



scout

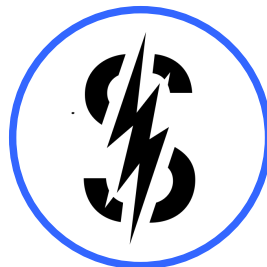
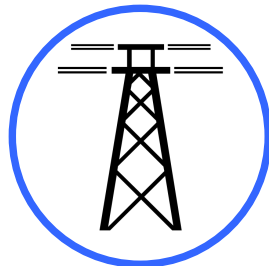
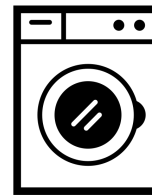
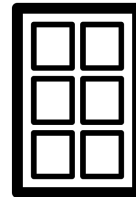
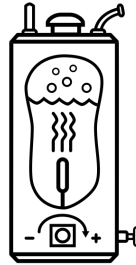
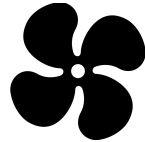
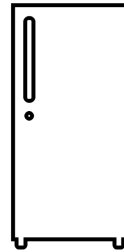
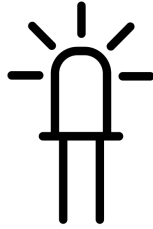
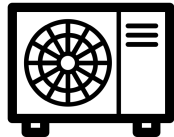
A Portfolio Impact Analysis Tool for Building
Energy Efficiency Technologies

Jared Langevin
Research Scientist
Lawrence Berkeley National Lab

Chioke Harris
Former EERE ST&P Fellow
Building Technologies Office

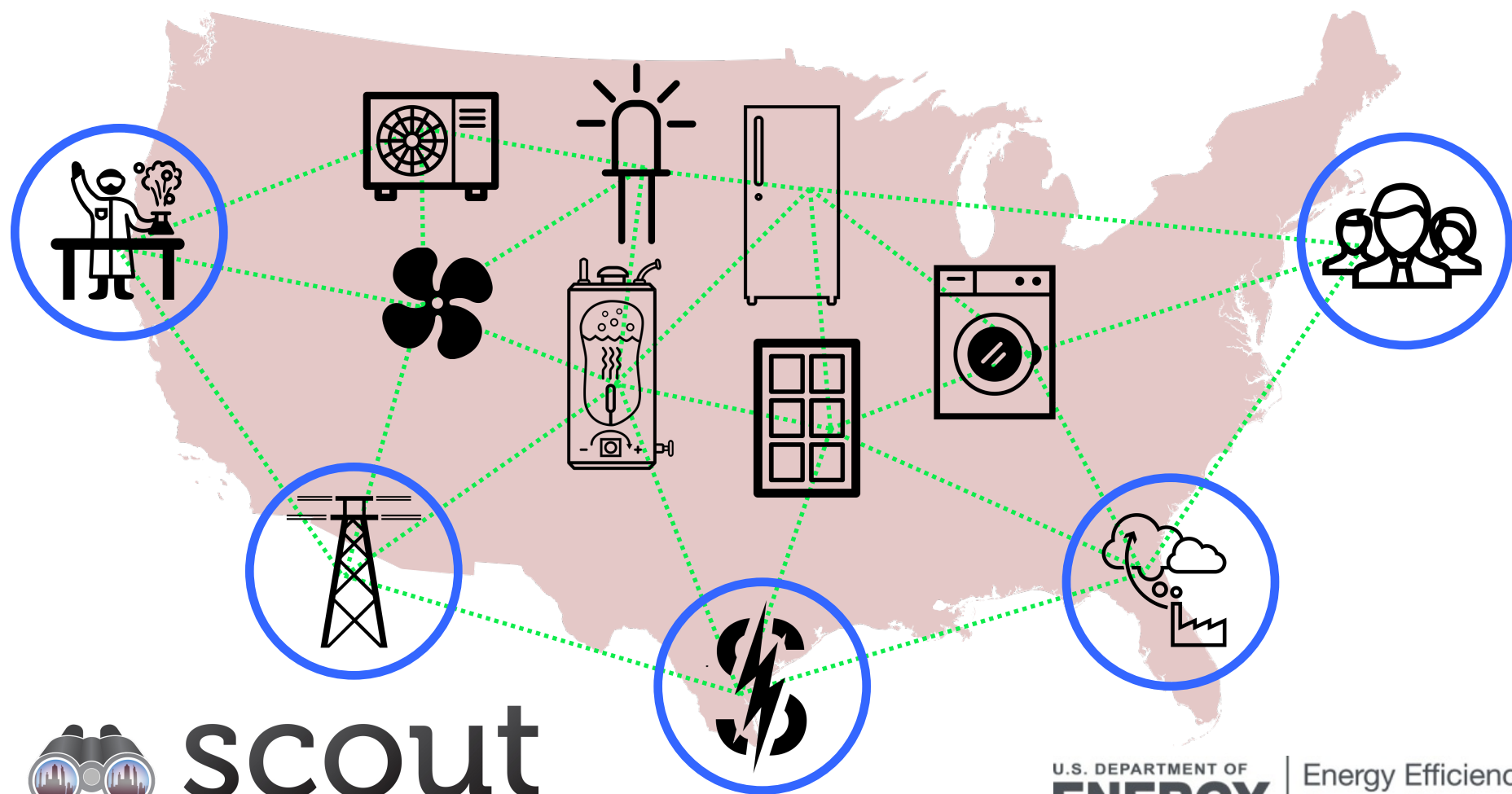
The problem: Many ways to reduce energy use in buildings, and multiple perspectives

- Technologies span multiple end uses and operating contexts
- Range of stakeholder goals/assessment criteria for technology development



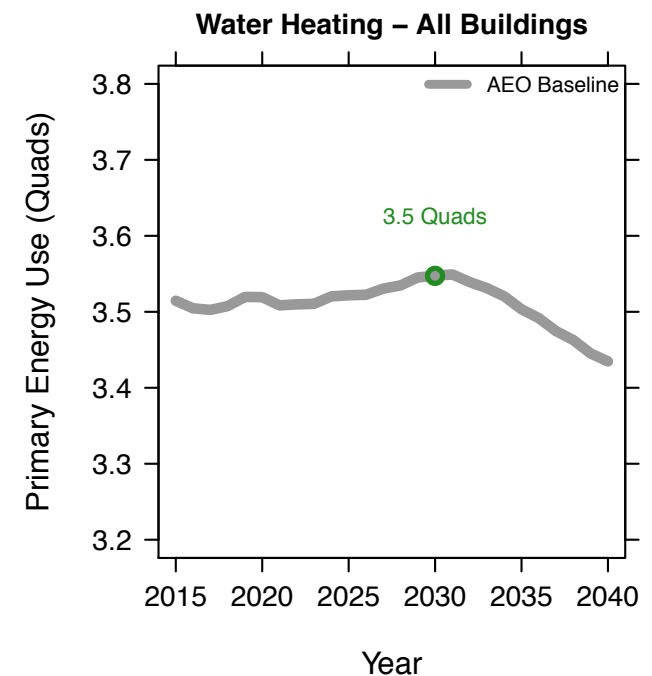
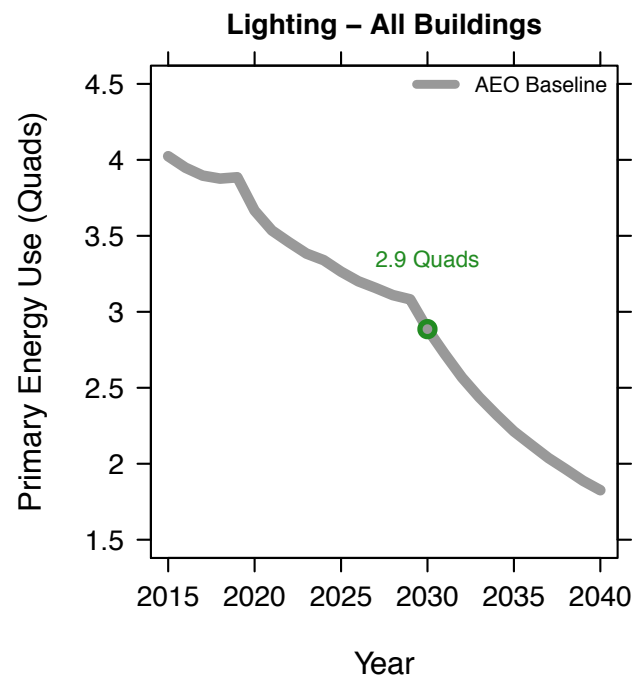
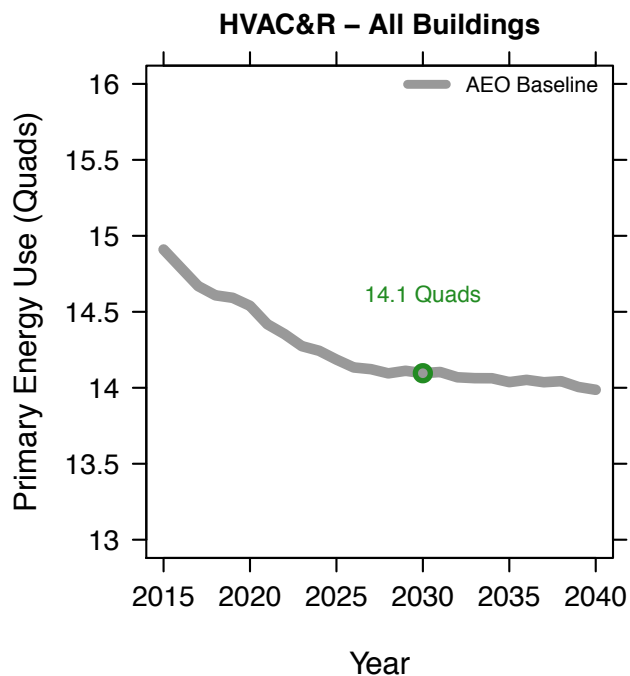
Scout establishes a level playing field for stock-wide EE impact assessment

- Technologies evaluated at a consistent scale, using a common methodology
- Technology impacts communicated using common variables and metrics



