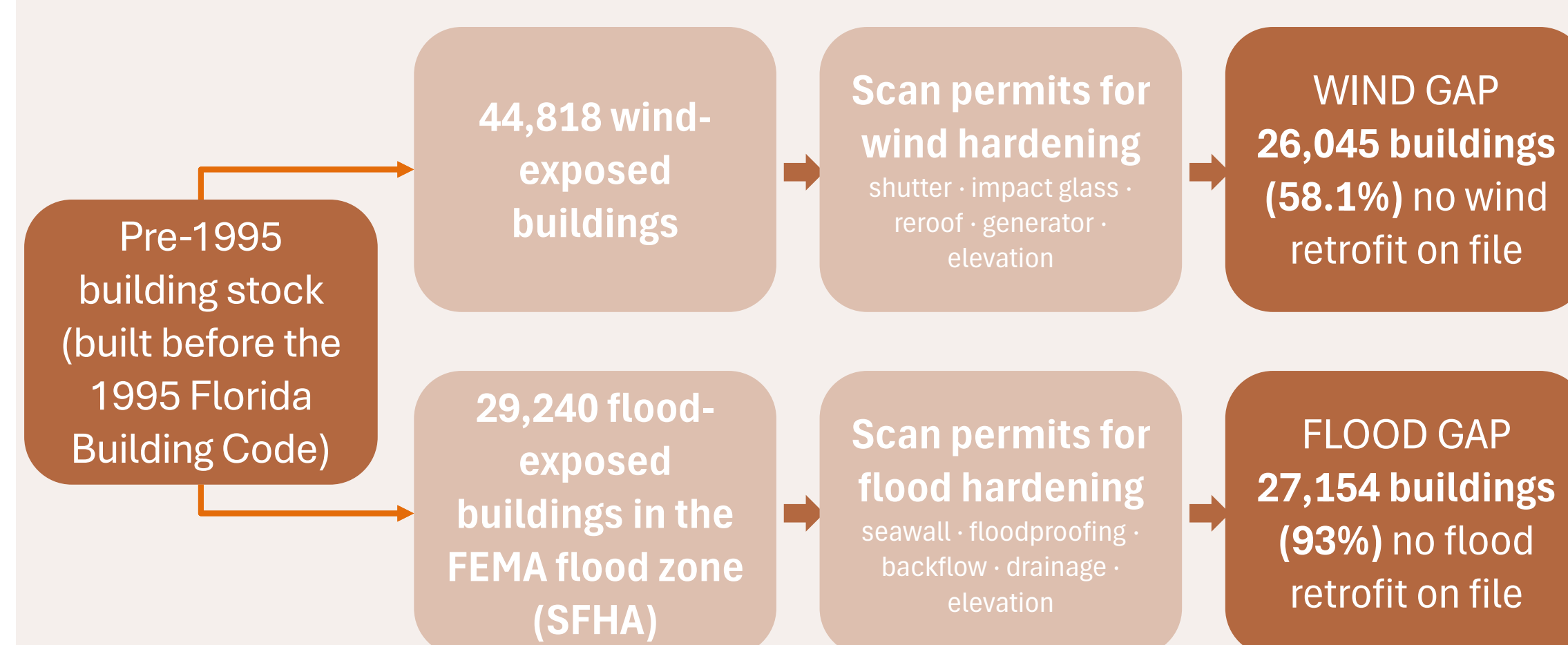
- ✓ Strict V/VE prohibition holds, 4/4,310 new builds
- ✓ Cat-1 CHHA density limit leaks, commercial share rising

