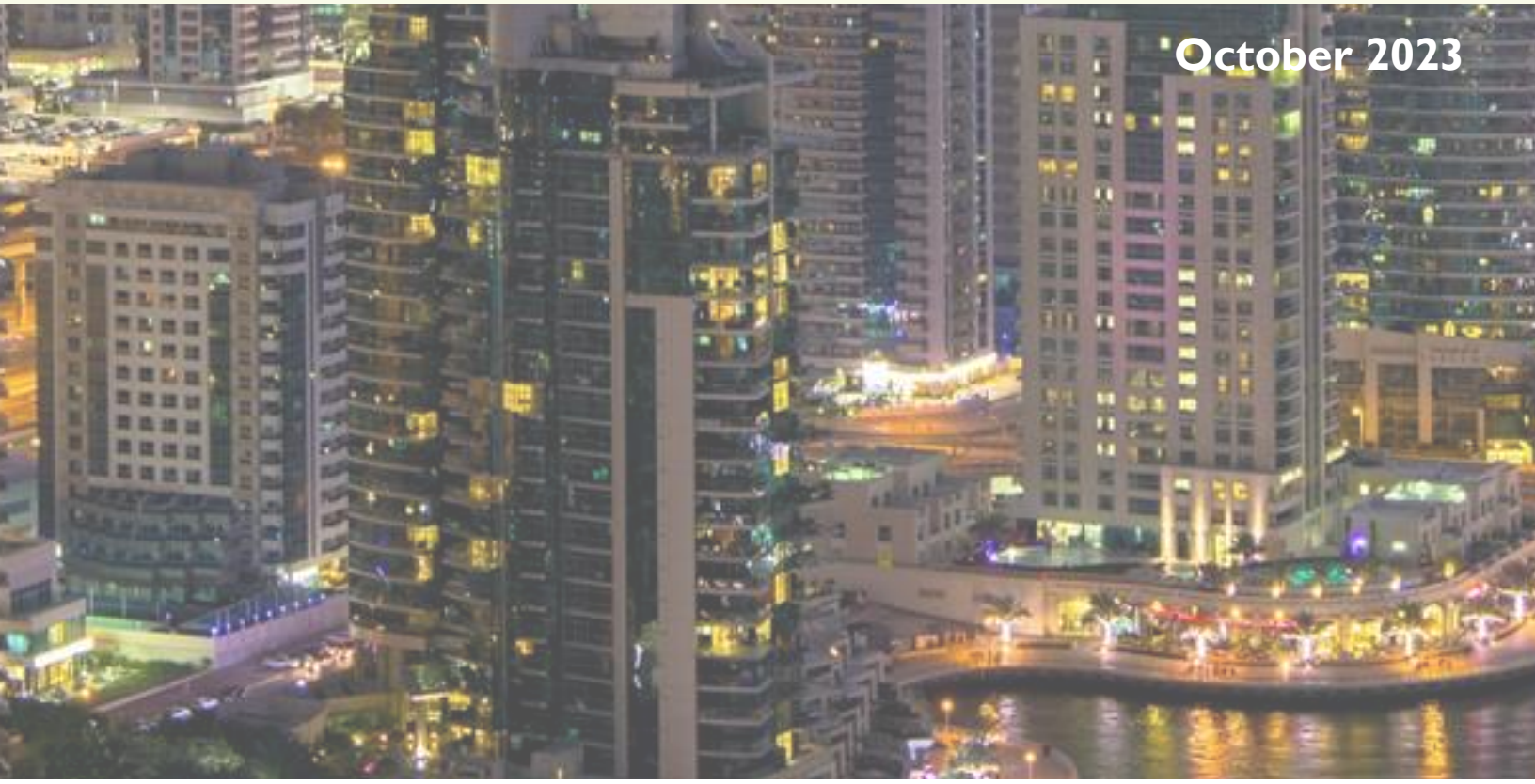
Climate Impacts of Building Performance Standards: Measuring the Pathway to Net-Zero



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Northeast Energy Efficiency Partnerships

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About ClearlyEnergy

ClearlyEnergy is an 80% women-owned certified small business and the recipient of several Department of Energy Small Business Innovation Research Awards. Working at the nexus of public policy and software solutions, ClearlyEnergy's projects include benchmarking and building performance standards, carbon accounting and disclosure, energy-efficient mortgages, virtual residential audits, and automated energy models. ClearlyEnergy's BEAM software has been used by more than fifteen jurisdictions large and small to achieve declining emissions goals from the building sector and has leveraged partnerships with the EPA, DOE, and National Labs to create forward-thinking energy solutions. A thought leader in the field of building performance standards with two recent reports on BPS design authored with Resources for the Future, ClearlyEnergy uses data-driven analytics and reporting to facilitate the energy transition.

About NEEP

NEEP was founded in 1996 as a non-profit whose mission is to serve the Northeast and Mid-Atlantic to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities. Our vision is that the region's homes, buildings, and communities are transformed into efficient, affordable, low-carbon resilient places to live, work, and play.

Disclaimer: ClearlyEnergy verified the data used for this white paper to the best of our ability. This paper reflects the opinion and judgments of the ClearlyEnergy staff and does not necessarily reflect those of ClearlyEnergy Board members, ClearlyEnergy Sponsors, or project participants and funders.

Executive Summary

Fourteen jurisdictions across the United States have passed building performance standards (BPS) policies, which set mandatory emissions or efficiency targets for large buildings. This study aims to understand and estimate potential emissions savings from BPS policies in the existing building sector and the role BPS can play in climate strategies.

The results are intended to help understand the climate impact of these programs both at the individual jurisdiction level and in aggregate, and to provide new jurisdictions with information that can be used when designing their own future BPS policies and programs. Eight of the 14 jurisdictions with BPS policies were evaluated. Together, these programs are expected to avoid 337.63 MMT of CO_2e emissions over their respective lifetimes, or 563.52 MMT by 2050 if no updates are made to the program targets. Annually, these programs combine to achieve savings equivalent to removing emissions from the entire state of Montana or New Hampshire and Delaware combined. BPS policies will also help jurisdictions meet their climate or emissions goals; BPS compliance can reduce anywhere from 8 to 63 percent of targeted carbon emissions reductions. Additional reductions depend on grid decarbonization remaining on schedule. In addition to emissions reductions benefits, BPS programs will improve indoor air quality, advance local jobs by encouraging building retrofits, and lower energy bills. Such policies may also increase property value and promote healthy and safe communities.

Introduction

To address climate change, governments at all levels are setting increasingly ambitious carbon reduction targets. Residential and commercial buildings account for 39 percent of carbon emissions nationwide;[1] in some urban areas, that number is as large as three quarters.[2] This marks a demonstrated need for significant emissions reductions in the building sector. Building performance standards (BPS) are emerging as an increasingly common strategy for towns, cities, counties, states, organizations, and companies to reduce energy consumption and greenhouse gas emissions from existing large buildings.

The full emissions impacts of BPS policies are not yet fully understood, but many jurisdictions are relying on them to cover a significant portion of their climate reduction goals. This study aims to understand and estimate the potential emissions savings from BPS policies on the existing building sector and the role BPS can play in achieving climate strategies and goals. The data should also be used to help inform future BPS policy development to ensure impactful results and shed light on how policy elements can affect outcomes.

As of August 2023, 14 jurisdictions in the United States, including federal buildings, have set BPS programs ranging in size from New York City and Washington state to Reno, Nevada and

[1] https://www.eia.gov/tools/faqs/faq.php?id=86&t=1

[2] https://media.rff.org/documents/Building_Performance_Standards.pdf

Montgomery County, Maryland. There are many more in development. This study analyzes BPS policies applied to federal buildings and enacted in seven jurisdictions: Boston, MA; Cambridge, MA; state of Colorado; Denver, CO; Montgomery County, MD; New York, NY; and Washington, D.C. Programs with sufficient data were analyzed to determine overall avoided emissions from the BPS policies and the impact these policies will have on the jurisdiction's economy-wide climate goals. See Appendix C for a comprehensive list of enacted BPS policies at the time of this study.

Defining Building Performance Standards

According to the federal definition, a building performance standard is defined as "an outcome-based policy and law aimed at reducing the carbon impact of the built environment by requiring existing buildings to meet energy- or greenhouse gas emissions-based performance targets."[3]

The 14 BPS programs that have been passed and signed across the United States, are in Boston, MA; Cambridge, MA; Chula Vista, CA; state of Colorado; Denver, CO; Federal Buildings Program; state of Maryland; Montgomery County, MD; New York, NY; Reno, NV; state of Oregon; St. Louis, MO; Washington, DC; and state of Washington.

While policy design differs across jurisdictions, all policies have the goal of reducing emissions from the largest buildings. All policies contain common elements such as identifying building size threshold for inclusion, identifying targets for building performance, and enacting timelines.

No two BPS policies are designed alike. Some programs mandate net-zero emissions by the end of the program; some aim for a percent reduction from a baseline. Different programs have varying size thresholds for inclusion in the policy or compliance timelines, and target metrics vary from ENERGY STAR® Score to Energy Use Intensity (EUI) to GHG emissions.

Different program designs will push building owners to plan their compliance strategy in different ways. For example, programs like Boston's Building Energy Reduction & Disclosure Ordinance (BERDO) with GHG compliance metrics will allow owners of all-electric buildings to claim carbon reductions associated with grid decarbonization. Programs like Washington D.C's Building Energy Performance Standard (BEPS) with energy efficiency targets might push building owners to make weatherization or HVAC capital improvements to their properties earlier in the program, with more potential savings later. The programs in Boston and Cambridge allow compliance at the building portfolio or campus level. Buildings in some jurisdictions, such as Denver, CO and Montgomery County, MD, will be subject to two BPS policies: one at the local level and one at the state. See Appendix A for a full list of definitions and metrics. See Appendix C for a breakdown of included programs and policy overviews.