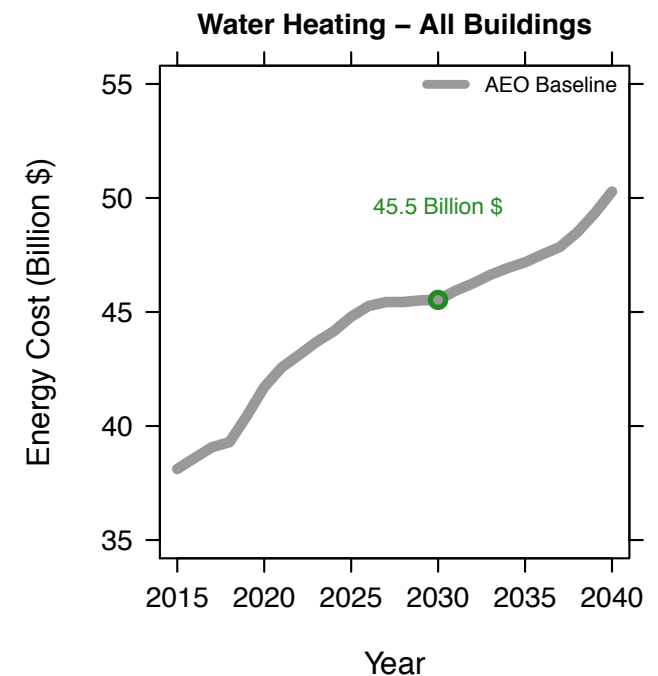
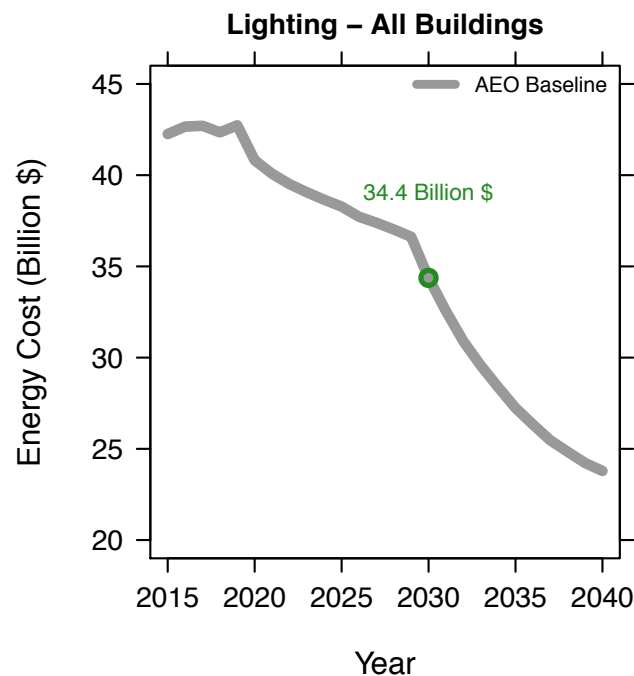
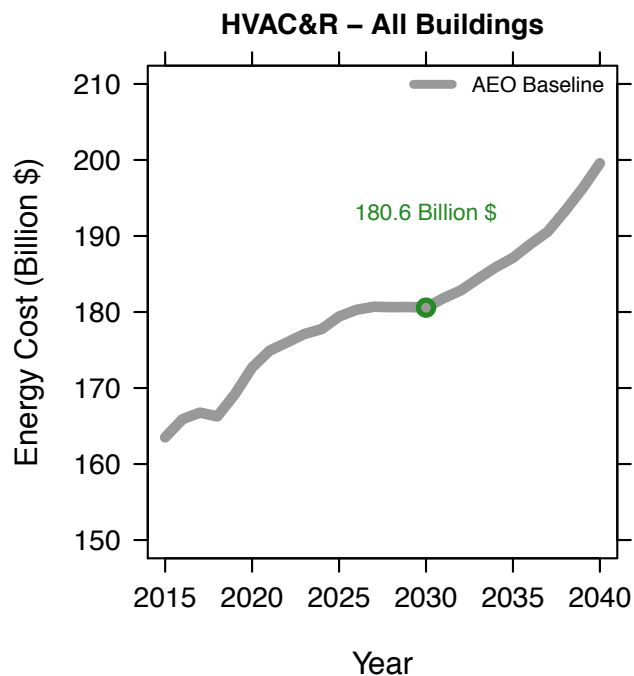
Starting point: EIA Annual Energy Outlook (AEO) U.S. primary energy use baselines

- AEO baselines represent “business-as-usual” projections
- EIA updates AEO projections annually
- Baselines split by climate, building type/vintage, fuel, end use, technology
- Energy use baselines can be translated to other variables (CO₂, cost)



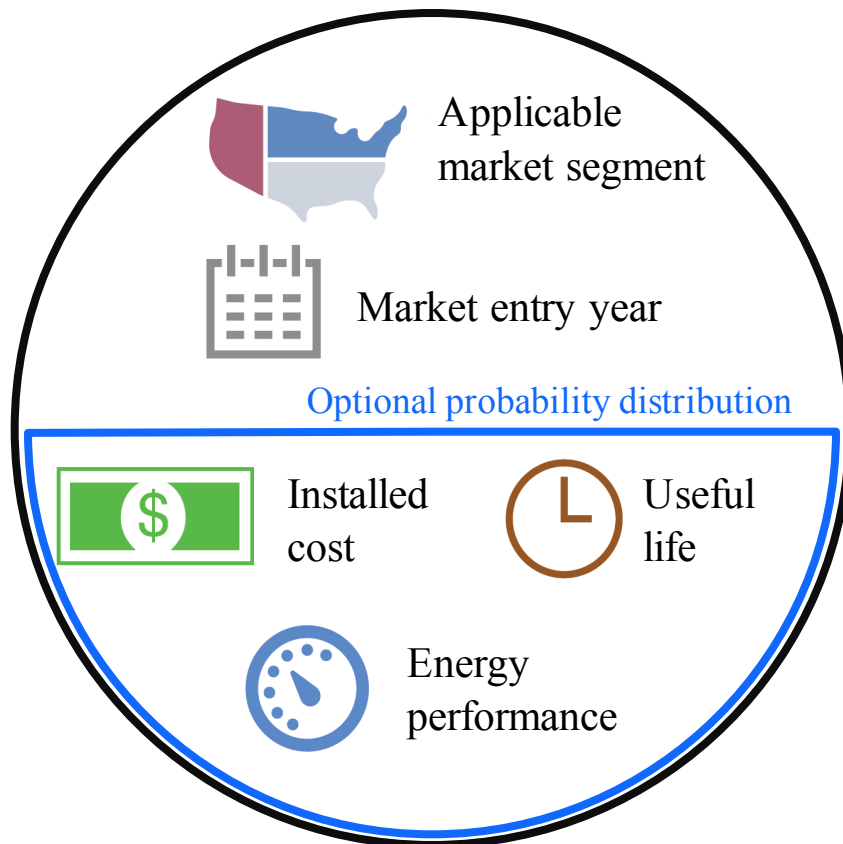
Starting point: EIA Annual Energy Outlook (AEO) U.S. primary energy use baselines

- AEO baselines represent “business-as-usual” projections
- EIA updates AEO projections annually
- Baselines split by climate, building type/vintage, fuel, end use, technology
- Energy use baselines can be translated to other variables (CO₂, cost)



Energy conservation measures (ECMs) are applied to AEO baseline energy use totals

- ECMs improve upon comparable baseline technology's energy performance
- Defined by applicable market/market entry, cost, performance, and lifetime
- Uncertainty may be added to cost, performance, and lifetime inputs

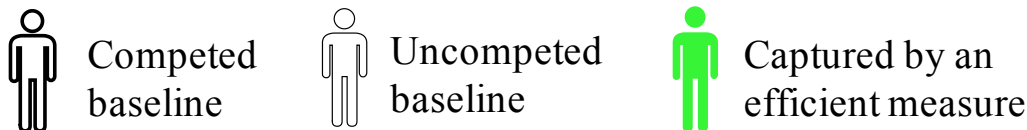
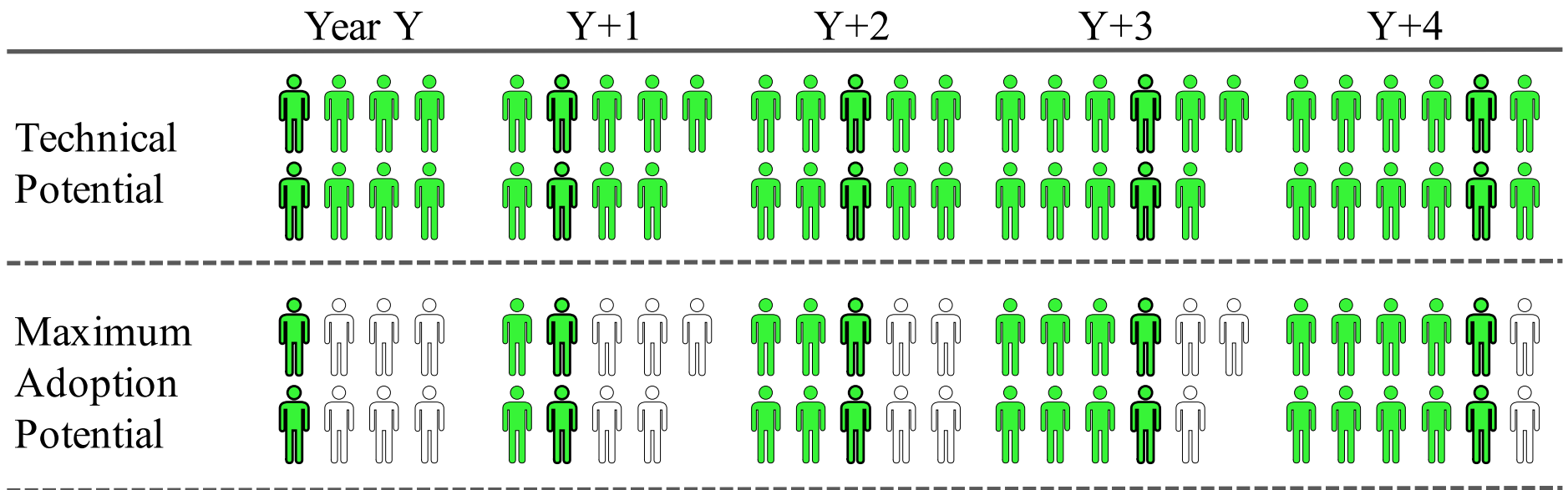


```
ENERGY STAR Central AC v. 5.0.json x
1  {
2    "name": "ENERGY STAR Central AC v. 5.0",
3    "climate_zone": "all",
4    "bldg_type": "all residential",
5    "structure_type": "all",
6    "end_use": "cooling",
7    "fuel_type": "electricity",
8    "technology": "central AC",
9    "market_entry_year": 2015,
10   "market_entry_year_source": {
20   },
21   "market_exit_year": null,
22   "market_exit_year_source": null,
23   "energy_efficiency": 4.40,
24   "energy_efficiency_units": "COP",
25   "energy_efficiency_source": {
45   },
}
```

