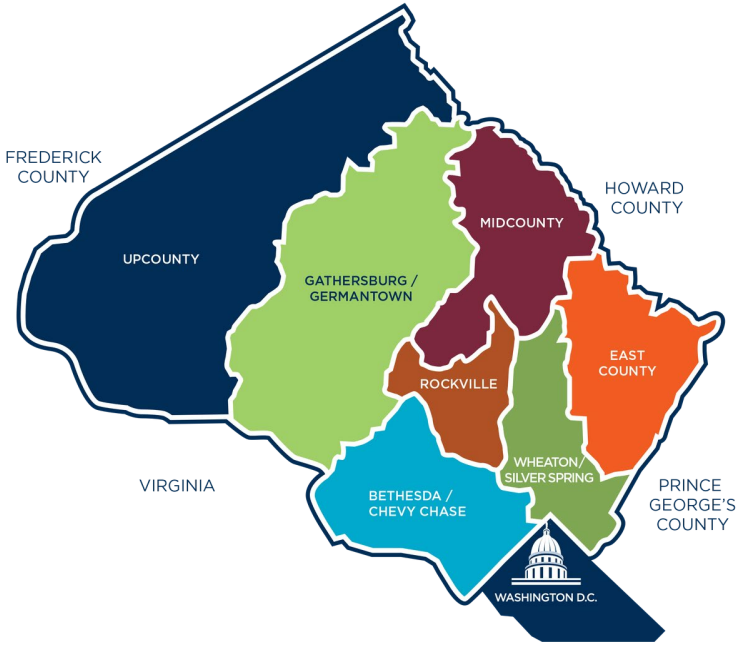
March 14, 2022

Building Energy Performance Standards (Bill 16-21): BEPS Technical Report

Standard Setting Research to Inform Regulations



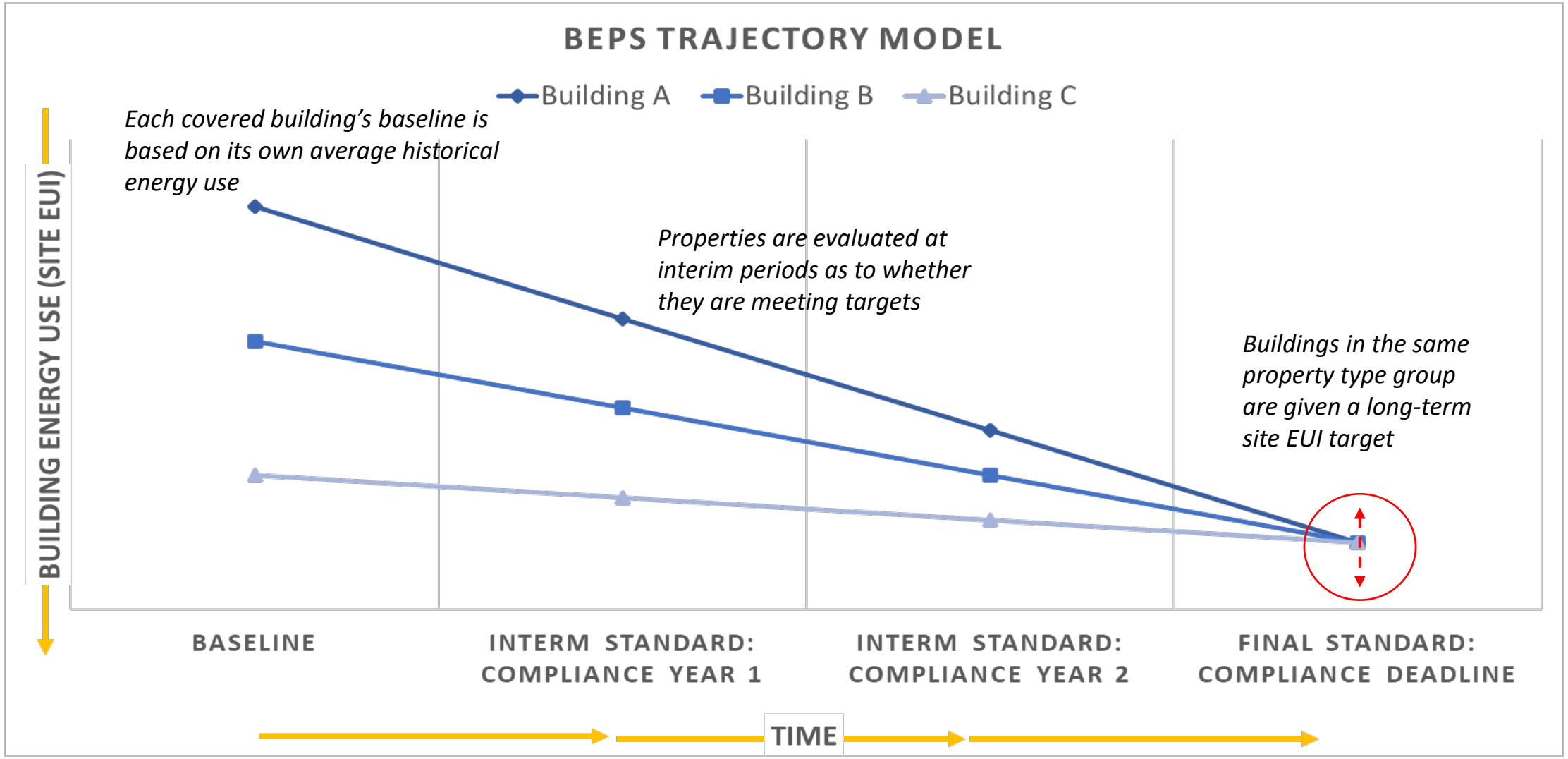
Learn more at https://www.montgomerycountymd.gov/green/energy/beps.html

Briefing Agenda

- Methodology for BEPS Technical Report Analyses
- Site EUI Target Calculation Approach
- Site EUI Options
- Building Inventory Analysis
- Impacts of BEPS Target Options:
  - County-wide Energy and GHG Benefits
  - Cumulative GHG Emissions Impacts
  - Financial Costs and Savings
- Case Studies
- Concluding Takeaways

BEPS Policy Overview

- Final standard (to be defined by regulation) will dictate scale of investments and emissions reductions



High-Level Methodology of BEPS Technical Analysis

Covered Buildings

- Develop an approximate covered buildings list
- Group covered buildings into building types to evaluate a range of technically feasible site EUI targets

Standard Setting Options

- Establish a recommended method for setting building performance standards
  - Use typical energy use profiles in building types representative of buildings in Montgomery County
  - Assume retrofits using commercially available technology