#### Parcel-level resolution

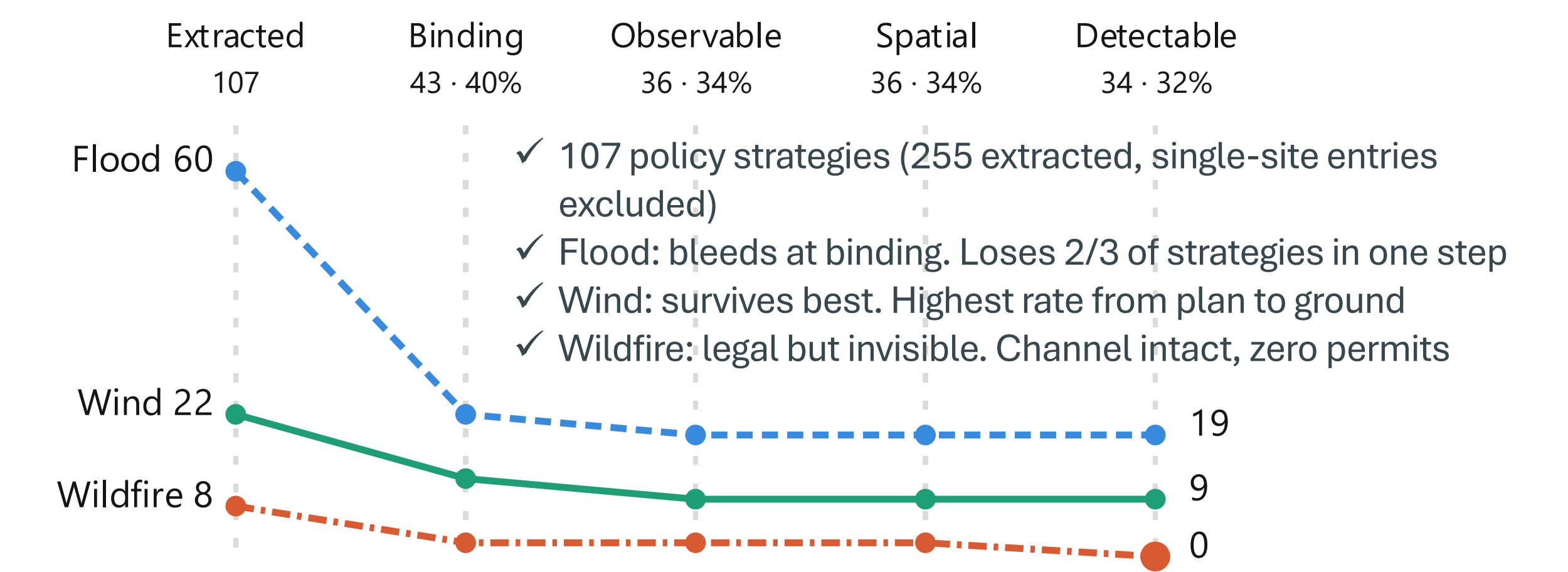
Sample block · 47% in gap



#### 5 STAGE 5: Permit-based gap analysis

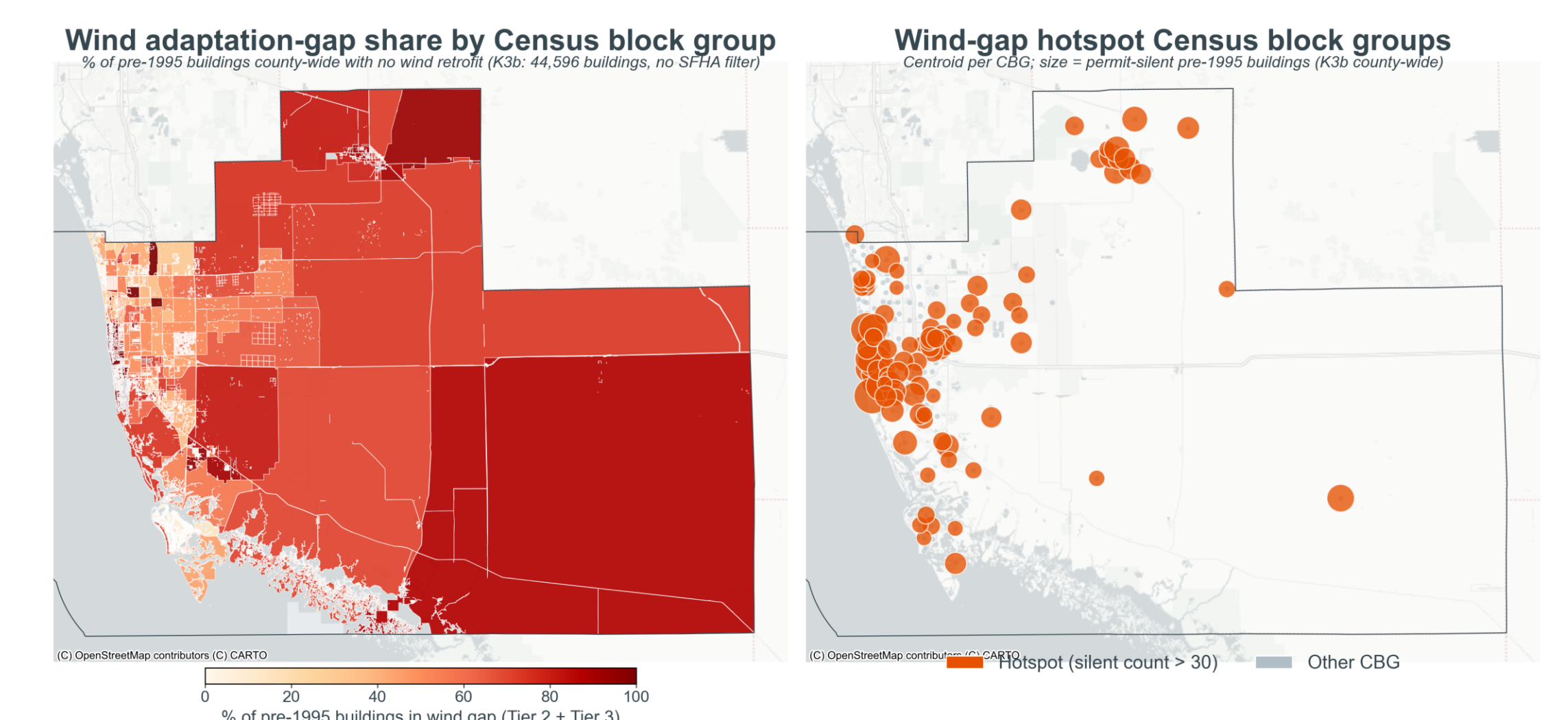


### Findings



#### Where the gap lives

Per-CBG share of legacy stock with BOTH wind AND flood gap.

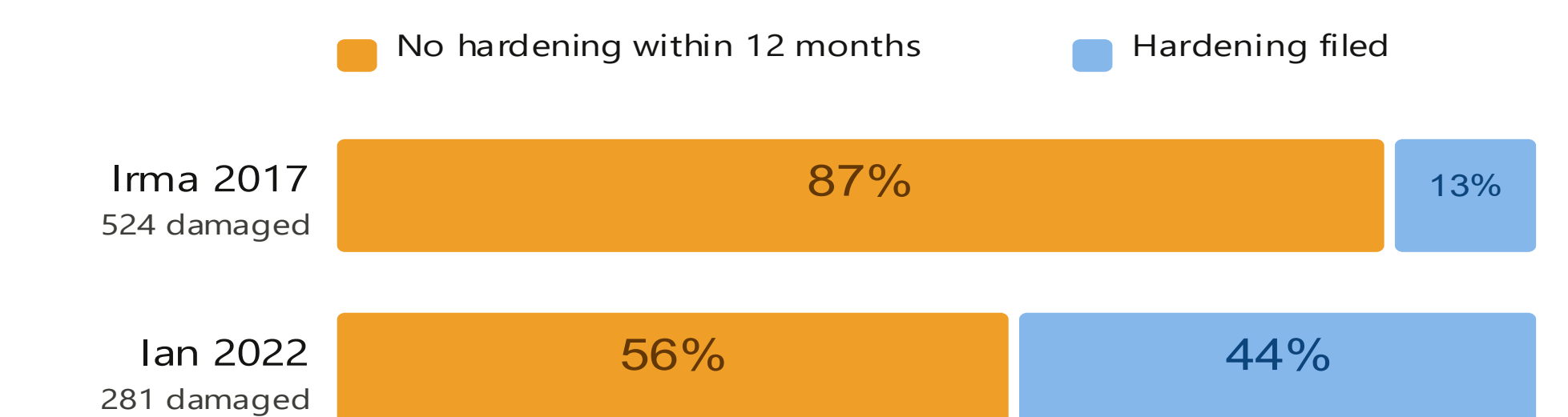


#### WHAT THE PIPELINE OUTPUTS

**26,045** of 44,596 with no wind-hardening permit

**27,154** of 29,105 with no flood-hardening permit

- ✓ Wind gap: follows tenure; strongest predictor is renting + minority rate, not income (r = -0.31)
- ✓ Flood gap: high at every income. 88% overall; even the wealthiest brackets exceed 85%, the poorest two reach 97%
- ✓ A few low-income, renter-heavy block groups top both lists
- ✓ Income predicts the wind gap, not the flood gap; allocation rules should differ



- ✓ Direct hits do not close the gap. Two major hurricanes, and most damaged buildings filed repairs only, no hardening
- ✓ 615 addresses remain damaged and never hardened. The highest-urgency outreach subset

#### Why the gap persists

- ✓ What gets filed is the visible fix. Reroofs dominate post-storm filings; 7 of 524 added impact glazing
- ✓ The cleanest action signal is price. The 2020 insurance shock lifted seawall permits 46%; hurricanes and federal reforms moved nothing comparable
- ✓ Outside help has not arrived. 3 federally funded mitigation projects, county-wide, ever

#### Application of the LLM-assisted Pipeline

- ✓ Parcel-level prioritization. The pipeline returns 8,928 permit-silent and 615 storm-damaged buildings.
- ✓ From plan quality to plan performance. Three decades of evaluation scored what plans say; this trace measures what they do, making implementation a quantifiable outcome variable.
- ✓ Cross-county portability. One LMS in, a per-building gap map out; open-source code and prompts.

### Research Questions

Where along the chain, from written strategy to standing building, does mitigation break down?

- Q1 · **Binding.** Do written strategies become enforceable?
- Q2 · **Channel.** Do binding strategies leave observable enforcement records?
- Q3 · **Ground.** Are new buildings kept out, and are legacy buildings retrofitted?