Scout ECM definitions and results are in JSON format

Multiple adoption scenarios determine ECM diffusion into AEO baseline markets

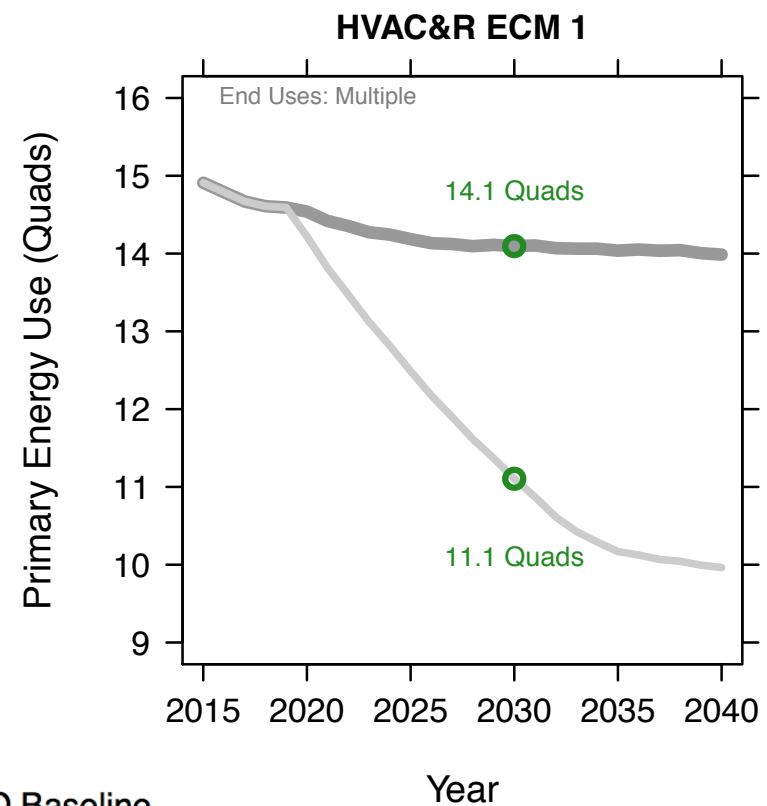
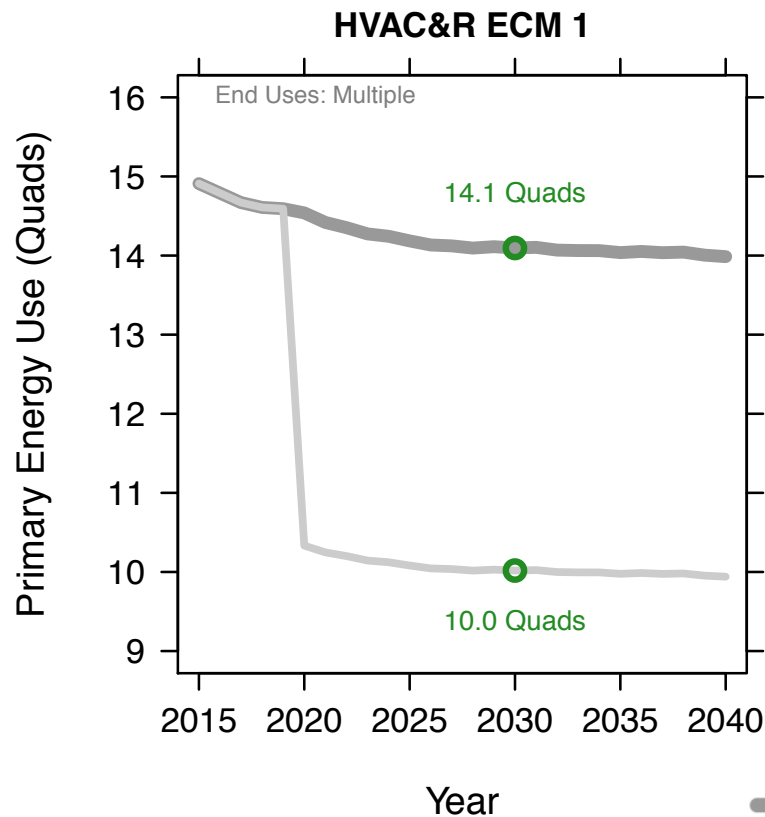
- Adoption scenarios distinguished by the competed market *available to ECMs*
- Technical potential: ECMs compete for total market in market entry year, new fraction of market in subsequent years
- Max. adoption potential: ECMs compete for new/replacement/retrofit fractions of total market annually



Multiple adoption scenarios determine ECM diffusion into AEO baseline markets

Technical potential

Maximum adoption potential

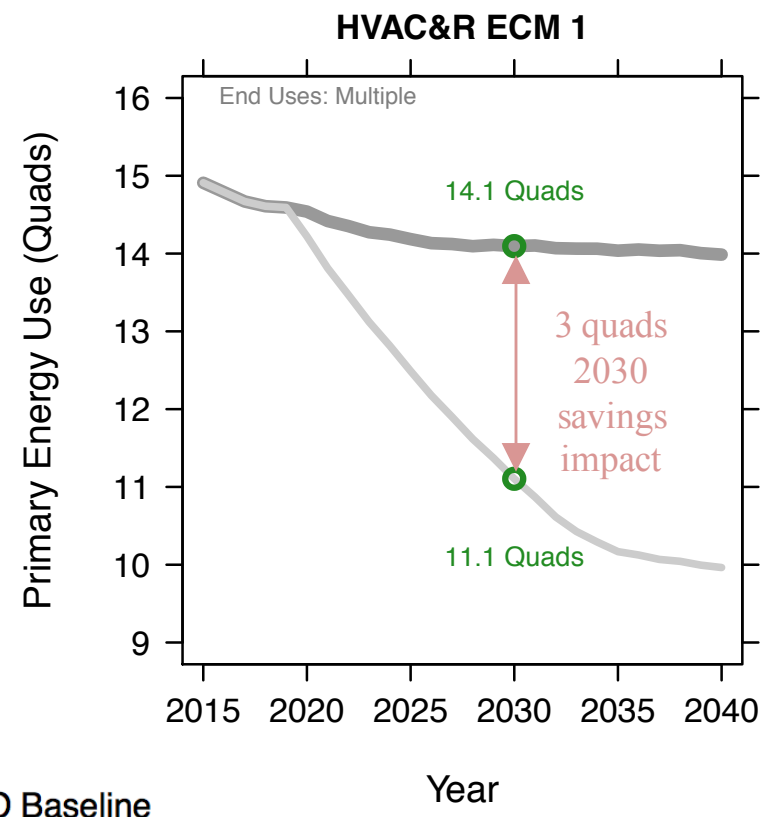
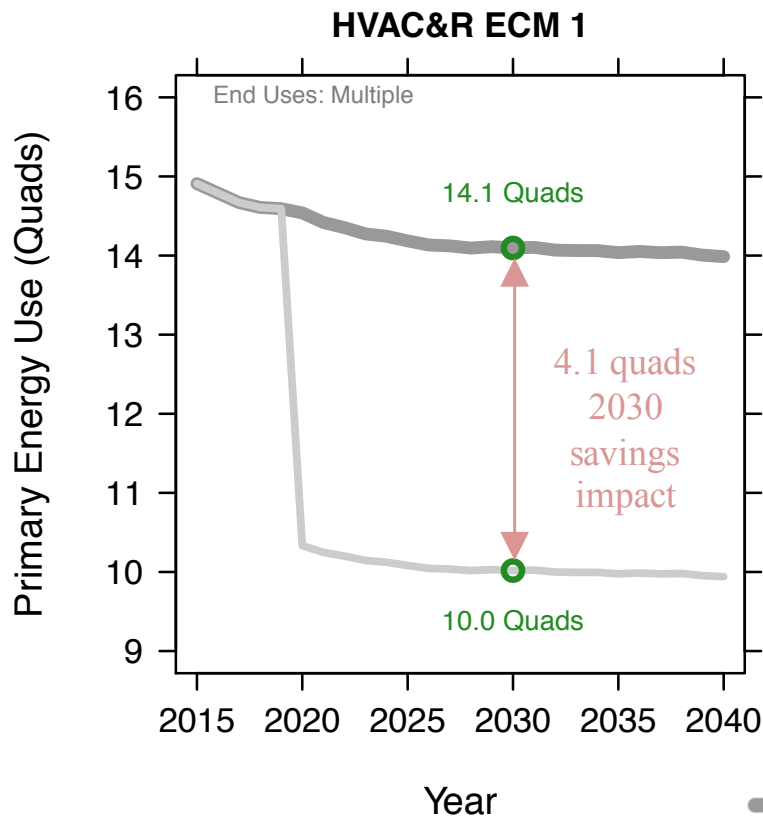