[3] https://www.sustainability.gov/federalbuildingstandard.html

Equity in Building Performance Standards

Reducing emissions and electrifying buildings is not only a climate issue, but an equity and public health one as well. Environmental Protection Agency (EPA) findings suggest stark differences in building electrification between low- and high-income neighborhoods. In cold to moderate climates, buildings in higher-income or majority white neighborhoods are more likely to be all-electric and less likely to be reliant on heating oil as a primary fuel source than in lower-income or communities of color. The largest differences are found in K-12 schools.[4] Studies have linked fossil fuel pollutants, specifically small particulate matter and nitrogen oxides, with health issues including lung cancer, COPD, asthma, coronary heart disease, congestive heart failure, and neurological damage. Many of these health issues are more frequently found in lower-income communities and communities of color and are disproportionately harmful to children and other at-risk groups.[5]

BPS policies also encourage healthier buildings through weatherization and electrification. Building upgrades will reduce the amount of on-site combustion and related pollutants. Building envelope and efficiency upgrades have also been linked to lower rates of sinus infections, allergies, and colds as buildings remain at more stable temperature and moisture levels.[6] One study has shown that energy-efficient office spaces can even improve employee productivity.[7]

According to a recent NEEP report, "A BPS also creates demand for a wide range of energy and building-related jobs with a skilled workforce able to implement them. Local clean energy jobs such as insulation and air-sealing technicians, electricians, plumbers, HVAC technicians, energy auditors, and more will be in high demand to help buildings comply with a BPS program."[8] These jobs hold many benefits, including adding well-paying jobs to the clean energy sector and supporting the local economy.

Some jurisdictions have built equity provisions into their policies. For example, Boston's BERDO policy establishes the Equitable Emissions Investment Fund to direct revenue generated from noncompliance penalties to Environmental Justice communities. Available funds can be used to alleviate energy burdens, improve indoor air quality in low-income housing or communities, create workforce development training programs, and other programs identified by the city.[9] Washington D.C. established the Affordable Housing Retrofit Accelerator, which provides enhanced technical and financial assistance to qualifying affordable housing buildings to meet BPS targets.[10]

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[4] https://www.energystar.gov/sites/default/files/tools/DataTrends_race_income.pdf

[5] https://www.aceee.org/sites/default/files/ee-health-1008.pdf

[6] https://www.mwalliance.org/sites/default/files/meea-research/health-fact-sheet-final.pdf

[7] https://pubmed.ncbi.nlm.nih.gov/26502459/

[8] https://neep.org/sites/default/files/media-files/bps_and_equity_brief.pdf

[9] https://www.boston.gov/sites/default/files/file/2021/12/Final%20Amended%20Docket%200775%20BERDO%202_0.pdf

[10] https://www.dcseu.com/retrofitaccelerator

BPS programs do not come without equity risks. Building owners may not be able to comply within the specified timeline due to several factors, and noncompliance penalties or building upgrades may be financially burdensome. Building upgrades such as electrification may increase property value and rental rates, thus pricing out current tenants. These considerations must be addressed through careful policy and program design to not price out "mom and pop" building owners.

Methodology

The team assessed each program for two metrics: a) cumulative avoided emissions over the life of the policy, and b) the share of the jurisdiction's economy-wide climate goals that will be achieved via BPS, broken out between reductions attributed to the BPS and grid decarbonization.

Cumulative Avoided Emissions Over Policy Lifecycle

Avoided emissions were measured and graphed by comparing a "business as usual" scenario against estimated emissions savings from each program. The business-as-usual, or no BPS, scenario takes into account local projections of grid emissions rates or renewable portfolio standard goals. To measure emissions savings in a BPS scenario, policy targets were applied to the covered building stock. Some jurisdictions conducted their own analyses; these studies have assumptions regarding compliance, building stock growth, and alternate pathways to compliance. Where no prior analysis exists, this study assumes full compliance with the standards and does not factor in projected growth to the building stock for the duration of the study period. The difference between the BPS scenario and business-as-usual scenario equals the total avoided emissions attributable to the policy over its lifetime. See section "Sources" for more information on data sources and analyses used.

Where available, the study relied on business-as-usual emissions scenarios calculated by the jurisdictions. Where they did not already exist, the project team gathered energy consumption data from sources such as benchmarking reports or GHG inventories for the baseline year. Consumption data was extended across the policy lifecycle with future grid emissions factors taken into account. Any GHG reductions in the business-as-usual scenarios are derived from grid decarbonization rather than changes in consumption.

Future grid emissions factors were taken from the Energy Information Administration's Annual Energy Outlook for the relevant grid region[11] and multiplied by the baseline energy consumption. Electric emissions were added to emissions from natural gas, and if available, delivered fuels and district energy.

This study also made some assumptions to normalize outcomes across jurisdictions. One assumption is that the business-as-usual scenarios will not account for regular building upgrades likely to occur over the policy lifetime without a BPS in place. For example, mechanical equipment generally gets replaced every 20-25 years and would improve building efficiency without the mandates of a BPS; business-as-

[11] Table 54.x. Emissions factors were calculated by dividing energy consumption by carbon dioxide emissions

usual scenarios assume no efficiency improvements. Accounting for future changes to building stock, energy consumption, and complementary policies were beyond the scope of this study.

Share of a Jurisdiction's Climate Goals

Each program was compared against the jurisdiction's overall climate goals to estimate how much BPS savings contribute to the total emissions reduction commitment. Total avoided emissions in the policy's final year were compared against the overall emissions targets, broken out by reductions solely from BPS compliance and emissions reductions from grid decarbonization in BPS-covered buildings.

Sources

Several jurisdictions conducted or commissioned their own policy analyses. These analyses examined factors including economic impacts, anticipated rates of noncompliance, grid decarbonization, and renewable portfolio goals. The following analyses were used in this report's analysis. Please refer to each study directly for a complete description of the methodology.

- Boston: "Boston Building Emissions Performance Standard: Technical Methods Overview"; prepared for the City of Boston by Synapse Energy Economics, Inc (Feb 2021).[12]
- State of Colorado: Economic Impact Analysis; prepared by the State of Colorado.[13]
- Montgomery County, Maryland: "Building Energy Performance Standards Development-Technical Analysis"; prepared for Montgomery County, Maryland Department of Environmental Protection by Steven Winter Associates (Feb 2022).[14]
- New York City: "Carbon Trading for New York City's Building Sector"; prepared for New York City Mayor's Office of Climate & Sustainability by the Guarini Center, HR&A, the Brattle Group, Institute for Policy Integrity, and Steven Winter Associates (Nov 2021).[15]
- Washington D.C.: "BEPS Greenhouse Gas Study"; prepared by DC Department of Energy & Environment (DOEE) (2022).[16]

Other jurisdictions were analyzed using a combination of publicly disclosed benchmarking data, existing building stock analysis, policy rules and regulations, and renewable portfolio standards. Sources for these jurisdictions include the following:

[12]https://www.boston.gov/sites/default/files/file/2021/02/Boston_Performance_Standard_Technical_Methods_2021-02-18_20-013.pdf

[13]Economic Impact Analysis, Regulation Number 28 – Building Benchmarking and Performance Standards, January 6, 2023

[14]https://www.montgomerycountymd.gov/green/Resources/Files/energy/Montgomery%20County%20Performance%20Ordinance%20-%20Building%20Energy%20Performance%20Standards%20Report%20-%20final.pdf

[15]https://policyintegrity.org/publications/detail/carbon-trading-for-new-york-citys-building-sector

[16]https://dc.beam-portal.org/helpdesk/kb/BEPS/85/

- Cambridge, MA: Cambridge Building Energy and Water Use Data Disclosure.[17]
- Denver, CO: Energize Denver Benchmarking Data.[18]
- Federal Buildings Program: Comprehensive Annual Energy Data and Sustainability Performance Report.[19]

The results for these jurisdictions were estimated by applying the stated targets of the policy to current building performance data. All analyses are based on the assumption that the policy will not change and that all buildings will comply with the policy.

This study will be updated with new jurisdictions as more analyses and more data become available. Many of the remaining jurisdictions have not yet identified any rules or targets of the policy, thereby making an analysis not possible at this time. These jurisdictions include:

- Chula Vista, CA
- State of Maryland
- Reno, NV
- St. Louis, MO
- State of Oregon
- State of Washington

Converting Energy Use Intensity (EUI) to Greenhouse Gas Emissions

For programs with metrics other than greenhouse gas emissions, future EUI metrics were converted into GHG emissions by assuming that buildings would reduce electric and gas consumption equally.[20] This ignores complementary electrification policies which would, over time, increase the fraction of electricity consumption relative to gas. Please refer to Appendix D for the process used to estimate GHG emissions from BPS buildings in future years.

Jurisdictional Analyses

The following pages contain overviews of analyses conducted for each individual jurisdiction. For a full overview of all policies, please refer to the "Results & Conclusions" section.

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[17] https://data.cambridgema.gov/Energy-and-the-Environment/Cambridge-Building-Energy-and-Water-Use-Data-Discl/72g6-j7aq

[18] https://www.denvergov.org/opendata/dataset/city-and-county-of-denver-energize-denver-anonymized-benchmarking-data

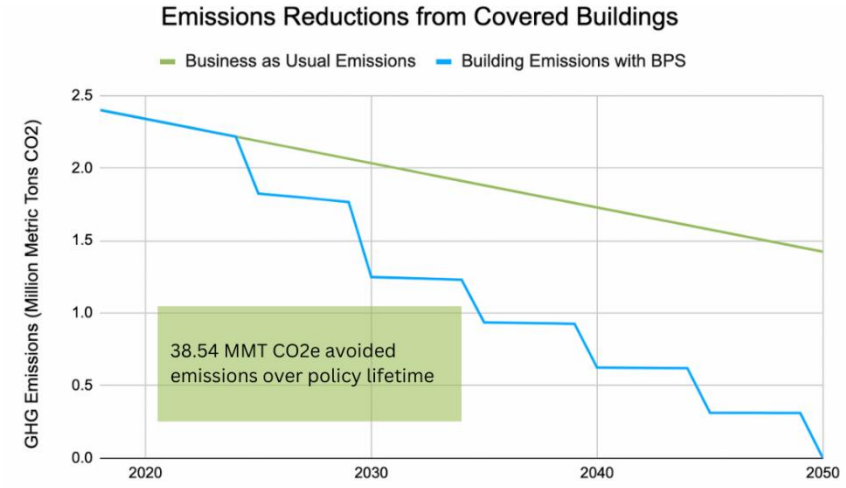
[19] https://ctsedwweb.ee.doe.gov/Annual/Default.aspx?ReturnUrl=%2fAnnual%2fReport%2fComprehensiveGreenhouseGasGHGInventoriesByAgencyAndFiscalYear.aspx

[20] Many BPS policies are designed with an EUI metric to encourage electrification. However, the team could not predict how people would change their energy consumption to comply with the energy-based metric. Thus the team made the assumption that natural gas and electric consumption would reduce equally.