County-Wide Impacts

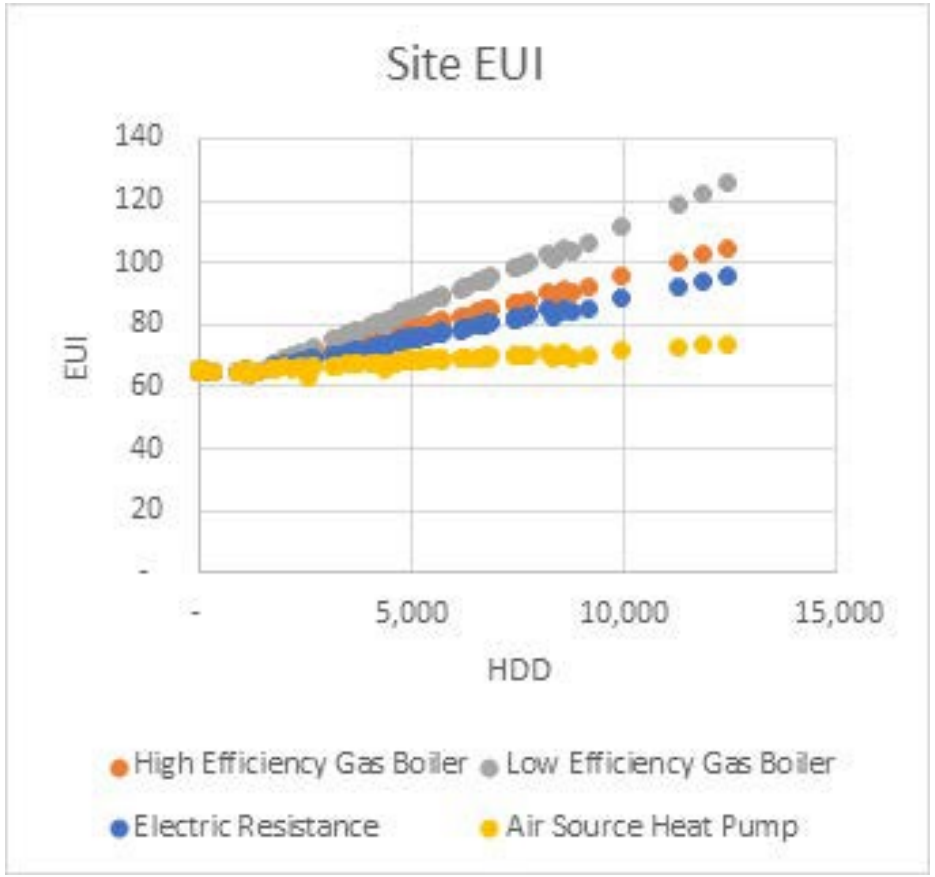
- Model county-wide impacts of potential BEPS targets to estimate:
  - Energy savings
  - GHG reductions
  - Cost savings
  - Cost impacts

Case Studies

- Select buildings representative of primary building types that would have to meet a BEPS target
- Create retrofit packages via desk audits to:
  - Test technical feasibility of potential site EUI targets,
  - Estimate the total capital costs,
  - Estimate energy cost savings of meeting targets

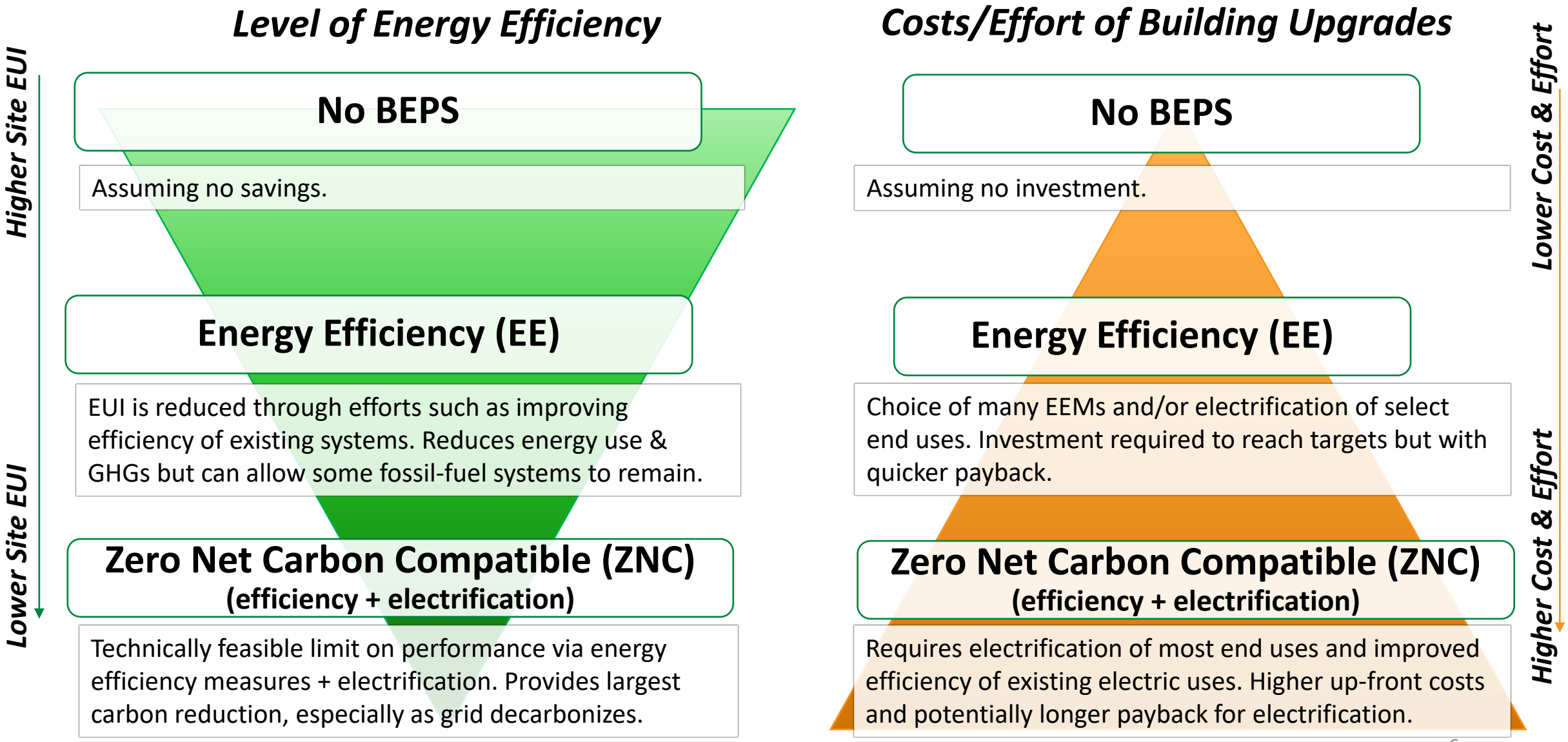
Electrification and Site Energy Use Intensity (site EUI)

- Site EUI measures energy use per square foot per year.
- The Site EUI metric in Bill 16-21 favors electrification regardless of the efficiency of the electric technology.
- **Electrification is one of the deepest forms of energy efficiency because electric equipment operates at higher efficiency than fuel-fired equipment.**
- Setting a low BEPS site EUI target would require buildings to electrify end uses efficiently over time *and* improve electric efficiency.