— AEO Baseline
— Efficient

Multiple adoption scenarios determine ECM diffusion into AEO baseline markets

Technical potential

Maximum adoption potential

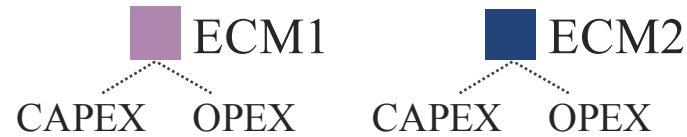


— AEO Baseline
— Efficient

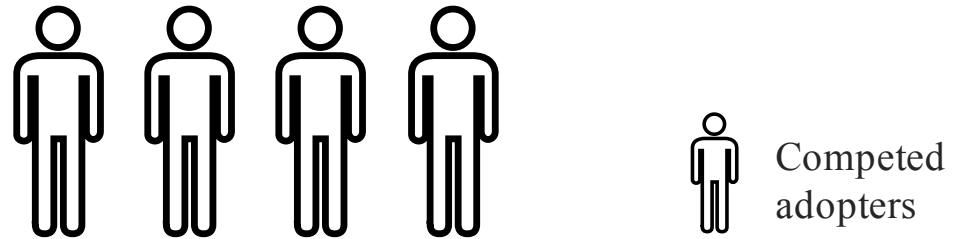
ECMs affecting the same baseline market are competed to remove savings overlaps

- ECM capital and operating costs determine their competed market shares
- Competition allows aggregation of savings impacts across ECM portfolio

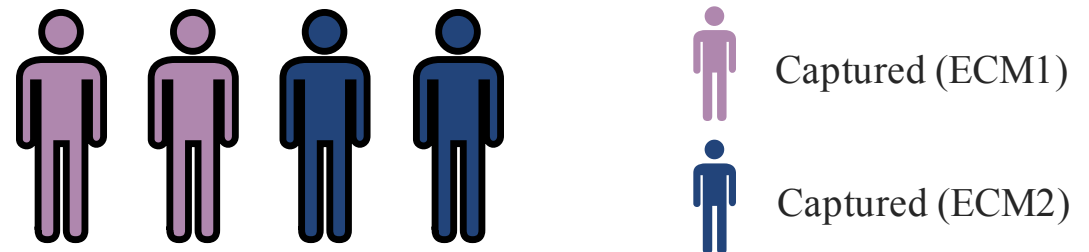
1 Determine competing ECM incremental unit capital/operating costs



1 Determine size of competed market (total primary energy)

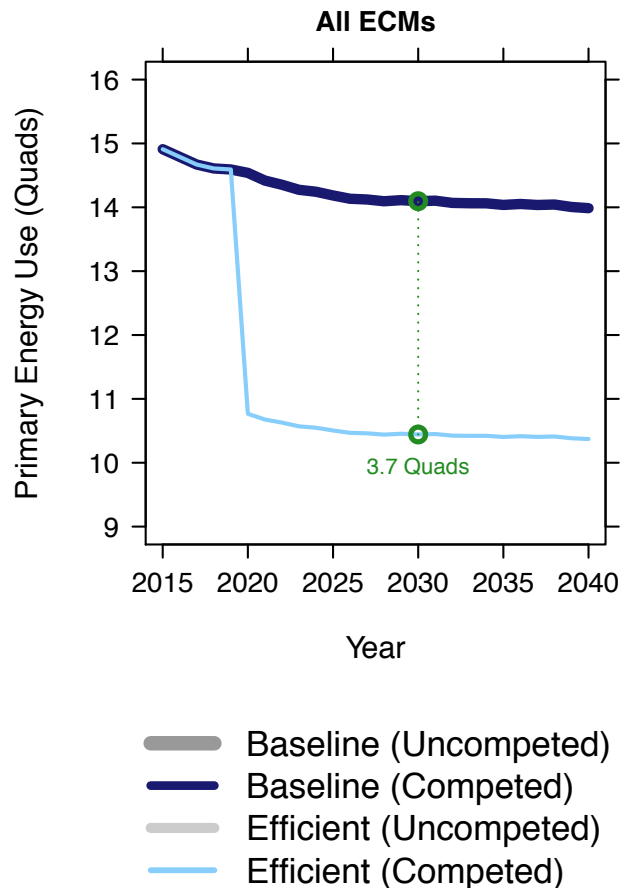


1 Apportion competed market across ECMs using logit model (residential) and cost model (commercial)



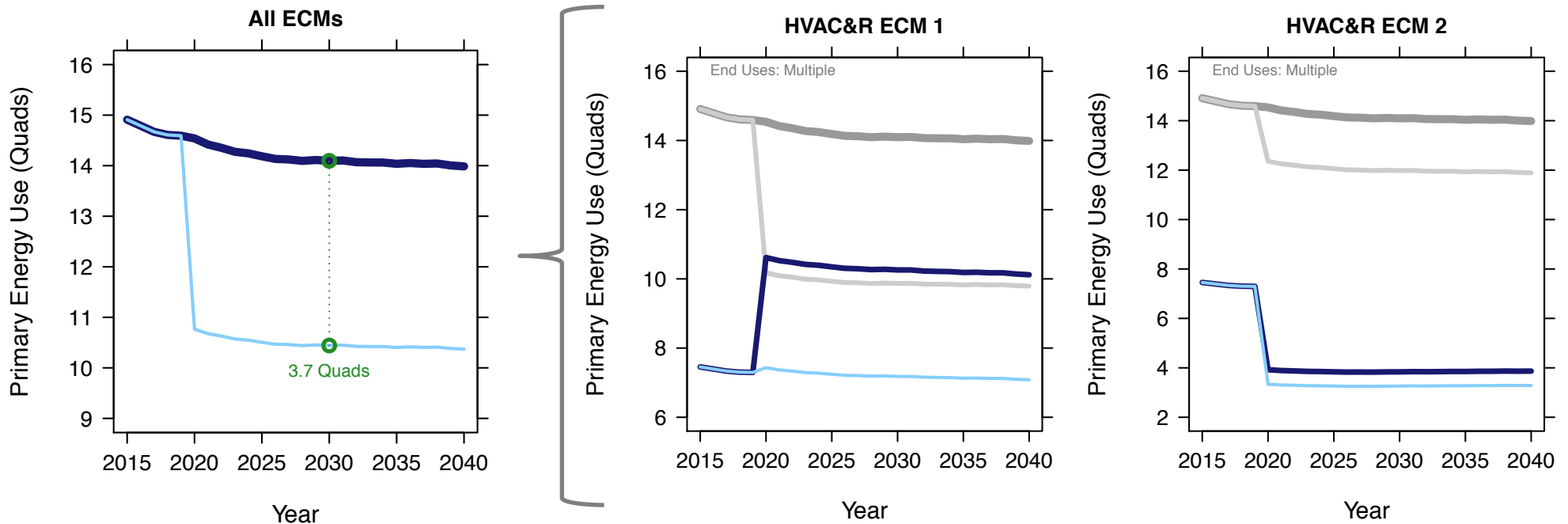
ECMs affecting the same baseline market are competed to remove savings overlaps

- Competed Baseline and Efficient results are summed across all ECMs



ECMs affecting the same baseline market are competed to remove savings overlaps

- Competed Baseline and Efficient results are summed across all ECMs



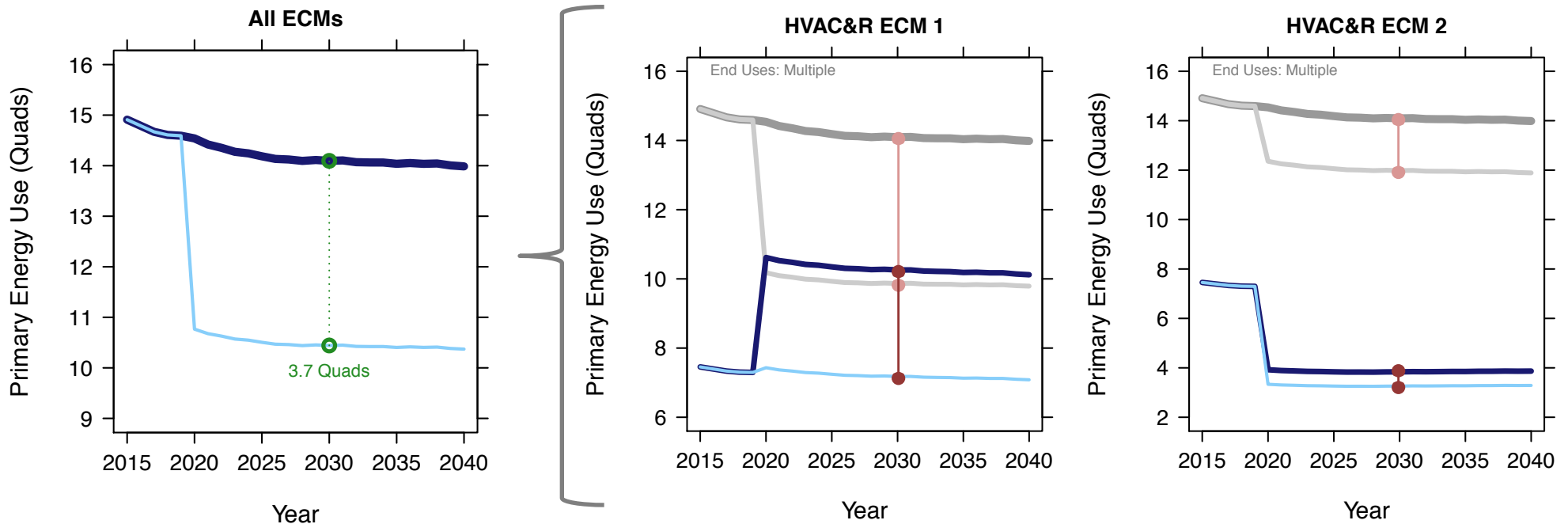
- Baseline (Uncompeted)
- Baseline (Competed)
- Efficient (Uncompeted)
- Efficient (Competed)

Accounting trick: baseline market apportioned among ECMs

- ECM1 baseline increases because ECM2 captures small fraction
- ECM2 baseline decreases because ECM1 captures large fraction
- Look strange individually, but **competed numbers** should add up