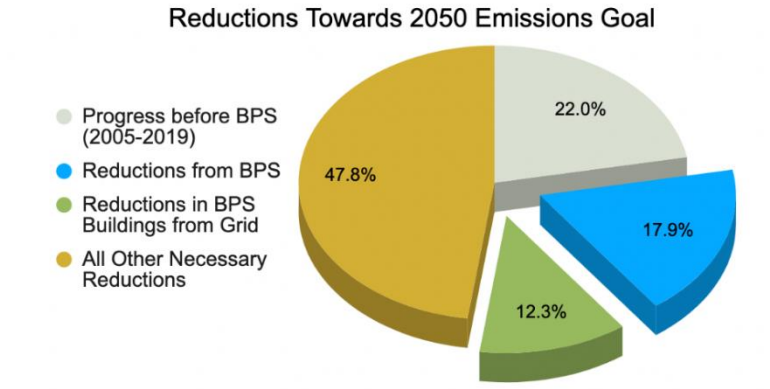
BOSTON, MA: BUILDING EMISSIONS REDUCTIONS & DISCLOSURE ORDINANCE (BERDO)

BERDO SNAPSHOT

# Covered Buildings: 5,927	Building threshold: >20,000 square feet or >15 residential units	BERDO goal: Net-zero emissions by 2050
Boston Citywide Goal: Net-zero emissions by 2050	Metric: GHG emissions	Avoided Emissions: 38.54 MMT CO2e



Emissions from BERDO-covered buildings with and without BERDO. "Business-as-usual" scenario involves grid decarbonization but no BERDO; BERDO scenario follows stated policy goalposts. Anticipated savings attributable to BERDO equals 38.54 million metric tons of CO2e.



Emissions reductions attributable to BERDO compared against Boston's overall goal of net-zero emissions by 2050. BERDO contributes 30.2% of necessary reductions, leaving 47% of baseline year emissions left to reduce in order to meet 2050 economy-wide goal.

Commentary: Boston, MA

The City of Boston, MA's Carbon Free Boston initiative pledges the city to carbon neutrality by 2050. As part of the effort to reach this goal, Boston passed the Building Energy Reduction & Disclosure Ordinance, or BERDO, which requires non-residential buildings over 20,000 square feet or residential buildings with more than 15 units to achieve carbon neutrality by 2050, with interim GHG emissions targets every five years.

Boston emitted 7.9 MMT of CO_2e 2005, the year it uses as its baseline for climate goals. By 2019, the beginning of BERDO, that number was down to 6.2 MMT. In 2019, existing buildings and stationary sources accounted for 69 percent of Boston's total emissions; large commercial and industrial buildings made up 51 percent of total citywide emissions and small residential buildings accounted for the remaining 18 percent.

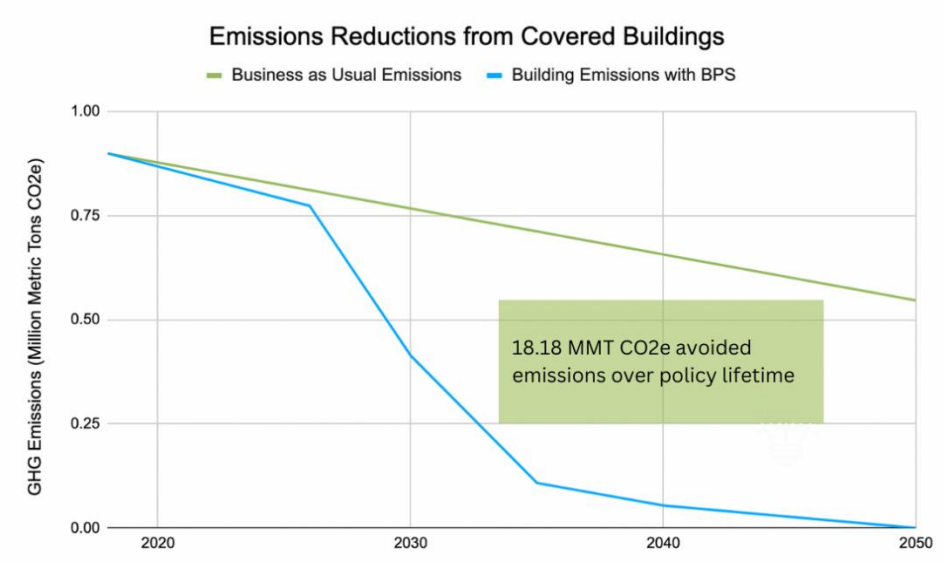
Analysis based on BERDO regulations, public benchmarking data, and a report prepared for the city of Boston shows that BERDO will avoid 2.4 MMT of emissions in the year 2050, the final year of the policy, or 30.2 percent of necessary reductions for Boston to meet its 2050 goal. 1.42 MMT, or 17.9 percent of necessary emissions reductions, will come from BERDO compliance; the remaining 0.97 MMT will come from reductions in grid emissions.

Over its lifetime, BERDO will avoid 38.54 MMT of emissions from BERDO compliance and grid decarbonization.

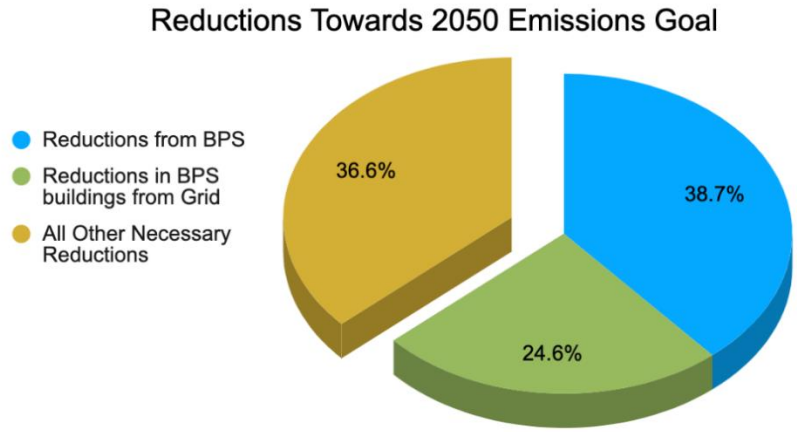
CAMBRIDGE, MA: BUILDING ENERGY USE DISCLOSURE ORDINANCE (BEUDO)

BEUDO SNAPSHOT

# Covered Buildings: 668	Building Threshold: >25,000 square feet	BEUDO Goal: Net-zero emissions by 2050
Cambridge Citywide Goal: Net-zero emissions by 2050	Metric: GHG Emissions	Avoided Emissions: 18.18 MMT CO2e



Emissions from BEUDO-covered buildings with and without BEUDO "Business-as-usual" scenario involves grid decarbonization but no BPS; BPS scenario based on stated policy goals and compliance cycles. Anticipated savings attributable to the BPS equals 18.18 million metric tons of CO2e.



Emissions reductions attributable to BEUDO compared against Cambridge's overall goal of net-zero emissions by 2050. The BPS contributes 63.3% of necessary reductions, leaving 36% of emissions left to reduce in order to meet 2050 city-wide goal.

Commentary: Cambridge, MA

The city of Cambridge's 2015 Climate Action Plan outlines several measures for the city to meet its goal of net-zero GHG emissions by 2050. In 2023, Cambridge adopted a BPS policy, known as BEUDO, which pledges net-zero emissions by 2035 from commercial buildings over 100,000 square feet and by 2050 for commercial buildings between 25,000 and 100,000 square feet and multi-family residential buildings containing 50 or more units. Buildings will need to meet interim targets defined as a percent reduction from their baseline average GHG emissions in the years 2018-2019.

In 2019, Cambridge's total citywide emissions equaled 1.41 MMT CO_2e. Of these emissions, more than 57 percent were attributable to residential and commercial buildings.

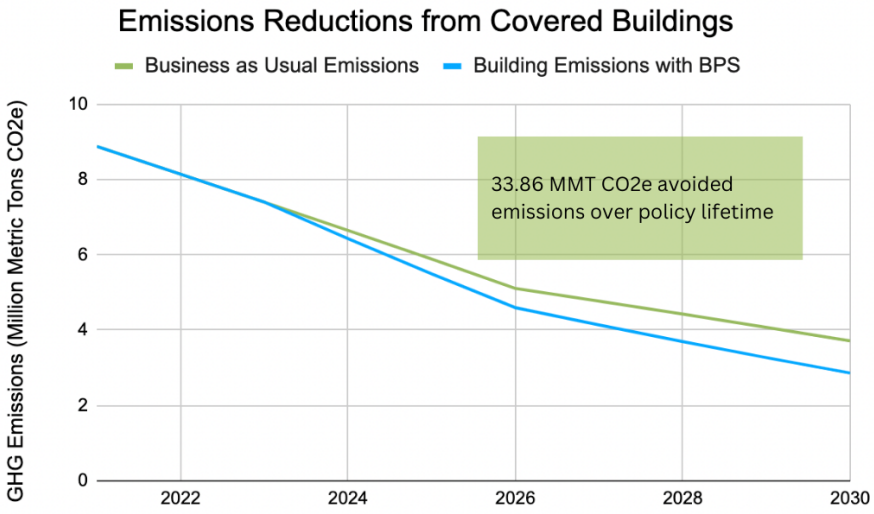
Analysis based on Cambridge's publicly disclosed benchmarking data and policy regulations show that the 2023 BEUDO policy will reduce 0.89 MMT in 2050, the final policy year, or 63.3 percent of total necessary emissions reductions to get the city to net-zero. Emissions reductions attributable to upgrades made by building owners to comply with the policy will equal 0.54 MMT, or 38.7 percent of necessary reductions; the remaining 0.35 MMT will come from reductions in grid emissions rates.

Over its lifetime, BEUDO will avoid 18.18 MMT of CO_2e emissions from policy compliance and grid emissions reductions.