Source: US EPA, Understanding and Choosing Metrics for Building Performance Standards and Zero-Carbon Recognition, May 2021

Overview of BEPS Standard-Setting Approach Options



Target Method 1: Energy Efficiency (EE) Target

- Achievable through energy efficiency measures for the typical building.
  - Most buildings should be able to achieve these reductions through efficiency and equipment optimization of electric and fossil fuel-based systems.
  - For some buildings, the easiest pathway may be electrifying some systems. Electrification is a very effective site EUI energy efficiency measure.
- Calculated by applying a moderate reduction of energy use to the typical building in each building type:

End Use	Percent reduction from the localized median EUI for EE target
Electricity	15%
Gas Space Heating	20%
Gas Water Heating	10%
Gas Cooking	0%
Gas Laundry/Other	0%

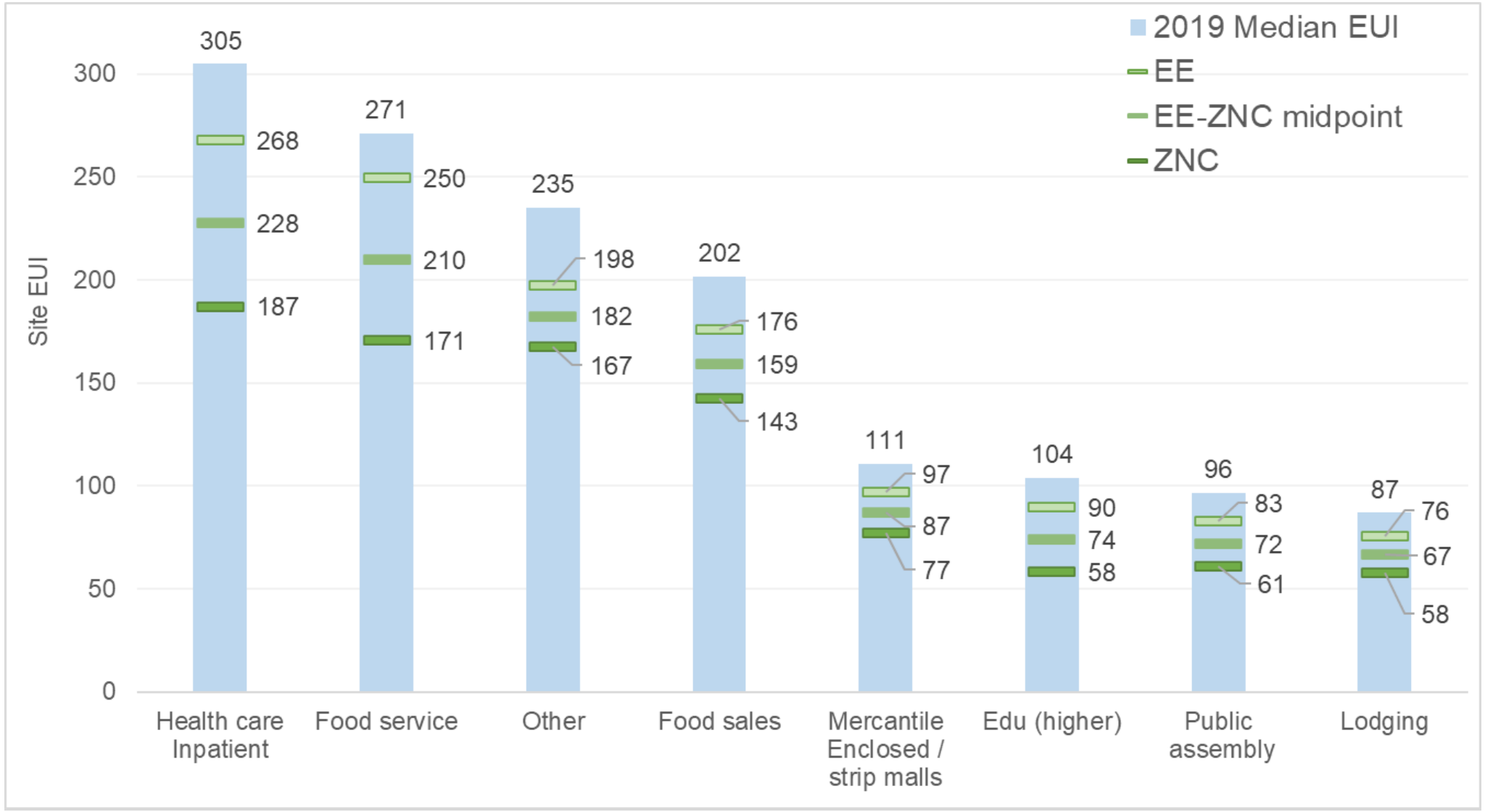
Target Method 2: Zero-Net Carbon Compatible (ZNC) Target

- An EUI level simulating the electrification of all fossil fuel end uses using market-ready technology in an energy efficient building.
- The ZNC targets are a technically feasible limit on building energy performance for each group