ECMs affecting the same baseline market are competed to remove savings overlaps

- Competed Baseline and Efficient results are summed across all ECMs



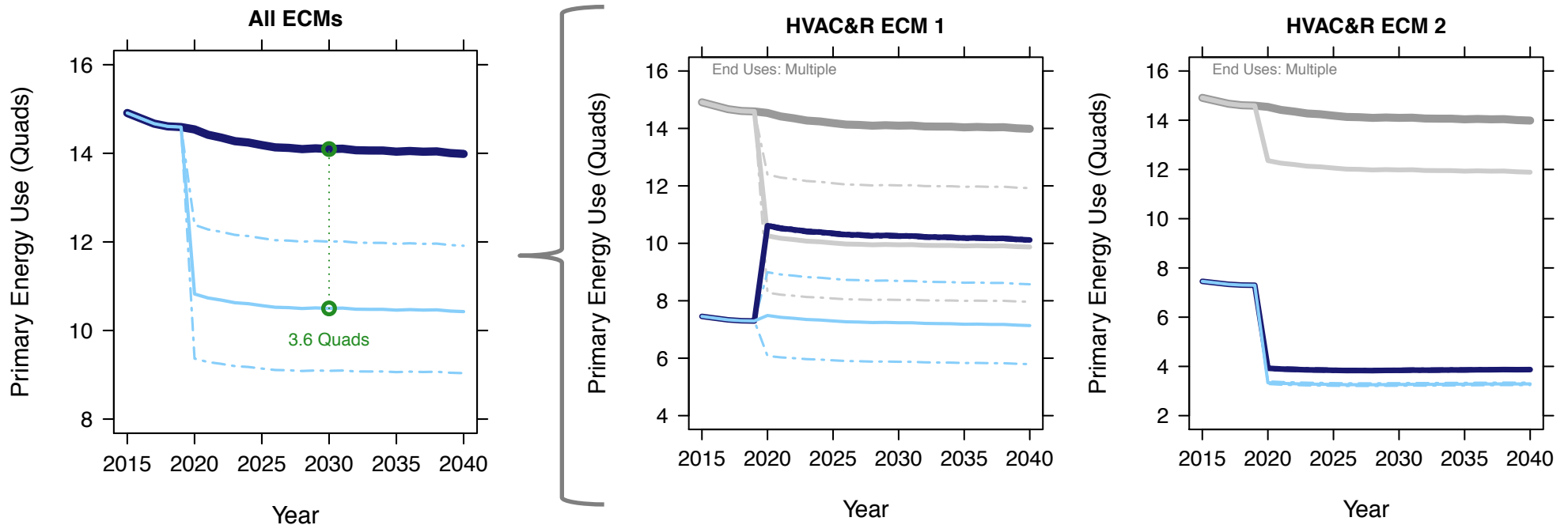
- Baseline (Uncompeted)
- Baseline (Competed)
- Efficient (Uncompeted)
- Efficient (Competed)

Uncompeted/competed savings impacts

- Uncompeted savings add up to more than total
- Competed savings add up to total savings

ECMs affecting the same baseline market are competed to remove savings overlaps

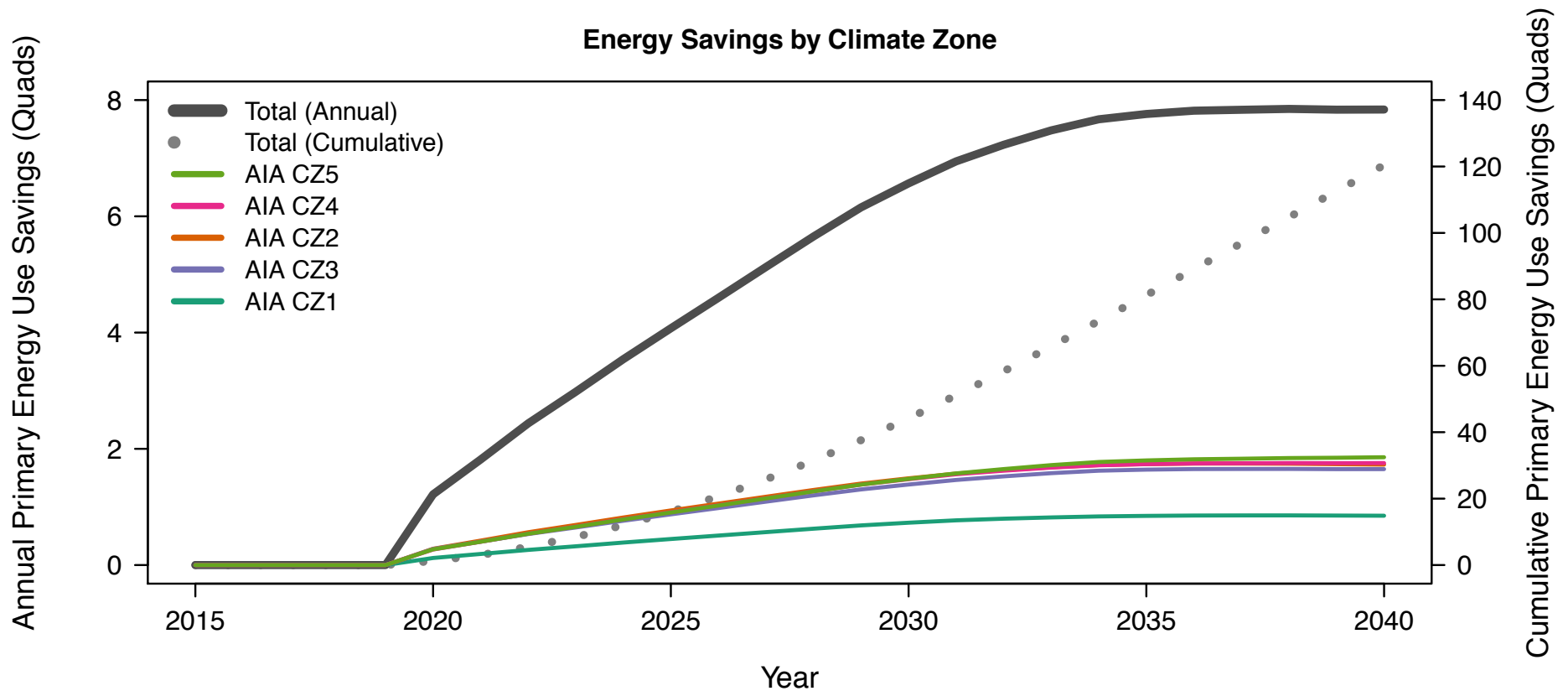
- Uncertainty assigned to ECM inputs propagates through to competed outputs



- Baseline (Uncompeted)
- Baseline (Competed)
- Efficient (Uncompeted)
- Efficient (Competed)
- - - Efficient (Uncompeted, 5th/95th PCT)
- - - Efficient (Competed, 5th/95th PCT)

ECM portfolio impacts can be examined by climate zone, building class, and end use

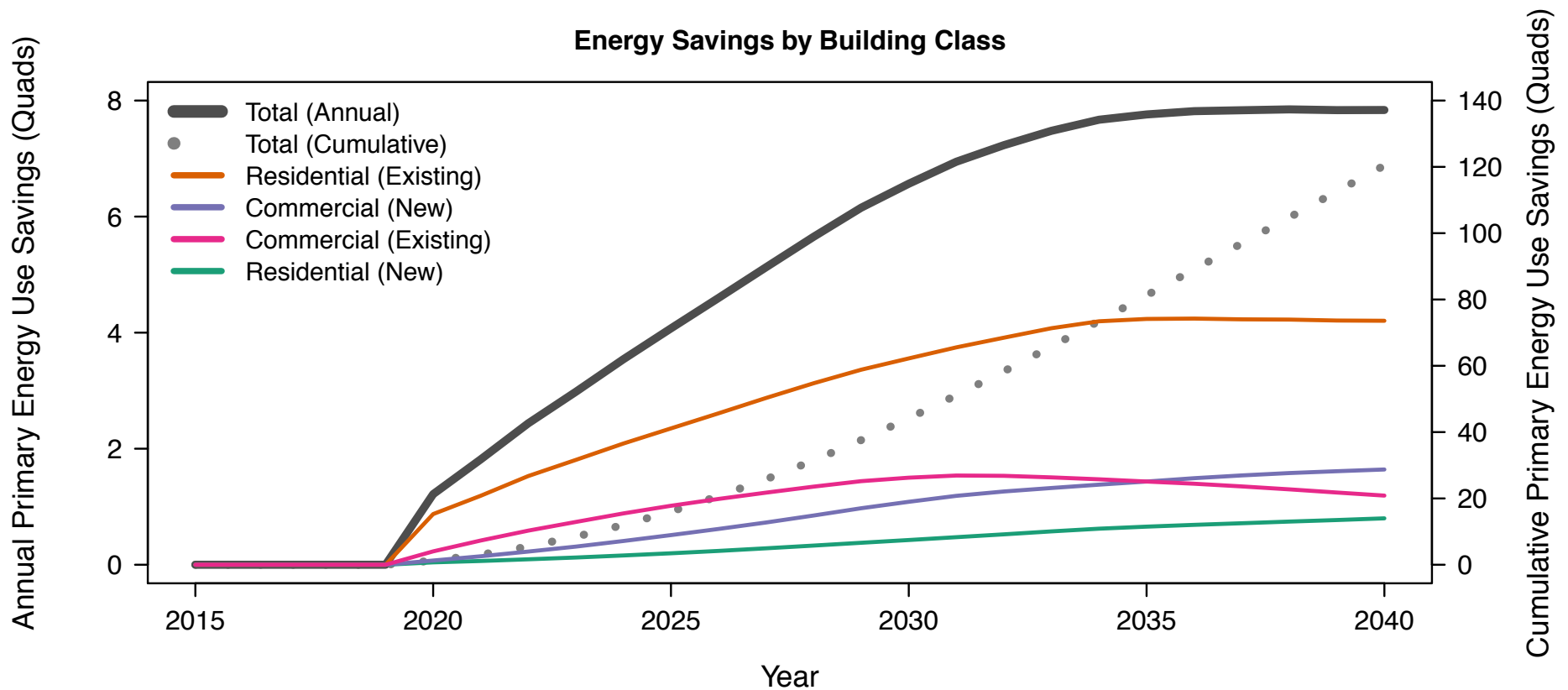
- Example finding: Savings are generally even across climates, but lower in AIA CZ1 (North), owing to a lower population