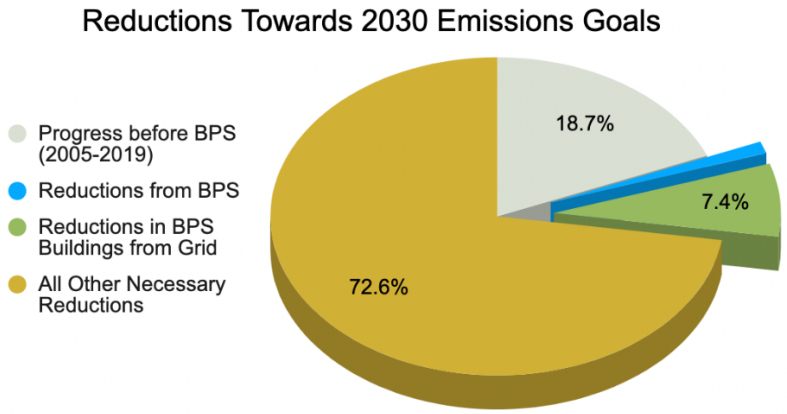
COLORADO: ENERGY PERFORMANCE FOR BUILDINGS

ENERGY PERFORMANCE FOR BUILDINGS SNAPSHOT

# Covered Buildings: 8,300	Building Threshold: >50,000 square feet	BPS Goal: 20% emissions reduction by 2030
Colorado Statewide Goal: 50% emissions reduction by 2050	Metric: Site EUI by property type GHGI	Avoided Emissions: 33.86 MMT CO2e



Emissions from BEPS-covered buildings with and without BEPS. "Business-as-usual" scenario involves grid decarbonization but no BEPS; BEPS scenario based on Colorado's Economic Impact Analysis.
Anticipated savings attributable to BEPS equals 33.86 million metric tons of CO2e.



Emissions reductions attributable to BEPS compared against Colorado's overall goal of 50% reductions by 2030. BPS contributes 8.6% of necessary reductions, leaving 72% of baseline year emissions left to be reduced in order to meet 2030 economy-wide goal.

Commentary: Colorado

Colorado's BPS is one strategy in the state's overall goal to reduce economy-wide emissions by 50 percent by 2030 compared to a 2005 baseline. To comply with the BPS policy, buildings over 50,000 square feet will need to reduce GHG emissions seven percent by 2026 and 20 percent by 2030 compared to a 2021 baseline. The BPS will continue past 2030 but will need another rulemaking session to determine further limits. Site EUI limits will be set by property type; final rules and regulations are expected in September 2023.

Colorado's baseline emissions in 2005 equaled 139.20 MMT CO_2e emissions; to meet the 50 percent goal would require the state to emit no more than 69.61 MMT by 2030. As of 2019, Colorado statewide emissions have already been reduced to 126.17 MMT. In 2019, Colorado's residential, commercial, and industrial fuel use sectors emitted 27.17 MMT; electric power emitted another 29.26 MMT. At the state level, industry, transportation, and power generation sectors represent a significant portion of emissions, while urban areas tend to see greater emissions from the building stock.

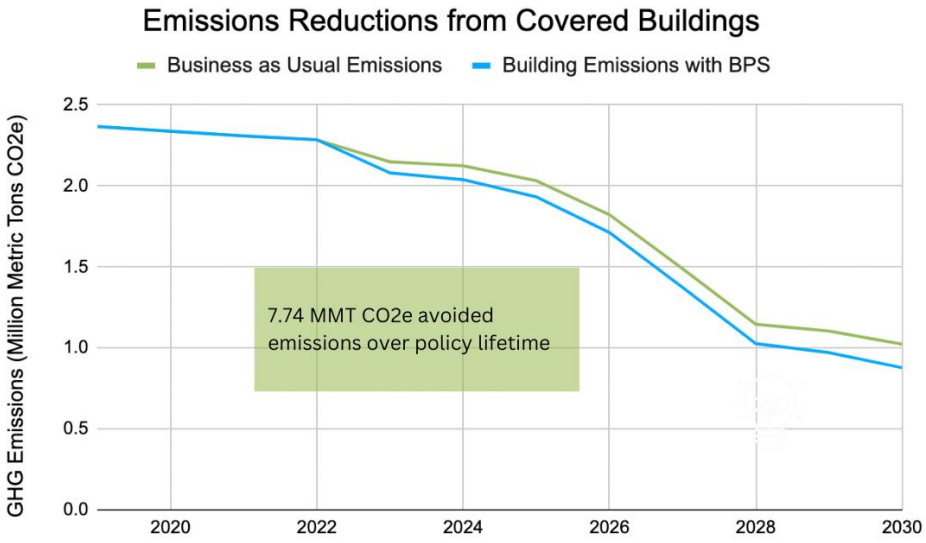
Analysis based on Colorado's Economic Impact Analysis shows that GHG emissions reductions tied to BPS will reduce about 33.86 MMT, or 8.6 percent of all necessary emissions reductions to meet the 2030 statewide goal. The legislative language makes it clear that reductions from the BPS should be made above and beyond emissions reductions attributable to decarbonization of the grid, so building owners will not be able to simply rely on greening of the grid to meet these goals. The BPS policy brings an element of certainty to decarbonization targets in the event the grid decarbonization projections fall short of expectations.

Please note that some emissions reductions may be double counted, as Colorado's baseline scenario includes Denver's BPS policy.

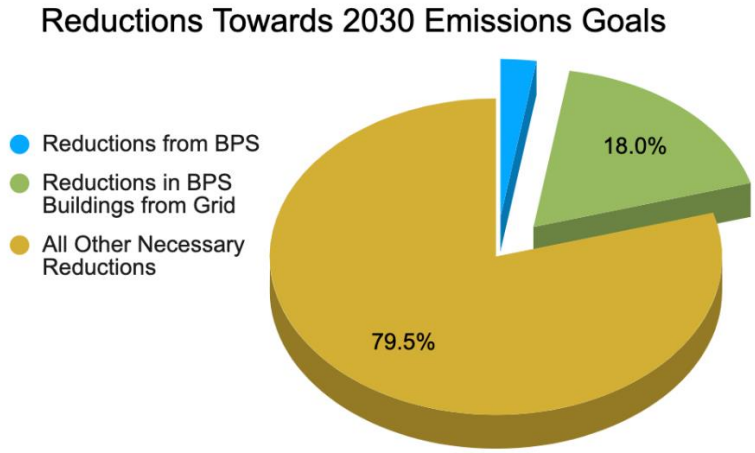
DENVER, CO:
ENERGIZE DENVER

ENERGIZE DENVER SNAPSHOT

# Covered Buildings: 3,004	Building Threshold: >25,000 square feet	Energize Denver Goal: 30% energy savings in covered buildings by 2030
Denver Citywide Goal: Net-zero emissions by 2040; 65% emissions reduction by 2030	Metric: Site EUI by property type	Avoided Emissions: 7.74 MMT CO2e



Emissions from Energize Denver-covered buildings with and without Energize Denver. "Business-as-usual" scenario involves grid decarbonization but no BPS; BPS scenario based on stated policy goals and compliance cycles.
Anticipated savings attributable to the BPS equals 7.97 million metric tons of CO2e.



Emissions reductions attributable to Energize Denver compared against Denver's overall goal of 65% emissions reductions by 2030. The BPS contributes 20.5% of necessary reductions, leaving 79% of emissions left to reduce in order to meet 2030 city-wide goal.

Commentary: Denver, CO

The city of Denver, CO's Climate Action Plan pledges the city to net-zero GHG emissions by 2040 and a 65 percent emissions reduction by 2030 relative to a 2019 baseline. Among other measures, Denver established the Energize Denver Ordinance to meet these goals, establishing 30 percent reduction site EUI targets for buildings over 25,000 square feet by 2030, with interim targets in 2024 and 2027.

Denver's baseline emissions in 2019 equaled 11.47 MMT of CO_2e. To meet the 2030 target of 65 percent emissions reductions, the city will need to emit no more than 4.0 MMT. In 2019, Denver's commercial and residential building sector was responsible for 47 percent of the city's total emissions, or 5.44 MMT.

Analysis based on Denver's benchmarking data and Energize Denver regulations show that a 30 percent site EUI reduction in covered buildings by 2030 will result in 1.53 MMT of avoided emissions in the year 2030, or 20.5 percent of necessary emissions reductions for the city to meet its 2030 goal. Of those reductions, 18 percent or 1.34 MMT will be a result of grid decarbonization on covered buildings; 0.17 MMT will be a result of policy compliance. The remaining 79.5 percent of emissions will need to be reduced in other sectors for the city to meet its 2030 goal.

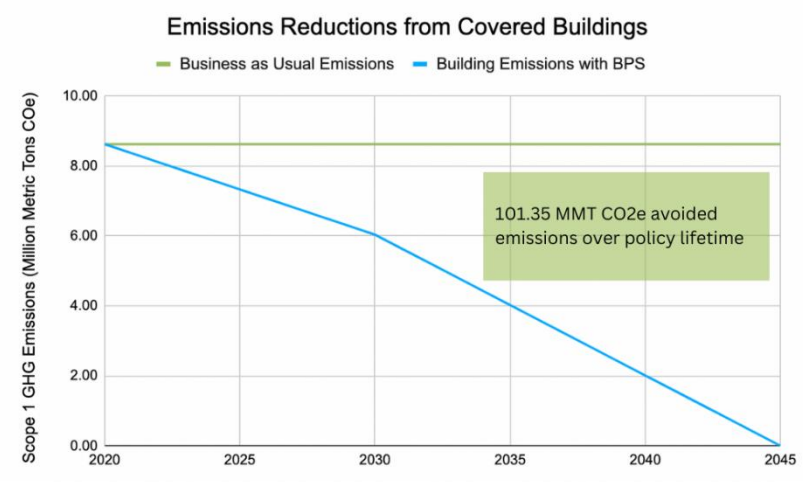
Over its lifetime, Energize Denver will avoid 7.74 MMT of emissions from the building sector.

Please note that the business-as-usual scenario does not include Colorado's statewide BPS policy, and as a result some savings may be double counted.