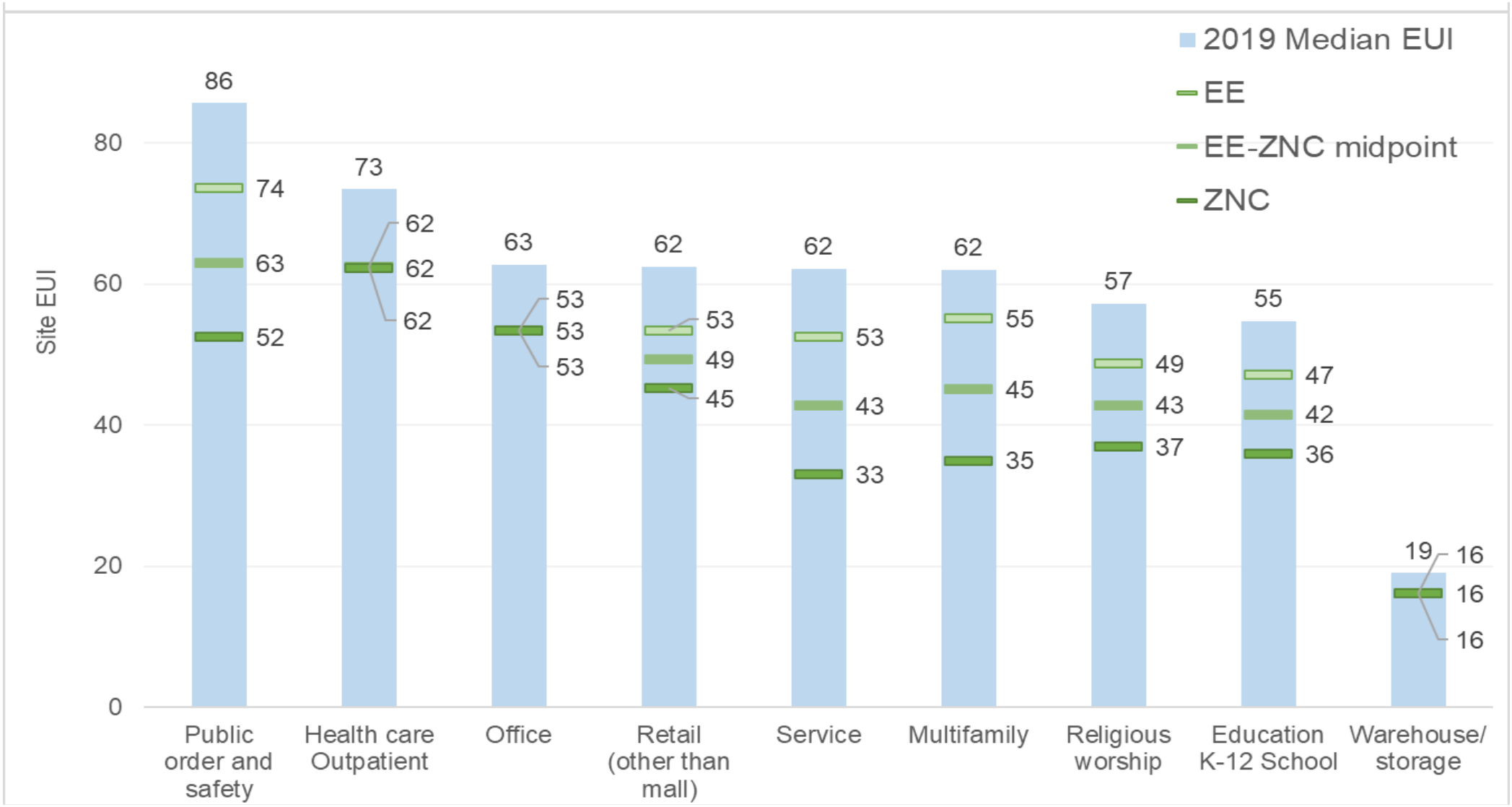
End Use	Percent reduction from the localized median EUI for EE target	Additional percent reduction starting from the EE target for ZNC target
Electricity	15%	0% (no further change)
Gas Space Heating	20%	68%, all electric (COP* 0.80 → 2.50)
Gas Water Heating	10%	59%, all electric (COP 0.90 → 2.20)
Gas Cooking	0%	39%, all electric (COP 0.45 → 0.74)
Gas Laundry/Other	0%	11%, all electric (COP 0.90 → 1.00)

**COP is the Coefficient of Performance of the equipment, defined as energy output (heat) divided by purchased energy input (gas or electricity). A COP of 0.8 is an annual efficiency of 80%. A heat pump can operate at average efficiencies of 250% (COP of 2.50) by extracting heat from the outside air.*

Site EUI Options from BEPS Technical Report (1 of 2)



Site EUI Options from BEPS Technical Report (2 of 2)



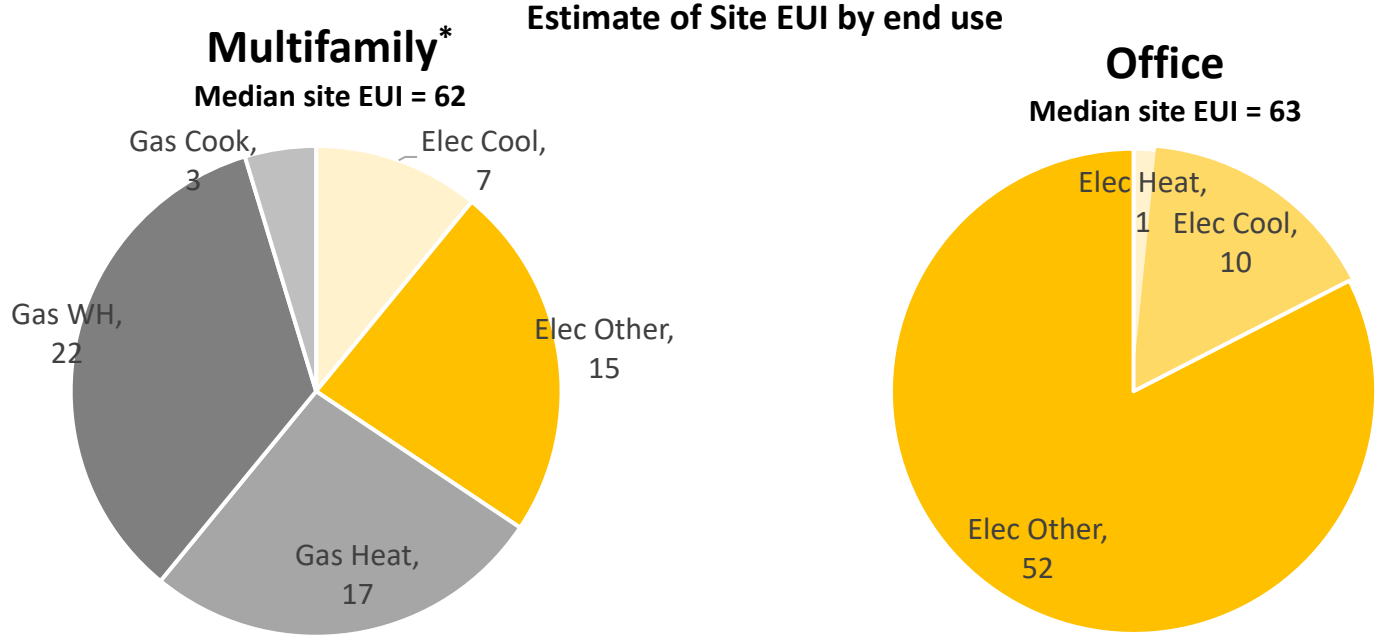
Site EUI Options from BEPS Technical Report

Building Type	2019 Median	EE	EE-ZNC Mid-Point	ZNC	% of covered area	% reduction from median needed for ZNC
Multifamily	62	55	45	35	34%	44%
Office	63	53	53	53	31%	16%
Enclosed/Strip Mall	111	97	87	77	7%	31%
Health Care Inpatient	305	268	228	187	4%	39%
Lodging	87	76	67	58	4%	33%
Warehouse/storage	19	16	16	16	4%	16%
Other	235	198	182	167	3.5%	29%
Retail	62	53	49	45	3.1%	27%
Food Sales	202	176	159	143	2.5%	29%
Public Assembly	96	83	72	61	2.1%	36%
K-12 School	55	47	42	36	1.8%	35%
Religious worship	57	49	43	37	1.5%	35%
Health Care Outpatient	73	62	62	62	1.3%	15%
Higher Education	104	90	74	58	0.2%	44%
Public Order/Safety	86	74	63	52	0.2%	40%
Food Service	271	250	210	171	0.01%	37%

Example Building Types – Achievable Savings

- Different buildings types use energy differently to meet their occupancy needs, and source that energy in different ways
- Some building types are already substantially electric (e.g., offices)
- Building types with large gas uses have more potential for reductions in site EUI (e.g., multifamily)

Estimate of Site EUI by end use



Site EUI	2019 Median	EE % reduction from median	Mid-Point % reduction from median	ZNC % reduction from median
Multifamily	62	11%	27%	**44%**
Office	63	16%	16%	**16%**