* Results based on prospective ECM portfolio with 2020 market entry years

ECM portfolio impacts can be examined by climate zone, building class, and end use

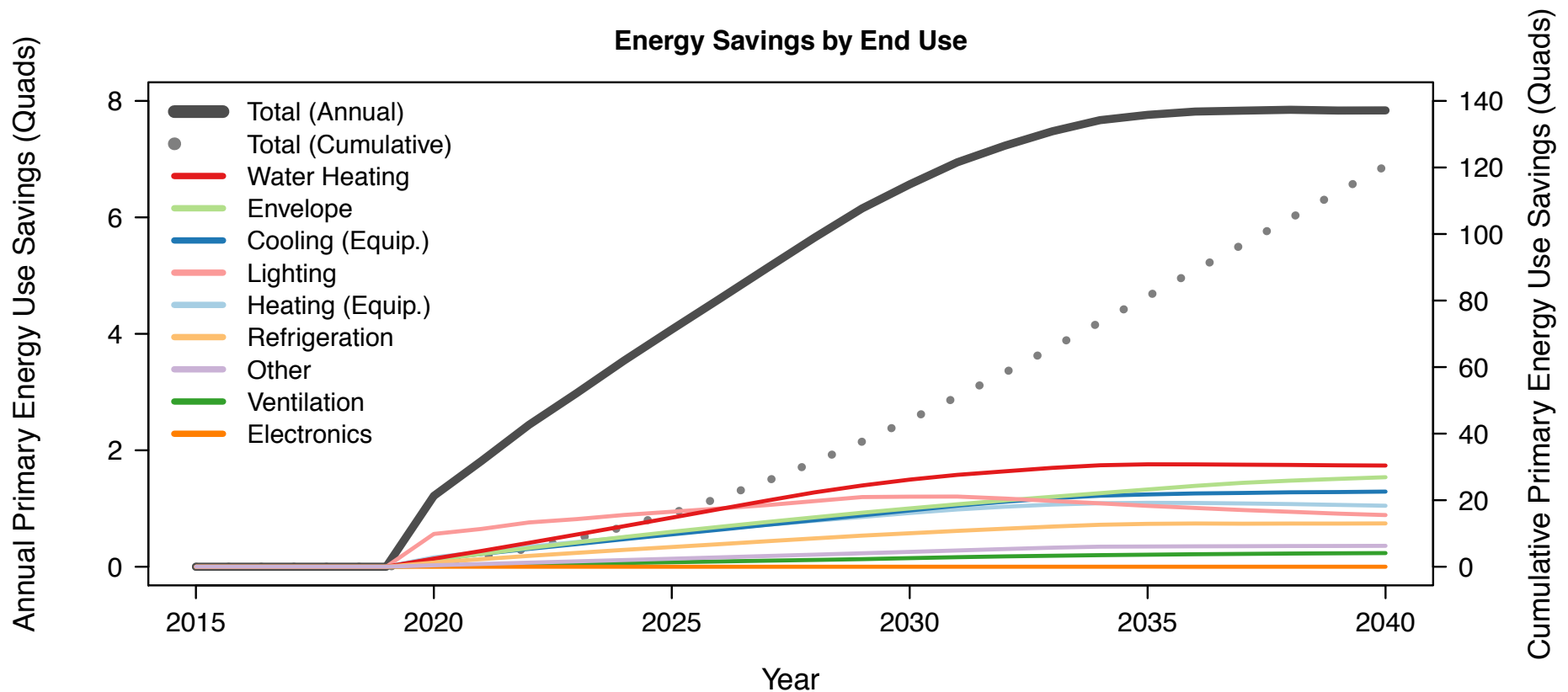
- Example finding: Savings are largest in residential existing buildings; savings in existing buildings decline as more new buildings accumulate



* Results based on prospective ECM portfolio with 2020 market entry years

ECM portfolio impacts can be examined by climate zone, building class, and end use

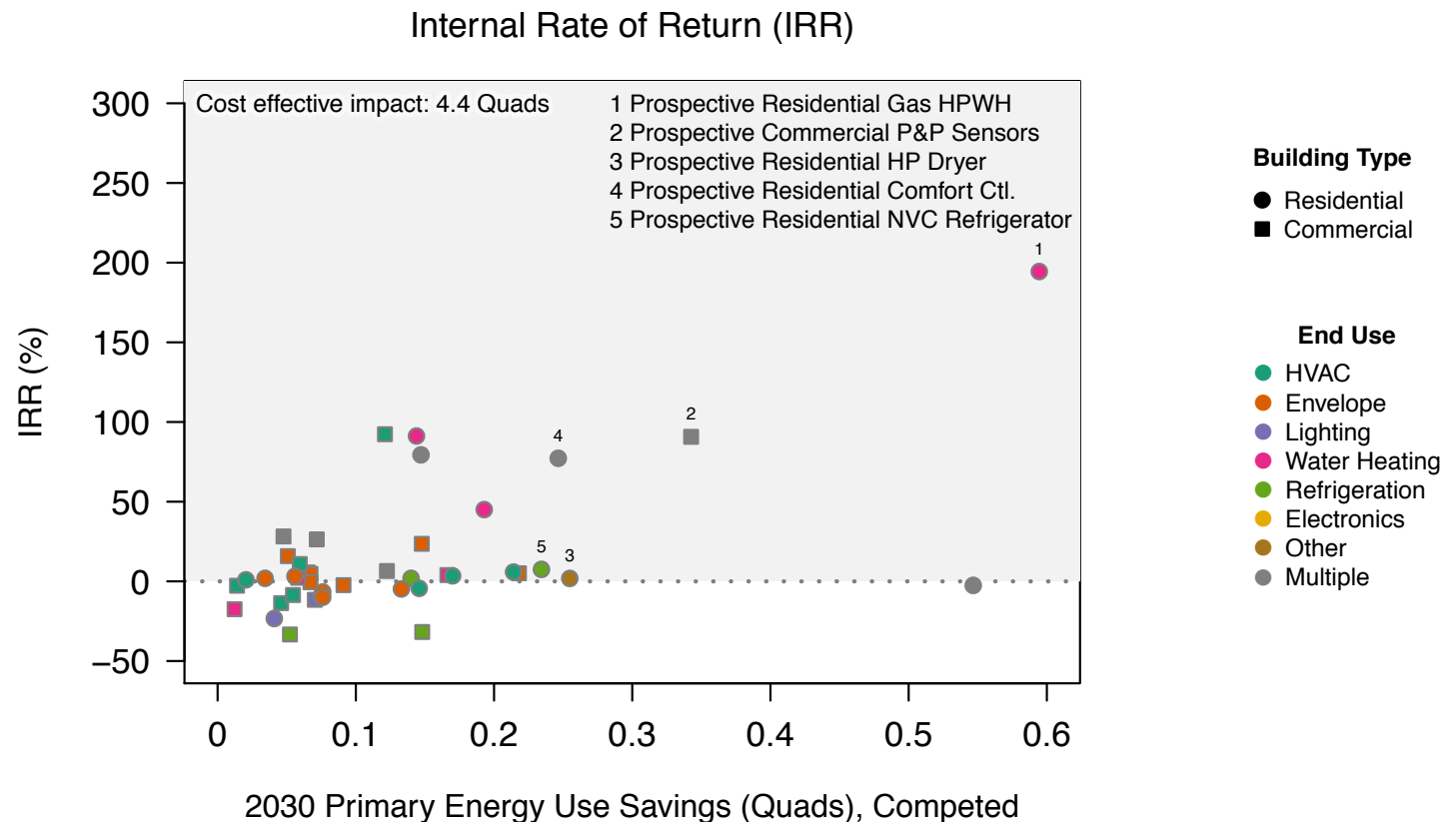
- Example finding: Water heating and envelope/HVAC show largest savings; lighting savings spike early due to quick turnover in baseline technologies