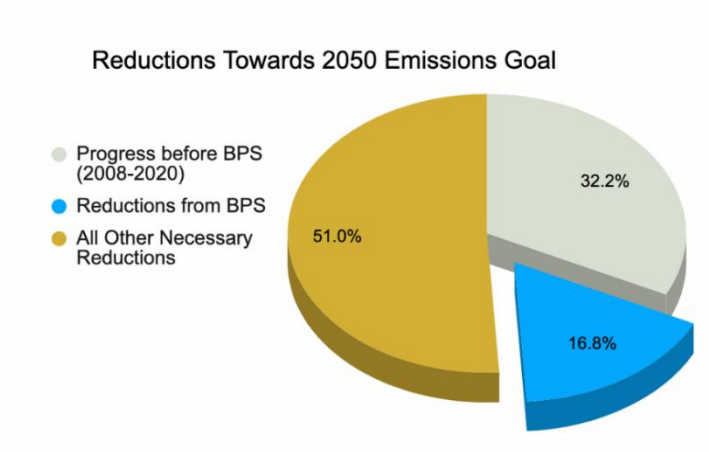
FEDERAL BUILDINGS: FEDERAL BUILDING PERFORMANCE STANDARD (BPS)

BPS SNAPSHOT

# Covered Buildings: 300,000	Building Threshold: All federal buildings and facilities	BPS Goal: Net-zero emissions by 2045
Federal Economy-wide Goal: Net-zero emissions from federal operations by 2050	Metric: Scope 1 onsite GHG emissions	Avoided Emissions: 101.35 MMT CO2e



Emissions from BPS-covered buildings with and without BPS. "Business-as-usual" scenario expects no major changes to onsite fossil fuel use; BPS scenario based on stated goalposts. Anticipated savings attributable to BPS equals 101.35 million metric tons of CO2e.



Emissions reductions attributable to BPS compared against overall Federal operations goal of net-zero emissions by 2050. BPS contributes 16.8% of necessary reductions, leaving 51% of baseline year emissions left to be reduced in order to meet 2050 operations goal. Federal BPS only covers Scope 1 emissions, so grid decarbonization will not impact policy goals.

Commentary: Federal

Please note that this section refers to the Building Performance Standard for Federal Buildings, not to be confused with the White House BPS Coalition working group.

The White House has committed to a number of climate measures as part of the federal sustainability plan, including net-zero emissions from federal operations including transportation, building emissions, electric, and procurement by 2050 and net-zero emissions from federal buildings by 2045. The Building Performance Standard (BPS) sets an interim target for each federal agency to achieve zero scope 1 emissions, or onsite burned fossil fuel emissions, in 30 percent of its building stock, measured in square footage by 2030. Carbon emissions from electricity are not included in the reduction calculation. The analysis assumed that the target of zero scope 1 emissions in 30 percent of each agency's building stock would result in a 30 percent decrease in emissions by 2030, as shown in the graph above.

In 2008, the baseline year for the policy, federal buildings and operations emitted 51.39 MMT of CO_2e ; by 2020, that number was down to 34.83 MMT. Buildings contributed 8.62 MMT, or 25 percent, of those emissions in 2020. Roughly 30 percent of those emissions will need to be reduced by 2030 in order to meet interim BPS goals.

Analysis based on stated goals and building stock data shows that the federal BPS is expected to contribute 16.8 percent of necessary emissions reductions to reach overarching net-zero emissions from federal operations by 2050, with buildings reaching the net-zero target by 2045. According to these goals and interim target, the Federal BPS is expected to avoid 101.35 MMT over its lifetime.

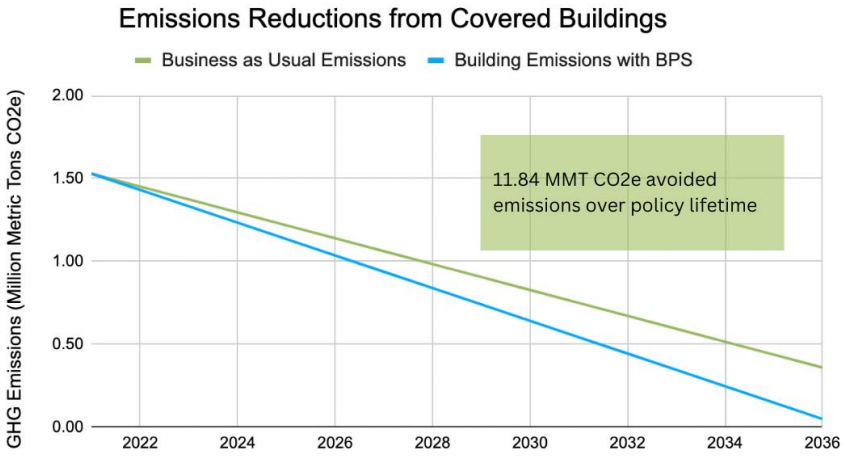
The federal BPS is distinct from other BPS programs in that it covers only scope 1 emissions from buildings and does not factor in upstream emissions from electricity production. One reason for this distinction is that the federal government has a separate clean electricity policy that requires federal facilities to purchase 100 percent clean electricity on a net-annual basis by 2030. The scope 1 BPS policy ensures that agencies must actively make building upgrades to comply with the policy.

Please note that some savings may be double counted between federal and other jurisdictional BPS programs when federal buildings are in a jurisdiction with a BPS program already enacted. However, these overlapping savings are likely to be small.

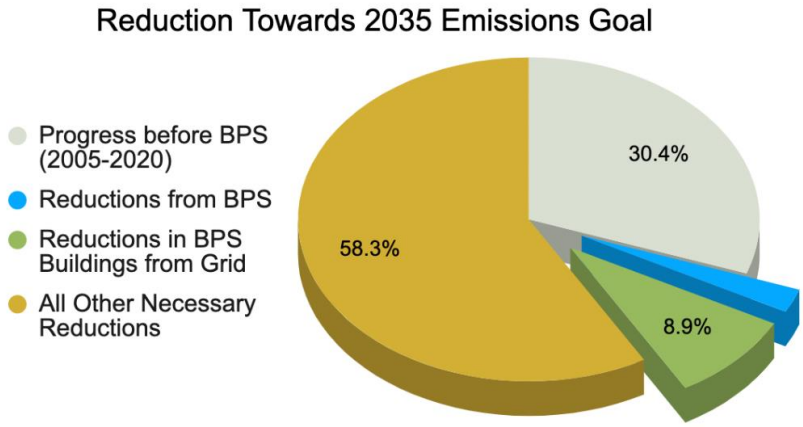
MONTGOMERY COUNTY, MD: BUILDING ENERGY PERFORMANCE STANDARD (BEPS)

BEPS SNAPSHOT

# Covered Buildings: 2,823	Building Threshold: >25,000 square feet	BEPS Goal: Site EUI Limit
Montgomery County Goal: Net-zero emissions by 2035	Metric: Site EUI by property type	Avoided Emissions: 11.84 MMT CO2e



Emissions from BEPS-covered buildings with and without BEPS. "Business-as-usual" scenario involves grid decarbonization but no BEPS; BEPS scenario based on analysis conducted by Steven Winter Associates. Anticipated savings attributable to BEPS equals 11.84 million metric tons of CO2e.



Emissions reductions attributable to BEPS compared against Montgomery County's overall goal of net-zero emissions by 2035. BEPS contributes 11.3% of necessary reductions, leaving 58.3% of emissions left to reduce in order to meet 2035 economy-wide goal.

Commentary: Montgomery County, Maryland

Buildings in Montgomery County, Maryland will also be subject to Maryland's statewide BPS program, but county goals require a more aggressive approach. Montgomery County has committed to net-zero community wide emissions by 2035, as opposed to Maryland's 2045 carbon neutrality goal. As a result, Montgomery County's BPS program has faster compliance deadlines and also lowers the building size threshold from 35,000 square feet in the statewide program to 25,000 square feet Montgomery County's program sets site EUI limits by property type; final rules and regulations are still being drafted, including site EUI targets.

In 2005, the program's baseline year, the county emitted 13.12 MMT of CO_2e; by 2020, emissions had decreased to 9.14 MMT. In 2021, buildings covered by the BPS policy emitted 1.33 MMT according to analysis prepared for the Montgomery County Department of Environmental Protection (DEP). Montgomery County's building stock, spanning small residential to large commercial buildings, made up about 48 percent of the county's total emissions in 2020. The bulk of the remaining 52 percent of emissions come from transportation, followed by other sectors including waste, agriculture, and water treatment.

Based on Montgomery County DEP analysis and modeled scenarios, emissions reductions from BPS buildings, both from BPS compliance and grid decarbonization, are expected to avoid 11.3 percent of necessary emissions reductions, or 1.48 MMT in the final policy year. Reductions from building upgrades by building owners looking to comply with the policy will reduce 0.31 MMT; the rest will come from grid decarbonization effects on covered buildings. The final 58.3 percent of remaining emissions will need to be reduced from other sources.

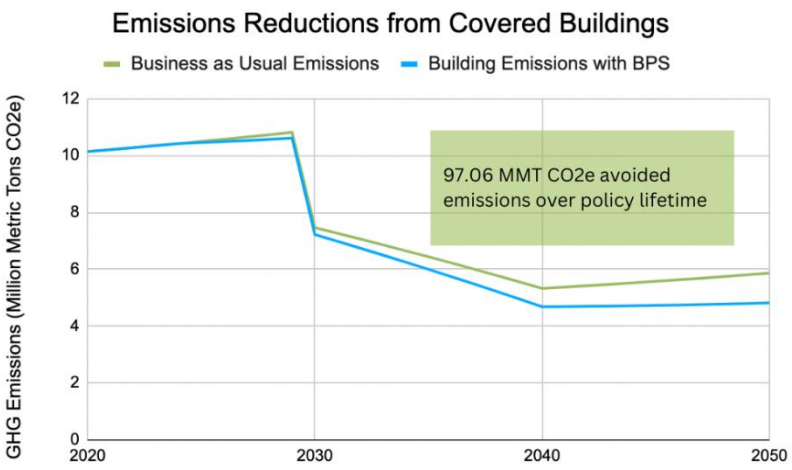
Please note that this analysis is based on a study outlining three modeled options for the policy prepared for the Montgomery County DEP; rules and regulations have not yet been finalized. For this analysis, the team chose to replicate the "Zero Net Carbon" (ZNC) model which sets EUI targets that simulate the electrification of fossil fuel end uses using market-ready technologies. For a full explanation of options, please refer to the full analysis prepared for Montgomery County DEP. This study is illustrative of potential savings if the county were to adopt a target similar to the pathway outlined in the Montgomery County analysis. Outcomes may vary as targets are finalized and adopted.

Assuming the ZNC model is written into regulation, the BPS policy is expected to avoid 11.84 MMT of emissions over its 18-year lifetime from both BPS compliance and grid factors on covered buildings.