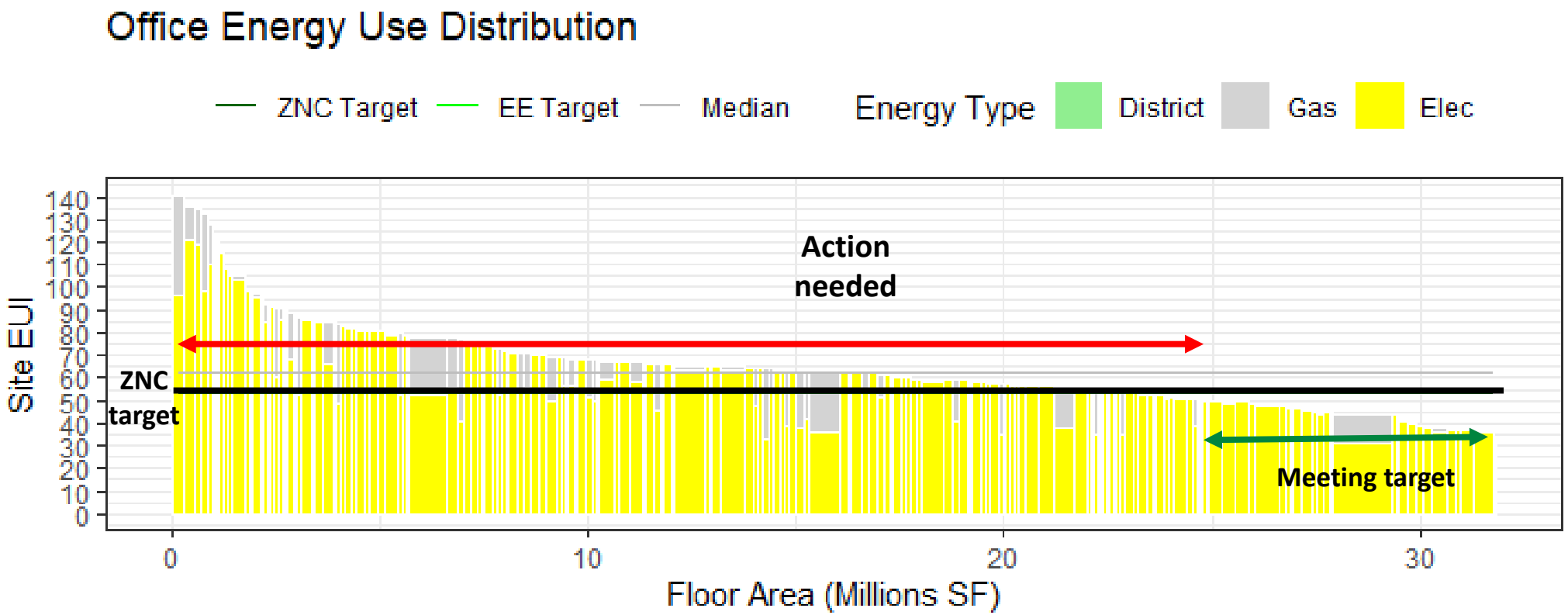
* MF, Old, Tall typology from DC benchmarking data

% of Buildings Needing to Reduce Site EUI to Reach Target

	Total covered	EE	EE-ZNC midpoint	ZNC
Office	391	81%	81%	81%
MF-New-Tall *(built after 1980, 4 stories and up)*	145	38%	59%	79%
Warehouse and storage	144	51%	51%	51%
MF-Short *(3 stories and shorter)*	101	56%	67%	89%
MF-Old-Tall *(built before 1980, 4 stories and up)*	90	70%	80%	90%
Mercantile Retail (other than mall)	82	71%	71%	71%
Other	76	66%	74%	74%
Lodging	73	60%	84%	93%
Religious Worship	71	61%	70%	70%
Food Sales	55	76%	76%	89%
Public Assembly	53	53%	53%	64%
Mercantile Enclosed and strip malls	45	64%	64%	69%
Education - K-12 School	40	83%	88%	98%
Health care Outpatient	38	87%	87%	87%
Public order and safety	11	100%	100%	100%
Health care Inpatient	10	100%	100%	100%
Education	3	33%	33%	33%
Food Service	1	100%	100%	100%
Total % of Buildings Needing To Reduce Site EUI to Reach Target	1429	**66%**	**72%**	**78%**

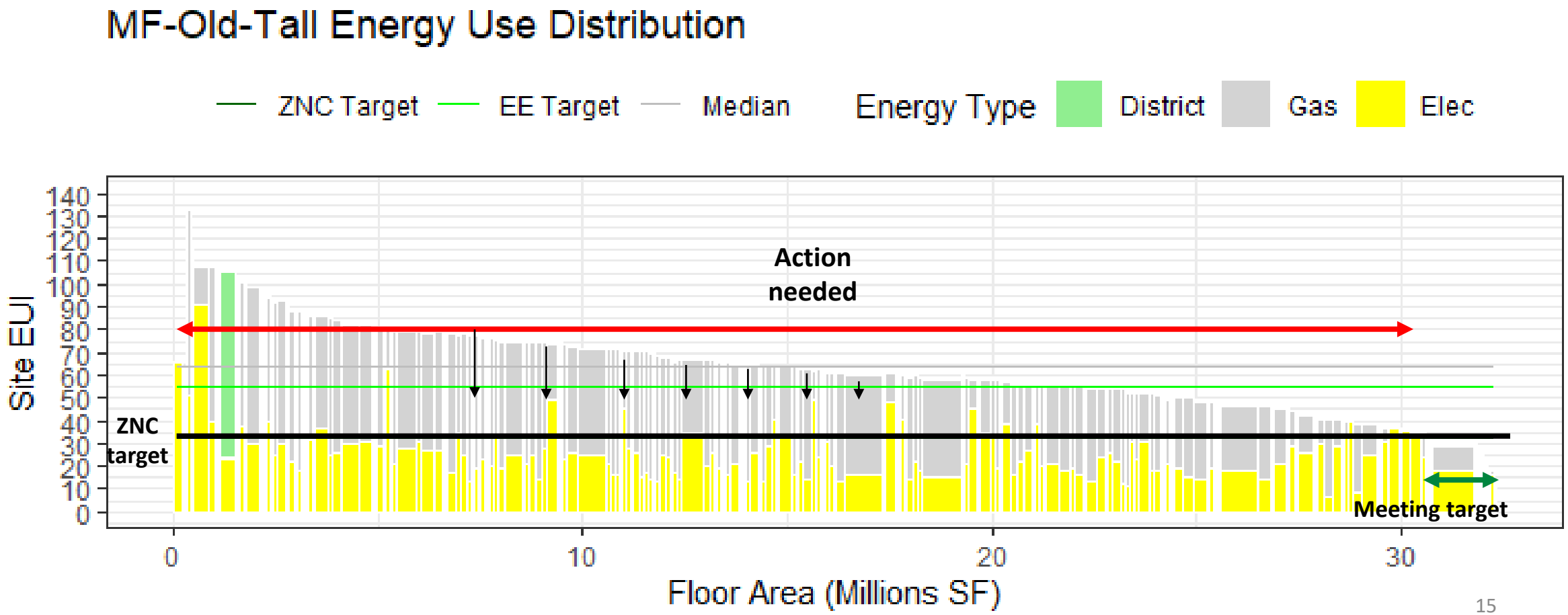
Energy Use & BEPS Targets, Sample Building Typologies