* Results based on prospective ECM portfolio with 2020 market entry years

ECM impacts can be compared against multiple cost effectiveness metrics

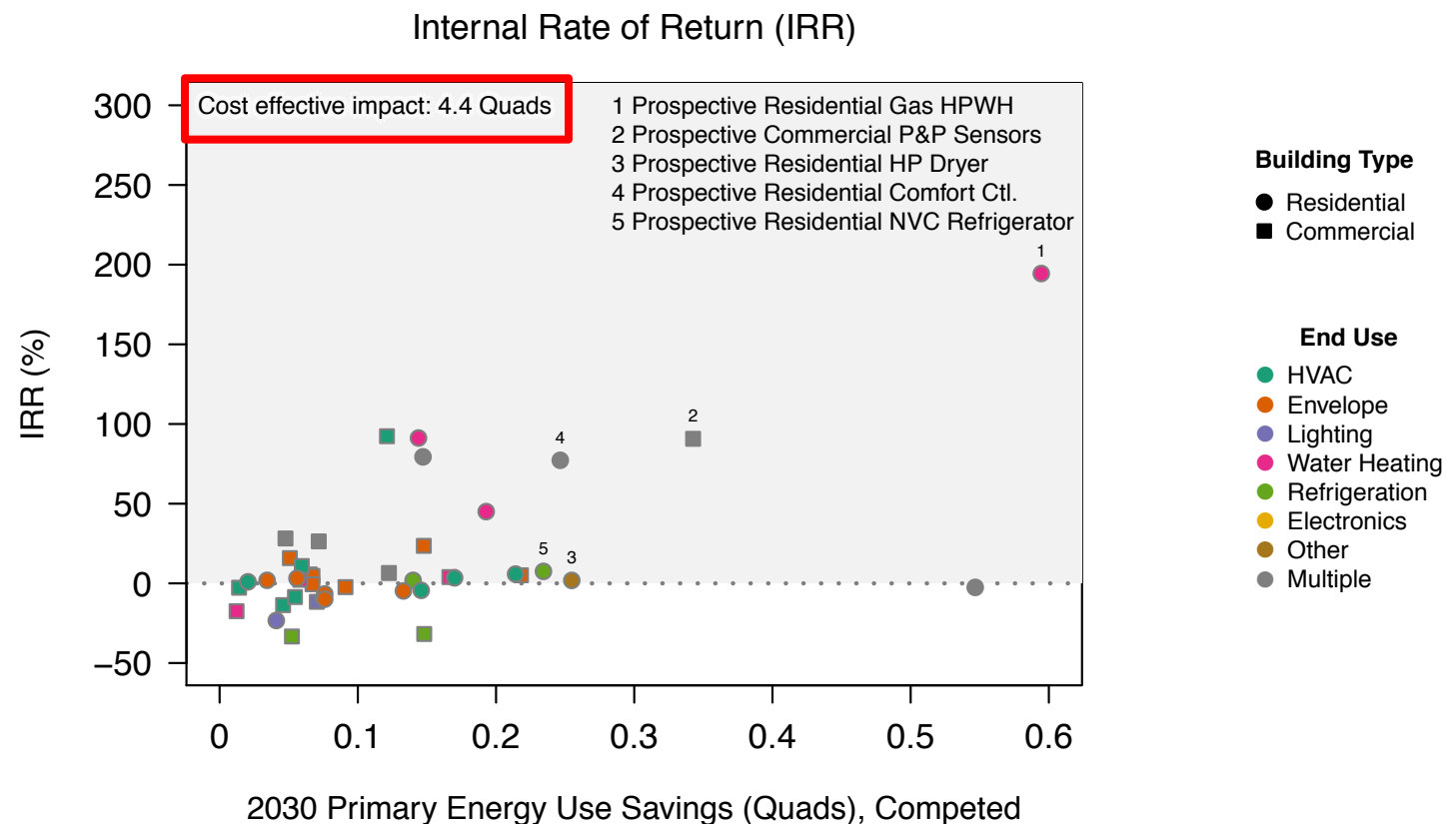
- Example finding: Under a consumer-focused cost effectiveness threshold ($IRR > 0$), 4.4 quads savings in 2030 are cost-effective; most top 5 ECMs are residential



* Results based on prospective ECM portfolio with 2020 market entry years

ECM impacts can be compared against multiple cost effectiveness metrics

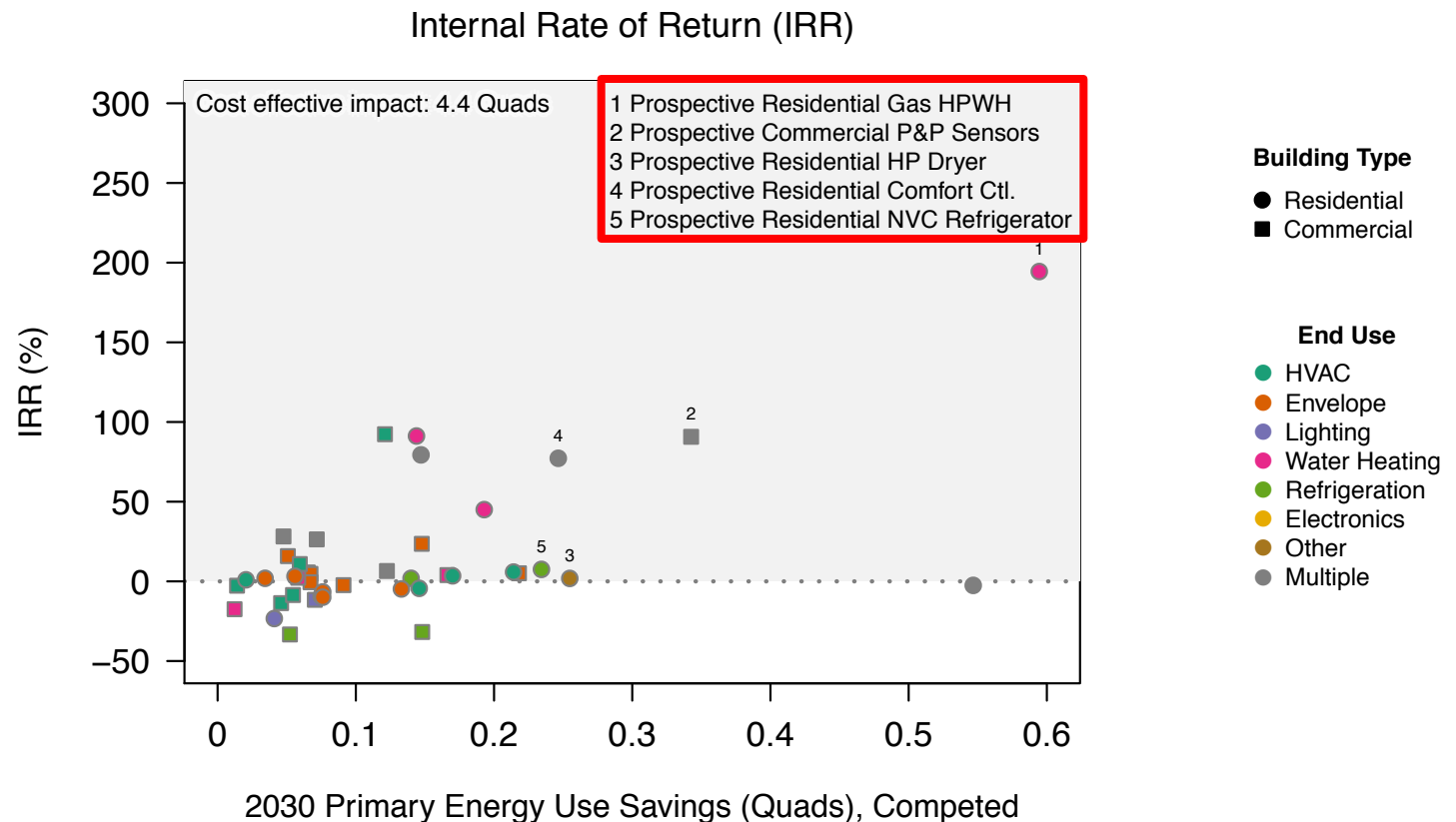
- Example finding: Under a consumer-focused cost effectiveness threshold ($IRR > 0$), 4.4 quads savings in 2030 are cost-effective; most top 5 ECMs are residential



* Results based on prospective ECM portfolio with 2020 market entry years

ECM impacts can be compared against multiple cost effectiveness metrics

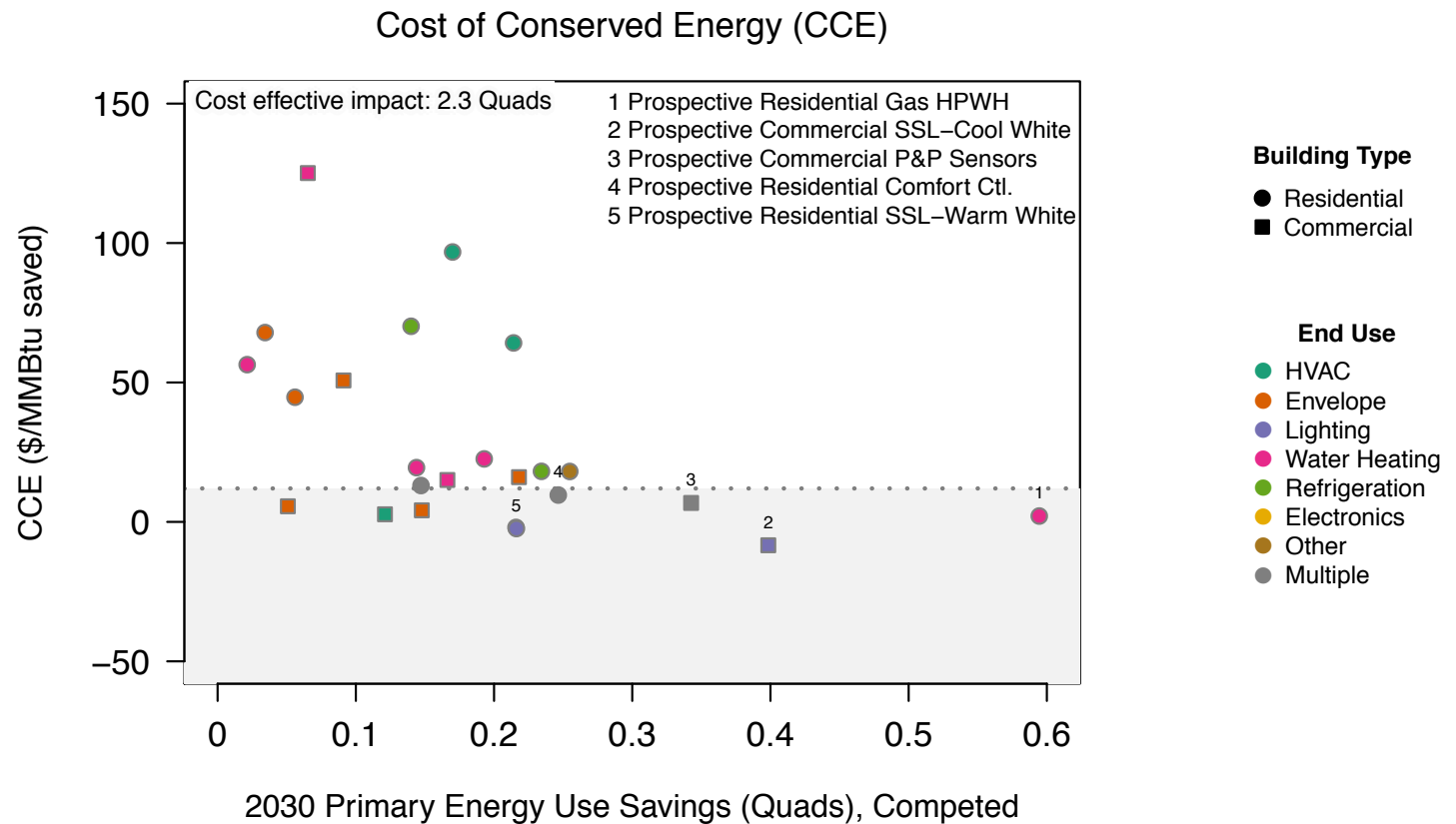
- Example finding: Under a consumer-focused cost effectiveness threshold ($IRR > 0$), 4.4 quads savings in 2030 are cost-effective; most top 5 ECMs are residential