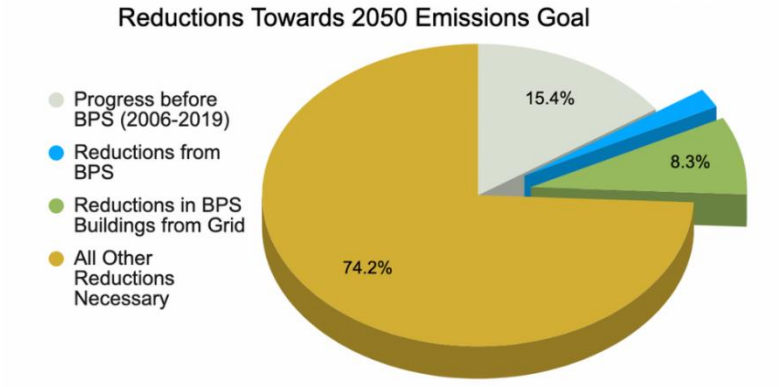
NEW YORK CITY, NY:
LOCAL LAW 97 (LL97)

LL97 SNAPSHOT

# Covered Buildings: 11,800	Building Threshold: >25,000 square feet	LL97 goal: 80% GHG emissions reductions by 2050
NYC Citywide Goal: 40% reduction by 2030 and 80% reduction by 2050	Metric: Emissions limits (GHGI) by property type	Avoided Emissions: 97.06 MMT CO2e



Emissions from LL97-covered buildings with and without LL97. Graph and analysis are from NYC'S "Carbon Trading for NYC's Building Sector," published for the Mayor's Office.
Anticipated savings attributable to LL97 equals 97.06 million metric tons of CO2e.



Emissions reductions attributable to LL97 compared against NYC's overall goal of 80% emissions reductions by 2050. LL97 contributes 10.3% of necessary reductions, leaving 74.2% of baseline year emissions left to reduce in order to meet 2050 economy-wide goal.

Commentary: New York City

As part of New York City's goal of 80 percent reduction in emissions by 2050, buildings covered under Local Law 97 will need to reduce emissions 80 percent relative to a 2005 baseline in the same timeframe. The policy sets an interim target of 40 percent emissions reduction by 2030. Buildings covered under LL97 include buildings over 25,000 square feet, or roughly 11,800 covered properties across the city. Buildings must stay within an emissions intensity, or GHGI, limit determined by property type. Further regulations will be developed in 2030.

Total citywide emissions in 2005 equaled 64.2 MMT of CO_2e; by 2019, emissions were down to 56.3 MMT. According to an analysis prepared for the New York City Mayor's Office of Climate & Sustainability, buildings covered by LL97 emitted 10.14 MMT in 2020.

Based on the city's overall and LL97 goals of 80 percent reduction by 2050, analysis found that emissions reductions from LL97-covered buildings will equal 10.3 percent of total necessary emissions reductions. Of that, 1.05 MMT of avoided emissions will be attributable solely to LL97 compliance, with the remaining 4.28 MMT coming from grid reductions in covered buildings.

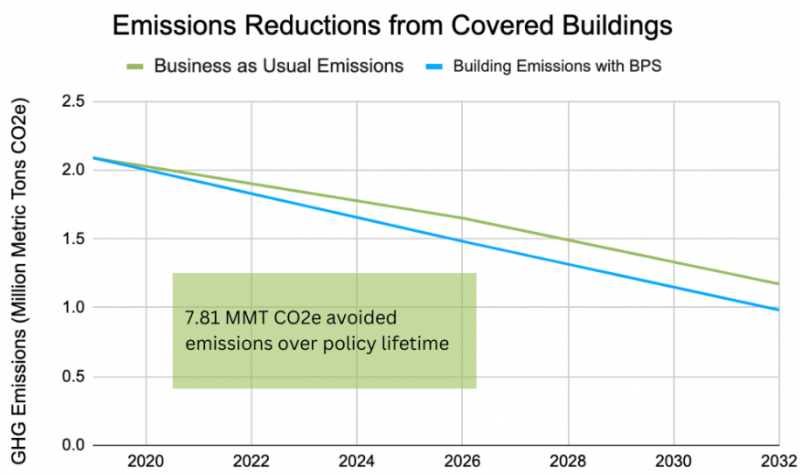
According to the prepared analysis, LL97 compliance is expected to avoid 14 MMT of emissions over its lifetime; when grid decarbonization is factored in, LL97 will avoid 97.06 MMT over its lifetime.

LL97 sets GHGI limits by property type in two compliance periods. Many properties are under this limit and thus will not need to proactively comply; many will remain in compliance due to grid decarbonization. Some buildings, particularly those with fossil fuel-dependent appliances, will need to make larger improvements to achieve GHGI targets. Therefore, on a net basis, the LL97 emissions limits are higher than the baseline emissions scenario; however, given the design of the policy, many buildings will need to take proactive steps, with a projected 14 MMT from fossil emissions reductions in the covered buildings.

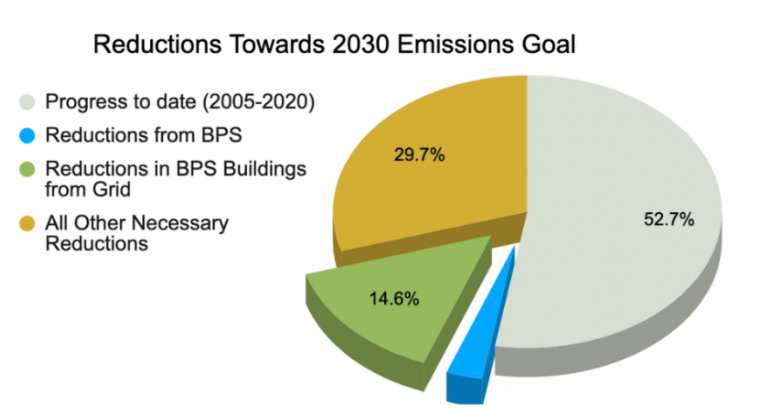
WASHINGTON D.C: BUILDING ENERGY PERFORMANCE STANDARD (BEPS)

BEPS SNAPSHOT

# Covered Buildings: 5,113	Building Threshold: >10,000 square feet	BEPS goal: Median Energy STAR score or Site EUI by property type
D.C. Citywide Goal: 60% GHG emissions reductions by 2030	Metric: Site EUI or Energy STAR Score	Avoided Emissions: 7.81 MMT CO2e



Emissions from BEPS-covered buildings with and without BEPS. Business-as-usual" scenario involves grid decarbonization but no BEPS; BEPS scenario based on "BEPS Greenhouse Gas Study" published by D.C. DOEE. Anticipated savings attributable to BEPS equals 7.81 million metric tons of CO2e.



Emissions reductions attributable to BEPS compared against D.C.'s overall goal of 60% emissions reductions by 2030. BEPS contributes 17.6% of necessary reductions, leaving 29.7% of baseline year emissions left to reduce in order to meet 2030 economy-wide goal.

Commentary: Washington, D.C.

Washington D.C.'s "Clean Energy DC Omnibus Act" calls for several aggressive climate goals, including a citywide goal of 60 percent reduction in GHG emissions by 2030 and carbon neutrality by 2045. The Act also establishes the Building Energy Performance Standard, or BEPS, the first operational BPS policy in the United States. D.C.'s BPS applies to groups of buildings beginning with buildings 50,000 square feet and greater in 2021, 25,000 square feet in 2027, and finally 10,000 square feet or greater in 2033.

D.C.'s policy generally requires building owners that don't meet the efficiency targets to reduce site energy intensity by 20 percent, measured either by ENERGY STAR Score or by Site EUI, to make energy efficiency improvements. The policy allows multiple pathways to compliance, including conducting a set of efficiency improvements deemed equivalent to the 20 percent performance pathway or reaching national median standard by property type, to give building owners more flexibility to comply.

In 2006, the baseline year for district-wide reduction goals, D.C. emitted 10.48 MMT of CO_2e; to meet the 60 percent goal would require the District to emit no more than 4.19 MMT by 2030. By 2019, district-wide emissions had been reduced to 7.17 MMT, leaving 2.98 MMT to reduce by 2030. In 2020, buildings made up 72 percent of the District's overall emissions.

Emissions reductions from BPS buildings, both from BPS-related reductions and grid decarbonization, are expected to avoid an additional 17.6 percent of D.C.'s total 2006 emissions, or 1.10 MMT. This leaves 1.86 MMT, or 29.7 percent of emissions, to be reduced from other sources in order for the District to achieve its 2002 goals. As D.C. is a dense urban area and BPS eventually covers buildings as small as 10,000 square feet, the BPS policy is likely to have a higher proportional impact than policies adopted and implemented elsewhere.

The BPS is expected to avoid 7.81 MMT of emissions over its lifetime by 2030, both from emissions reductions from BPS compliance and from grid decarbonization in BPS-covered buildings. Analysis is based on a study by the D.C. Department of Energy & Environment.

Results

Each BPS in this analysis is represented in units of greenhouse gas emissions to allow for comparability. Results from programs may vary from results stated here, as not all programs use GHG metrics. Additional assumptions were necessary to convert these programs from energy intensity into GHGs to allow for comparability. Each program also has a different timeline and deadline. Target metrics and policy years have been standardized where possible, but results may not be fully comparable.

Some results in this study are based on stated policy goals applied to benchmarking data; other results are based on the anticipated or planned outcome of a policy based on an existing economic analysis. For example, Cambridge's analysis assumes that all building owners will reach a net-zero emissions target by 2050, thereby zeroing out the emissions from 2019; New York City's economic study examines factors like trading programs under the BPS, grid policies, and expected noncompliance. See each jurisdiction's full commentary for a list of sources used.