% of Buildings Needing to Reduce Site EUI to Reach Target	Total covered	EE	EE-ZNC midpoint	ZNC
Office	391	81%	81%	**81**%



Energy Use & BEPS Targets, Sample Building Typologies

% of Buildings Needing to Reduce Site EUI to Reach Target	Total covered	EE	EE-ZNC midpoint	ZNC
MF-Old-Tall *(built before 1980, 4 stories and up)*	90	70%	80%	**90%**



Impact: County-Wide Energy and Emissions Reductions

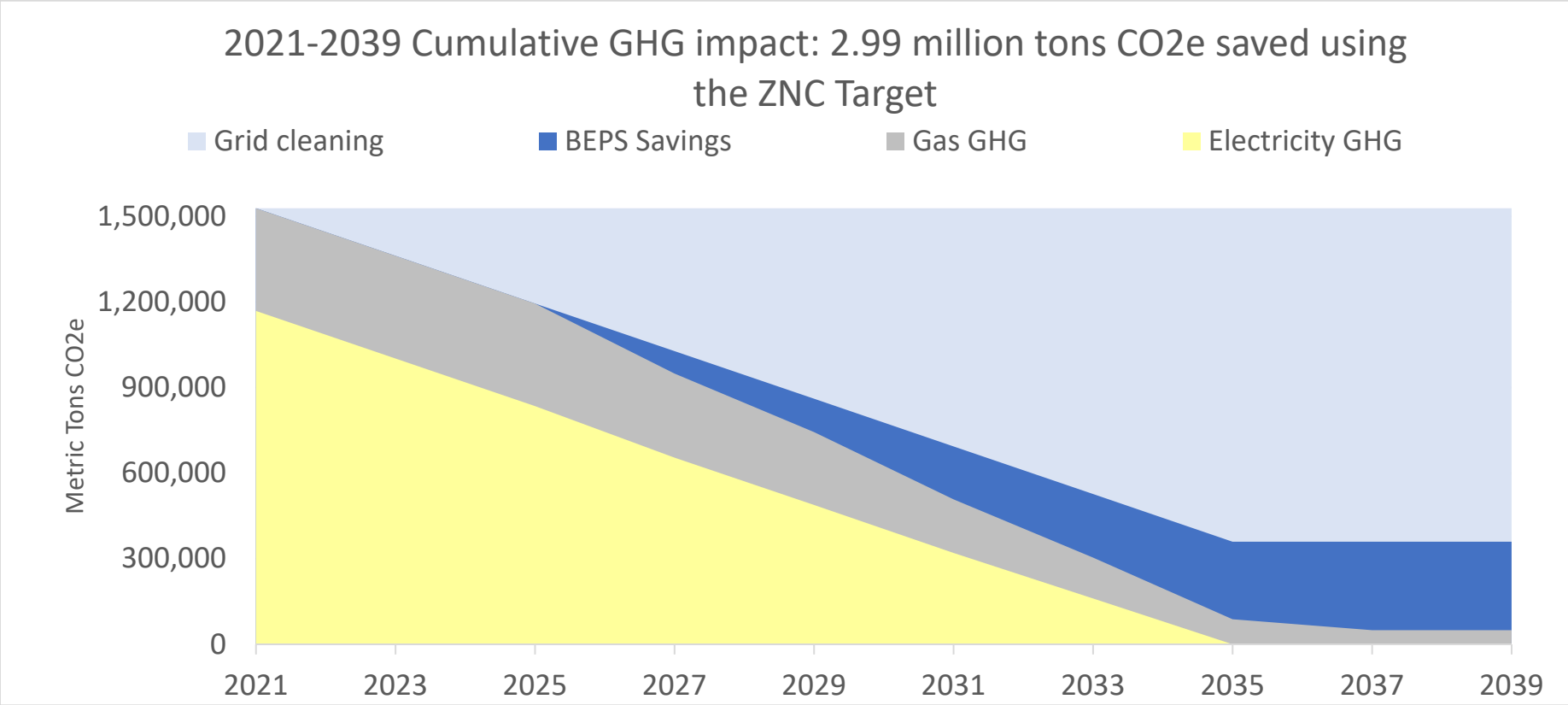
Selecting an EE target would allow new fossil-fuel equipment to be installed, locking buildings into a long period of fossil fuel use until the next replacement cycle, e.g., 15-20 years.

Selecting a ZNC target, if implemented along with the realization of a 100% carbon-free electricity supply, would result in the deepest emissions reductions.

	EE	EE-ZNC midpoint	ZNC
Reduction in Site EUI vs baseline	23%	28%	35%
Reduction in On-site Fossil Fuel Emissions	46%	66%	86%
Reduction in emissions vs baseline (**NO** change from today's grid)	19%	22%	26%
Reduction in emissions (carbon free electric supply)	87%	92%	97%

Impact: County's Cumulative GHG Emissions

- The transition to a carbon-free electricity supply will provide the most carbon emissions savings in buildings.
- BEPS enables further emissions reductions by:
  - Reducing on-site emissions through fossil fuel efficiency and/or electrification
  - Improving electric energy efficiency and easing the burden on the supply side to provide electricity from carbon-free sources