* Results based on prospective ECM portfolio with 2020 market entry years

ECM impacts can be compared against multiple cost effectiveness metrics

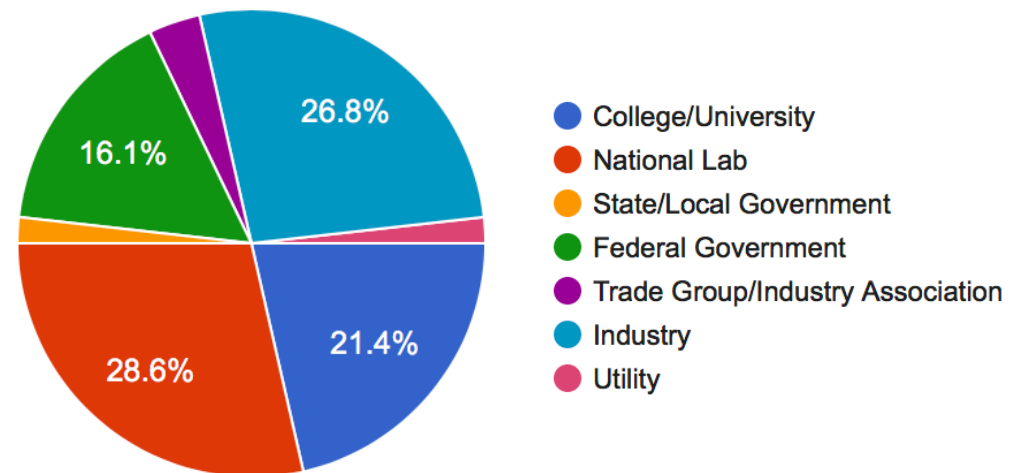
- Example finding: Under a portfolio-focused cost effectiveness threshold (CCE < energy cost), 2.3 quads savings in 2030 are cost-effective; lighting ECMs move into top 5



* Results based on prospective ECM portfolio with 2020 market entry years

Scout beta testing release is out; subsequent testing depends on results

- Follows round of internal alpha testing at BTO to identify bugs, streamline workflow
- Beta testing goals
 - Familiarize testers with Scout
 - Determine Scout's value across multiple organization types
 - Evaluate aspects of the Scout user experience

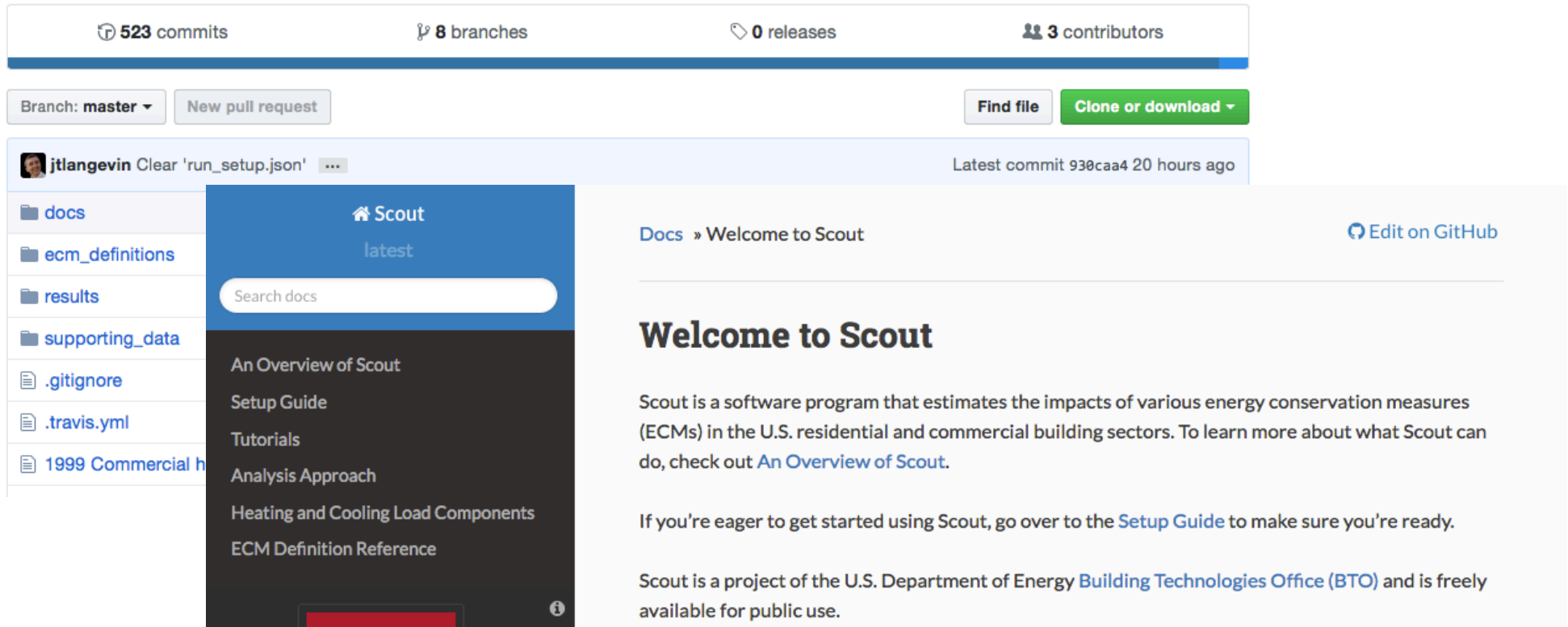


BTO recently distributed a beta release of Scout to a targeted mix of stakeholders (N=57).

Let us know you'd like to participate in future testing:

<https://goo.gl/forms/1a7t6Z4Mg7r33S7N2>

Extensive user documentation and tutorials have been developed



The screenshot displays the GitHub repository for the Scout project. At the top, it shows 523 commits, 8 branches, 0 releases, and 3 contributors. The current branch is 'master', and there is a 'New pull request' button. A search bar and 'Find file' button are present, along with a 'Clone or download' button. The repository owner is 'jtlangevin', and the latest commit is '930caa4' from 20 hours ago. The left sidebar shows the file structure: docs, ecm_definitions, results, supporting_data, .gitignore, .travis.yml, and 1999 Commercial h. The main content area shows the 'Welcome to Scout' page, which includes a search bar, a list of documentation topics (An Overview of Scout, Setup Guide, Tutorials, Analysis Approach, Heating and Cooling Load Components, ECM Definition Reference), and a link to 'Edit on GitHub'. The page text describes Scout as a software program that estimates the impacts of various energy conservation measures (ECMs) in the U.S. residential and commercial building sectors. It also mentions that Scout is a project of the U.S. Department of Energy Building Technologies Office (BTO) and is freely available for public use.

Access the documentation and find out how to contribute:

<https://github.com/trynthink/scout#scout->

Web interface is under development; results visualizations prototype complete

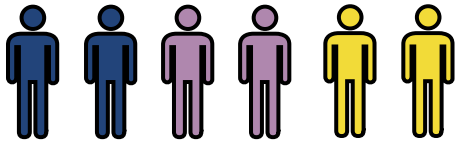
The interface includes a sidebar with filters for Group By (End Uses, Climate Zones, Building Class), Adoption Scenario (Technical Potential, Max Adoption Potential), Year Range (2017 to 2040), End Uses (Heating, Cooling, Envelope, Ventilation, Lighting, Water Heating, Refrigeration, Electronics, Other), and Climate Zones (AIA CZ1 to AIA CZ5).

The 'ECM Cost Effectiveness' section displays the following metrics:

- 1,803 Billion \$ Total Avoided Costs
- 1,494 Billion \$ Avoided Energy Costs
- 309 Billion \$ Avoided CO₂ Costs
- 6,248 Mt Avoided CO₂ Emissions
- 119 Quads Avoided Energy Use

The scatter plot shows Average Payback (Y-axis, 15-25 years) versus IRR (X-axis, 2017-2040) for various end uses. The line graph shows Energy (Quads), CO₂ (MMT), and Cost (\$) trends from 2010 to 2045 for three scenarios: Baseline Case, Efficient (Technical Potential Adoption), and Efficient (Max Adoption Potential).

Technical improvements can be integrated into existing Scout codebase

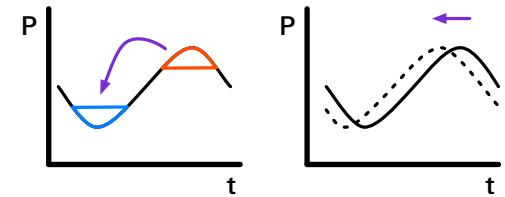


Consumer adoption modeling

Improve understanding of EE uptake vs. conventional options



OpenStudio integration
Streamline transfer of OS results to Scout ECM inputs, add residential OS stock models



Peak demand/demand-response ECMs
Incorporate marginal emissions rates, time of use



Update thermal load components
Existing data from 1999 studies



Benchmark savings against TRMs
Verify consistency in ECM definitions

Icon attributions

Slide 2: LED (Nikita Kozin); Water heater (Michael Thompson); Air conditioning unit (Arthur Shlain); Fan (Edward Boatman); Refrigerator (shashank singh); Washing machine (Ed Harrison); Window (Arthur Shlain); Utility tower (Maurizio Fusillo); Lab scientist (Edward Boatman); Business team (lastpark); Energy dollar (Nicholas Menghini); United States (Bohdan Burmich)

Slide 6: Calendar (Khomsun Chaiwong); Gauge (Nicolas Vicent); US Dollar (Christopher Beach); Clock (Nadya Bratt)

All icons available from the Noun Project
(thenounproject.com)