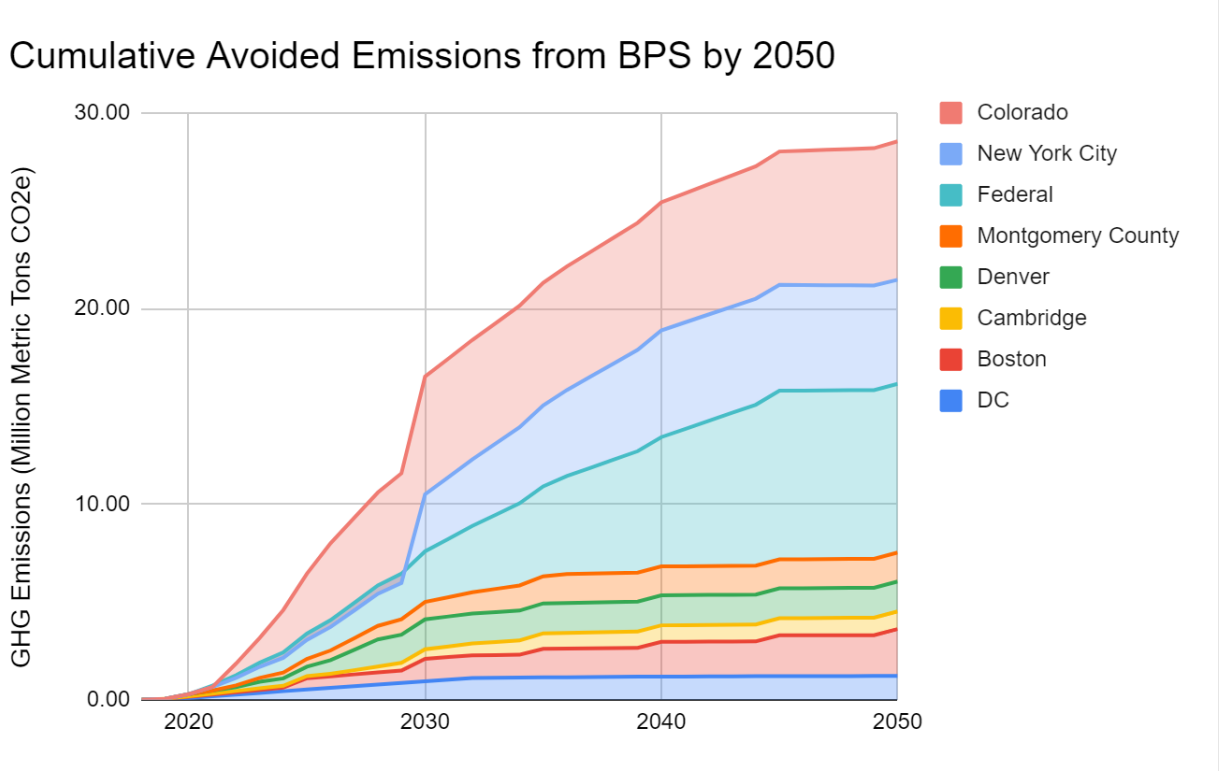


Figure 1: Cumulative avoided emissions attributable to both BPS compliance and grid decarbonization in each of the eight jurisdictions analyzed. Program impacts were projected out to 2050 for jurisdictions with policies ending earlier. See section "Cumulative Impacts of BPS" for methodology.

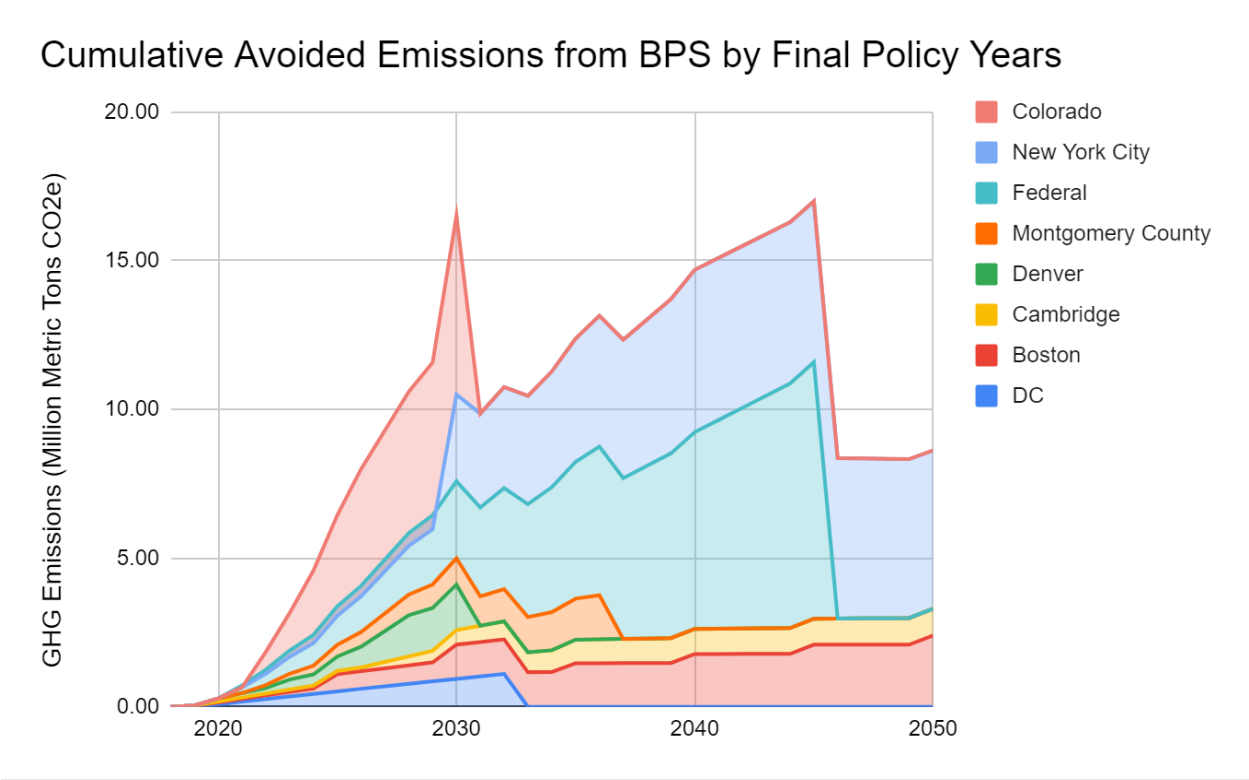


Figure 2: Cumulative avoided emissions attributable to both BPS compliance and grid decarbonization in each of the eight jurisdictions analyzed. Cumulative avoided emissions end in final policy years in jurisdictions for policies ending prior to 2050.

Impact of Grid Decarbonization on Climate Goals

Jurisdiction	Cumulative Reductions by 2050 (BPS and grid; MMT CO_2e)	Cumulative Reductions by 2050 (BPS compliance; MMT CO_2e)	Cumulative Reductions by 2050 (grid decarbonization; MMT CO_2e)
Boston, MA	38.54	22.43	16.11
Cambridge, MA	18.18	12.36	5.82
Colorado	165.28	18.17	147.11
Denver, CO	38.34	5.26	33.08
Federal Program	144.48	144.48	0
Montgomery County, MD	32.56	6.82	25.74
New York, NY	97.06	14.12	82.94
Washington, D.C.	29.06	5.77	23.29
Total	**563.52**	**229.41**	**334.11**

Grid decarbonization will play a major role in emissions reductions from BPS-covered buildings. Many states have adopted rigorous renewable portfolio standards (RPS), which mandate the amount of renewable energy that the jurisdiction must deliver to the grid. The result is electric grids that are expected to include more renewable sources every year.[21] For the purposes of this report, electrification upgrades made by building owners to comply with policies are counted as BPS compliance reductions; changes in emissions attributable to greater renewable content and lower grid emissions factors are counted as grid decarbonization reductions. This analysis found that in most cases, more than half of expected emissions reductions from covered buildings will come from the grid. The exceptions are the federal program, which only covers scope 1 onsite emissions and therefore will not be impacted by grid reductions, and Boston, MA, and Cambridge, MA.

This study assumes stated grid reductions goals will be met on schedule. However, a number of outstanding factors, such as utility and political will, funding, and availability of renewable sources can influence the rate of compliance with renewable portfolio standard (RPS). Delays in grid decarbonization will affect the breakdown of emissions reductions between grid and on-site efficiency reduction requirements.

By imposing an enforceable compliance point at the building-owner level, BPS programs provide a different pathway towards enforcing environmental targets from RPS programs, but with a unique set of challenges. While the breakdown of emissions reductions from electrification or BPS compliance is uncertain, the overall reduction objective will likely be met if the program is enforced.

Grid decarbonization and building energy efficiency policies are being enacted concurrently. BPS programs are an important tool in the policy toolkit towards net-zero, but jurisdictions can plan these programs in a way that complements existing or planned grid emissions reductions. For example, programs like the federal or Maryland BPS with scope 1 targets incentivize building owners or organizations to make infrastructural changes to support electrification and zero emissions without relying on reductions from the grid. The federal BPS complements other federal programs such as the clean electricity target mandating federal facilities purchase 100 percent carbon-free electricity by 2030 on a net-annual basis.[22]

The scope 1 focus of the BPS is meant to encourage agencies to make building upgrades above and beyond those planned grid emissions reductions. Other BPS programs focus on both scope 1 and 2 emissions, giving jurisdictions less control over potential outcomes, especially in cases where the jurisdiction has less electricity buying power than the federal government. Alternatively, a program which sets emissions or consumption targets at the building level can reach its objectives even if grid decarbonization fails to materialize.

[21] https://www.eia.gov/energyexplained/renewable-sources/portfolio-standards.php

[22] https://www.sustainability.gov/federalsustainabilityplan/carbon.html

To aid in decarbonizing the grid, building programs could be structured to reduce strain on the grid. BPS designs like New York City's LL97 that leverage grid flexibility by incenting load shifting to low emitting, high availability hours can help contribute to grid stability.

Cumulative Impacts of BPS

Jurisdiction	BPS Final Year	Cumulative Impact of BPS and Grid Over Policy Lifetime	Annual Impact of BPS and Grid In Policy Final Year	Cumulative Impact of BPS and Grid by 2050	Per Building Annual Impact
Metric:	*Year*	*MMT CO_2e*	*MMT CO_2e*	*MMT CO_2e*	*MT CO_2e*
Boston, MA	2050	38.54	2.40	38.54	405
Cambridge, MA	2050	18.18	0.90	18.18	1,347
Colorado	2030	33.86	6.02	165.28	725
Denver, CO	2030	7.74	1.53	38.34	509
Federal Program	2045	101.35	8.63	144.48	29
Montgomery County, MD	2035	11.84	1.48	32.56	524
New York, NY	2050	97.06	5.32	97.06	451
Washington, D.C.	2032	7.81	1.11	29.06	217
Total		**337.63**	**27.39**	**563.52**	

Some of the programs analyzed do not yet have targets set all the way out to 2050. For this analysis, these program impacts were all projected out to 2050. To do this, the avoided emissions in the final target year were assumed to persist. For example, Washington D.C.'s published targets end in 2032 with expected cumulative savings of 7.81 MMT and 2032 annual avoided emissions of 1.11 MMT. The 1.11 MMT savings is assumed to persist past 2032 which represents a hypothetical and conservative assumption that policy metrics will not change. This approach allows comparable results regardless of the final policy year.