Impact: County-Wide Estimated Financial Costs and Savings

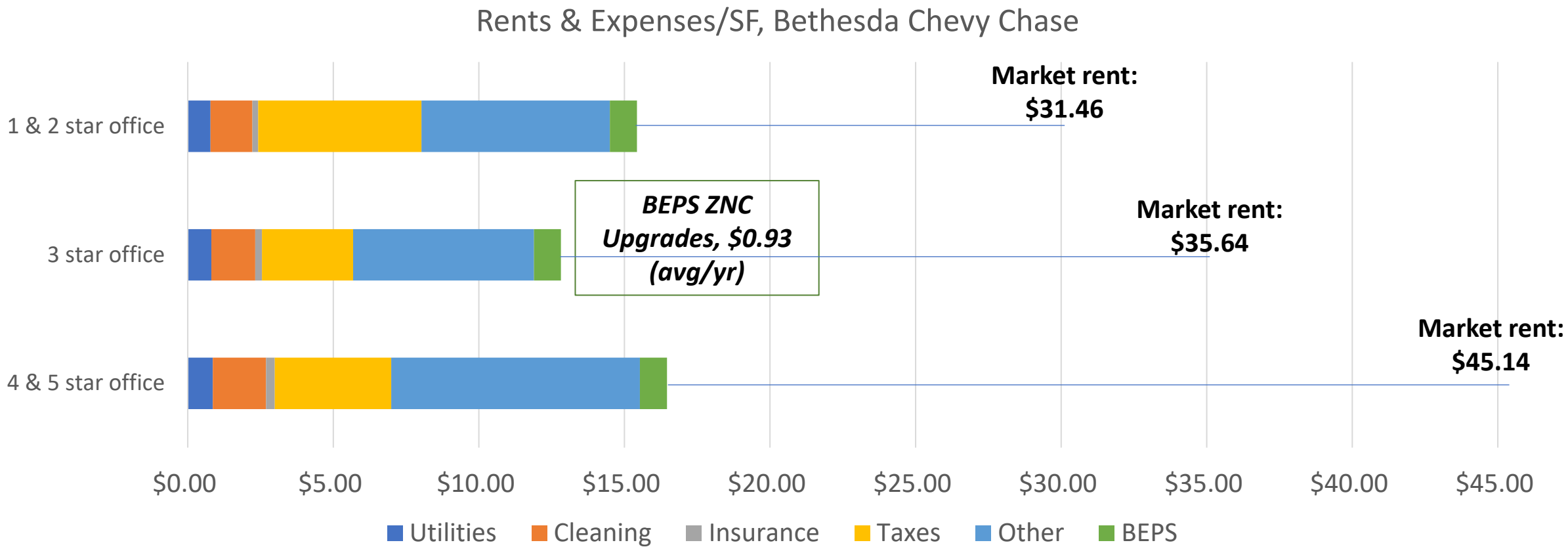
Costs = full cost of new system, not incremental cost above standard replacement.

	No BEPS	EE	EE-ZNC midpoint	ZNC	
Energy Costs (annual, post-BEPS)	$543	$458	$451	$437	*Million*
Energy Cost Savings (annual, post-BEPS vs baseline)	$0	$85	$92	$106	*Million*
% Energy Cost Savings (annual, post-BEPS vs baseline)	0%	16%	17%	19%	*% lower than baseline*
Total BEPS Related Capital Cost* (annual average over 15 years)	$0	$111	$160	$216	*Million*
BEPS Related Capital Cost* / SF / year (annual average over 15 years)	$0	$0.48	$0.69	$0.93	*$/SF/year*

Most major in-building equipment (i.e., mechanical equipment) is likely to be replaced prior to 2035. This capital cost can be redirected toward deeper retrofit projects. This creates a lower "effective" cost of compliance, but baseline capital costs are highly building dependent on factors outside of the study. Baseline capital cost outlay, financial incentives, and financing were too building-specific to determine, and thus, are not included in this report.

BEPS Related Capital Costs / SF in Context

- Costar market reports show annual expenses per square foot as well as rental income per square foot
- Report shows total average rental income for Bethesda/Chevy Chase offices: $41.26 per square foot
- Operating expenses per square foot are ~$11-15 per square foot



Case Studies

- **Case studies evaluated 9 buildings:**
  - 3 offices (class A, older mixed-fuel, older all-electric)
  - 3 multifamily buildings (new high-rise, old affordable high-rise, affordable garden-style)
  - 2 lodging (hotel with conference, standard hotel)
  - 1 worship facility

- **Desktop audits were performed to develop energy efficiency measure (EEM) packages:**
  - EE Target Package
  - ZNC Target Package
  - Less-than-Five-Year Payback Package

- **Each measure and package summarize total costs and savings to estimate:**
  - Site EUI and GHG reduction
  - Cost savings
  - Capital cost
  - Simple payback (in years)
  - Return on investment

Case Study Example: Garden Style Multifamily, EE

Building Information
Square Footage: 50,000 – 75,000 SF
Year Built: 1950 – 1955
2019 Site EUI (kBTU/SF): 120

Total investment: $1,261,000
Cost savings/yr: $58,600
EE Package Cost: $16-$25/SF
EE Package ROI: 5%

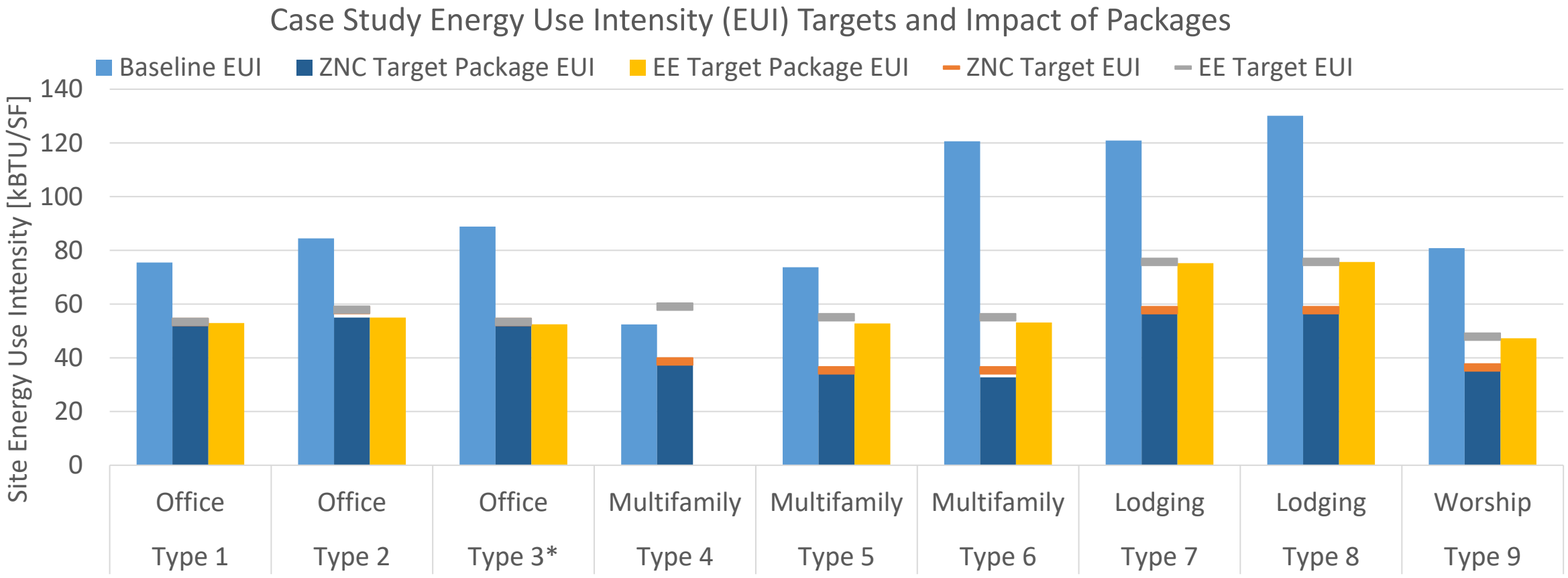
Case Study Example: Garden Style Multifamily, ZNC

Building Information
Square Footage: 50,000 – 75,000 SF
Year Built: 1950 – 1955
2019 Site EUI (kBTU/SF): 120

Total investment: $1,621,000
Cost savings/yr: $60,400
ZNC Package Cost: $25 - $28/SF
ZNC Package ROI: 4%

Impact: Case Study Buildings – Technical Feasibility

- In all case studies, the ZNC target was technically achievable with existing technology and systems through a combination of energy efficiency, electrification, and on-site solar PV
- Targets are technically achievable using today's technology



Case Study Buildings – Costs/Benefit Terminology

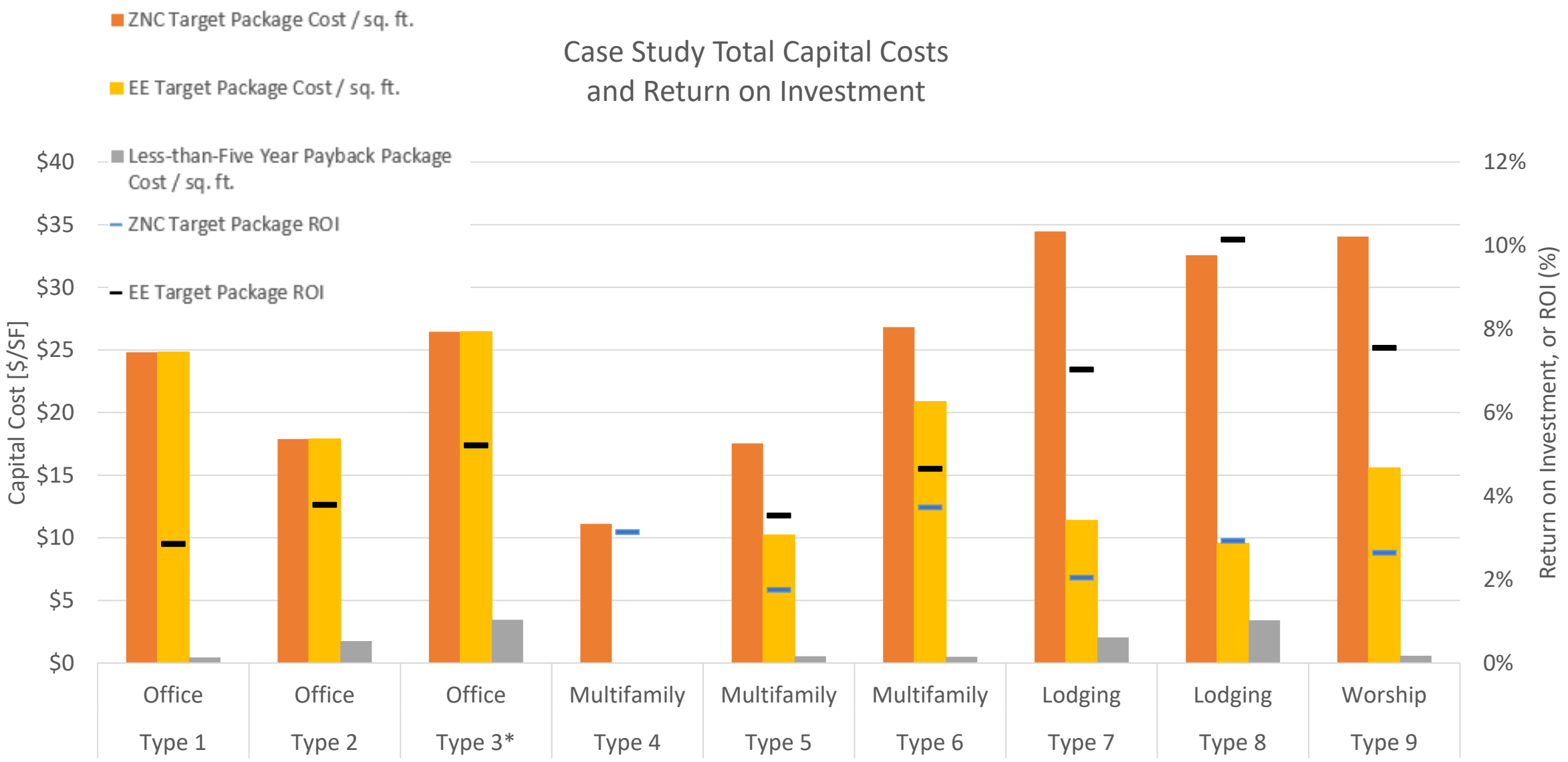
- **Cost per square foot** = total cost of all efficiency measures in the target package over the course of the BEPS compliance period divided by gross floor area
  - Costs = full cost of new system, not incremental cost above standard replacement.
  - Most major in-building equipment (i.e., mechanical equipment) is likely to be replaced prior to 2035. This creates a lower "effective" cost of compliance, but baseline capital costs are highly building dependent. Baseline capital cost outlay, financial incentives, and financing are not included in this report.
- **Savings per square foot** = total **annual** savings from all efficiency measures in the target package divided by gross floor area
- **Simple payback** = total project cost divided by the energy cost savings per year
  - Equates to the number of years until the annual cost savings "pay back" the up-front investment
- **Return on Investment (ROI)** = energy cost savings per year divided by the total cost, converted to a percentage
  - Equates to the percentage return of a particular investment.

Impact: Case Study Buildings – Costs/Benefits

- The ZNC target packages delivered a positive return on investment for all case-study buildings
- The EE target packages generally offered a stronger ROI compared to the ZNC target packages due to the less intensive energy savings required.
- Costs = full cost of new systems over whole BEPS period, not incremental cost above standard replacement.

	EE	ZNC
Cost* per square foot	$10 - $26 ***Average: $17***	$11 - $34 ***Average: $25***
Annual savings per square foot	$0.30 - $1.40 ***Average: $0.90***	$0.30 - $1.50 ***Average: $0.77***
Simple Payback	13 – 35 years ***Average: 24 years***	19 – 57 years ***Average: 32 years***
Return on Investment	3% – 10% ***Average: 6%***	2% – 5% ***Average: 3%***

Impact: Case Study Buildings – Costs/Benefits by Building



BEPS Technical Analysis Conclusions

- The most aggressive BEPS standard **(ZNC) is technically achievable with market-available technology**
- **Any BEPS target is better than no target**: Both EE and ZNC target approaches will produce GHG emission reductions compared to a business-as-usual scenario
- As BEPS targets become more stringent, ways for buildings to reach BEPS standards become more limited and increasingly expensive:
  - **EE targets** permit some fossil-fuel uses to remain, delaying deepest GHG emissions reductions, but can be achieved via a wider range efficiency measures and/or electrification of select end uses
  - **ZNC targets** requires fuel-switching/electrification in most building types with fossil-fuel based systems, which yields higher up-front costs and potentially longer payback, but gets the County closer to its 2035 climate goals
- Choosing where to set the targets should consider the impact to highly fossil-fuel-dependent buildings
  - EE and ZNC targets for some building types where the typical building is already all-electric
  - The difference between targets is large for building types that have greater use of fossil-fuel systems, such as multifamily and lodging (e.g., hotels, motels).