The eight programs are expected to avoid a cumulative 337.63 MMT of CO_2e emissions over their respective policy lifetimes,[23] or 563.52 MMT by 2050 assuming no future changes to policy targets.

[23] "Respective policy lifetime" refers to the time period between the jurisdiction's baseline year and final target year. This is different for each jurisdiction. See each jurisdiction's Commentary Page for specifics.

Annually, these programs will combine to achieve a savings of 27.39 MMT, a savings equivalent to removing emissions from the entire state of Montana, or New Hampshire and Delaware combined.[24]

Programs with the largest expected gross emissions reductions, both cumulative by 2050 and in the final policy year, include Colorado (165 MMT), Federal Buildings (144 MMT), and New York City (97 MMT). Cambridge, MA and Colorado have the largest annual per-building impact with the average building avoiding an annual 1,347 MT in Cambridge and 725 MT in Colorado. Federal Buildings, which had one of the highest cumulative 2050 avoided emissions, will have one of the lowest per-building impact with the average federal building avoiding 29 MT annually. Please note that per-building cumulative avoided emissions are represented in metric tons rather than million metric tons.

Impact of BPS on Jurisdictional Climate Goals

Each of the jurisdictions in the study have set economy-wide carbon reduction goals to mitigate the effects of climate change. The percent of carbon reductions attributed to BPS on economy-wide goals varied widely across jurisdictions.

Jurisdiction	BPS Impact Towards Economy-Wide Goal (%)	Impact from BPS Compliance (%)	Impact from Grid Decarbonization (%)
Boston, MA	30.2	17.9	12.3
Cambridge, MA	63.3	38.7	24.6
Colorado	8.6	0.8	9.4
Denver, CO	20.5	2.5	18
Federal Program	16.8	16.8	0
Montgomery County, MD	11.3	2.4	8.9
New York City, NY	10.3	2	8.3
Washington, D.C.	17.6	3	14.6

BPS programs tended to make up a larger percentage of economy-wide emissions reductions in cities than in statewide or countywide programs. For example, Boston's BPS will achieve 30.2 percent of its climate goals, whereas Montgomery County's BPS covers 11.3 percent. This is expected, as emissions from buildings make up a greater percentage of a city's carbon emissions than they do for a county or a state. At the state and county level, emissions from industrial activities, transportation, and agriculture are more prevalent. Nationally, buildings account for 39 percent of carbon emissions;[25] in

[24] https://www.eia.gov/environment/emissions/state/

[25] https://www.eia.gov/tools/faqs/faq.php?id=86&t=1

some urban areas, that number is as large as three quarters.[26] However, gross emissions reductions from BPS programs in statewide or federal building portfolios are still quite significant, and in some cases present opportunities for substantial gross emissions reductions. Both gross emissions reductions, in tons, and reductions as a percent of the jurisdiction's goal are important, and program design should account for the impact of a BPS given the makeup of the local economy and other factors like occupant health and comfort.

Impact of Future Policy Changes on BPS Effectiveness

All assumptions about grid decarbonization are based on jurisdictional renewable portfolio goals. Changing policies, utility incentives, and funding from the Inflation Reduction Act may impact investments in the grid. BPS targets or overall jurisdictional climate goals may also change as varying political interests come into play. Funding may also impact a jurisdiction's ability to enforce or implement a program. Some jurisdictions, like D.C. and New York City, have written their policies or targets to be reevaluated after the first compliance periods, leaving room to evaluate the program's impact and update objectives.

Several jurisdictions have reported that active benchmarking or BPS programs have been threatened with cancellation or delay by new administrations. If jurisdictions feel that their BPS may be threatened by political interests, enforcement may not be a priority, thereby changing expected compliance outcomes.

Conclusion

Analysis has shown that building performance standards (BPS) can be an important policy in the toolkit to reduce emissions. The eight programs in this study are expected to avoid a cumulative 337.63 MMT of CO_2e emissions over their respective policy lifetimes, or 563.52 MMT by 2050 assuming no future changes to policy targets. Annually, these programs combine to achieve a savings of 27.39 MMT, a savings equivalent to removing emissions from the entire state of Montana, or New Hampshire and Delaware combined. New jurisdictions are expected to follow suit and adopt their own policies to meet their own objectives. The actions demonstrated by larger and well-resourced jurisdictions, as well as their success stories, will likely inspire smaller communities with fewer and smaller buildings to consider similar policies.

At the time of this publication, many jurisdictions with BPS policies did not have sufficient data or regulations for analysis; in most cases, rules or targets had not yet been established or data wasn't required to be publicly disclosed. Some jurisdictions also had privacy or access concerns, or limited bandwidth to organize, clean, and make sense of available data. This finding highlights the importance of tools that allow jurisdictions to easily see, organize, and track their data and progress towards goals.

Complementary policies, such as grid decarbonization efforts, renewable portfolio standards (RPS), and building codes, can be highly effective strategies to amplify the impact of a building performance

[26] https://media.rff.org/documents/Building_Performance_Standards.pdf

standard. Jurisdictions should consider aligning these complementary policies to maximize reductions from both scope 1 and 2 emissions. Policymakers may want to consider designing future BPS programs that complement reductions in grid emissions. Programs that provide incentives, technical assistance for building owners (such as the D.C. Affordable Housing Retrofit Accelerator or the Boston Retrofit Resource Hub), or property manager training and strategic energy management can also be extremely valuable in the effort to reduce emissions from the built environment and are likely within a jurisdiction's control to implement and manage.

This study shows that BPS programs will be important tools in the effort to reduce carbon emissions and are an innovative, viable approach to reduce the emissions from buildings. However, current projections show that the bulk of emissions reductions will come from anticipated grid decarbonization. Given the limited amount of data currently available, it is hard to draw certain conclusions about the effectiveness of each policy design and element. For example, the target metric of each policy, whether it be GHG emissions, EUI, or ENERGY STAR Score, does not seem to majorly impact emissions reductions. Overall, emissions reductions from BPS programs have the potential to be a significant source of avoided emissions and should be considered by every jurisdiction seeking to decrease its carbon footprint.

Appendix A: Definitions & Metrics

- *Baseline Year:* a historic year that serves as a comparison point for future emissions goals.

- *Benchmarking:* the process of measuring energy performance of a single building over time relative to other similar buildings. Similar buildings often include buildings in the same jurisdiction or with similar characteristics (property type, size, etc).

- *Building Performance Standard (BPS):* A building performance standard in this study is defined according to the Federal standard, or "an outcome-based policy and law aimed at reducing the carbon impact of the built environment by requiring existing buildings to meet energy- or GHG emissions-based performance targets."

- *Climate Goals:* the overall goal a jurisdiction has set for itself with regard to climate impacts and carbon emissions.

- *CO_2e:* Carbon dioxide equivalent, or amount of greenhouse gases emitted converted into carbon dioxide equivalent potency.

- *Compliance Cycles*: periods during which compliance with a standard is being measured.

- *ENERGY STAR Score*: a 1-100 scale providing a snapshot of a building's energy performance calculated by EPA's ENERGY STAR Portfolio Manager(R) tool. The higher the score, the better the performance and efficiency of the building.

- *Energy Use Intensity (EUI)*: a measure of the energy use of a building as a function of its size and occupancy, often expressed as energy use per square foot per year.

- *Site EUI:* intensity of all energy the property consumes on-site, including onsite generated renewables or grid purchase.
- *Source EUI:* the intensity of the total amount of raw fuel required to operate the property. In addition to onsite consumption, source EUI examines losses during generation, transmission, and distribution.

- *Weather-Normalized EUI*: intensity of energy use consumed by the property during 30-year average weather conditions; this metric accounts for variability of extreme weather years.

- *Greenhouse Gas (GHG) Emissions:* the release of greenhouse gases such as carbon dioxide (CO_2), which trap heat, into the atmosphere.

- *Greenhouse Gas Intensity (GHGI):* a measure of GHG emissions of a building as a function of its size and occupancy, expressed as GHG emissions per square foot per year

- *GHG Inventories:* a list of emission sources and the associated emissions, often prepared by a state or city. Emissions are tallied and quantified using standardized methods to assess total emissions.

- *Grid Emissions Factors:* a measure of carbon or carbon equivalent emitted per unit of electricity generated from the grid. Emissions factors can be local, regional, or nationwide.

- *Grid Emissions Projections:* future projections of grid emissions factors (see above definition) based on stated goals, policies, and renewable portfolio goals.

- MMT = *million metric tons*

- *MMBtu* = million British thermal units

- *Renewable Portfolio Standards:* a policy that requires utilities sell a certain percent of electricity from renewable sources to jurisdictions by a certain year.

- *Scope 1 Emissions:* emissions generated onsite or from sources that are directly controlled by the facility (i.e., onsite fossil combustion, furnaces, etc.).

- *Scope 2 Emissions:* emissions generated off site or indirectly from onsite operations (i.e., electricity purchased from the grid).

- *Scope 3 Emissions:* indirect emissions from onsite activities (i.e., waste generation, building materials).

- *Threshold (building size)*: the building size determined by the jurisdiction at which point compliance with a benchmarking or BPS policy becomes mandatory.

- *Conversion Factors*
    - 1 MWh = 3.412 MMBtu
    - 1 MMBtu Natural gas = 10 Therms Natural gas
    - 1 MMBtu natural gas = 0.0529 MT CO_2e natural gas
    - 1 MT CO_2e from electric = MWh * grid emissions factor
    - 1 MT CO_2e from natural gas = Therms natural gas * 1.89
    - 1 MMT = 1,000,000 MT
    - 1 MMT Carbon dioxide = 3.67 MMT Carbon
    - 1 Million Metric Ton (MMT) = 0.9072 Million Short Tons (MST)

Appendix B: Full Results Table

						Policy Lifetime			Reductions Persisting to 2050	
Jurisdiction	**Number of Buildings**	**BPS Final Year**	**BPS Impact Towards Economy-Wide Goal**	**Impact from BPS Compliance**	**Impact from Grid Decarboniza-tion**	**Cumulative Reductions of BPS and Grid**	**Annual Reductions of BPS and Grid In Policy Final Year**	**Per Building Annual Reductions in Final Year**	**Cumulative Reductions of BPS and Grid**	**Annual Reductions of BPS and Grid in 2050**
Metric	(Units)	(Year)	(%)	(%)	(%)	(MMT CO_2e)	(MMT CO_2e)	(MT CO_2e)	(MMT CO_2e)	(MMT CO_2e)
Boston, MA	5,927	2050	30.20	17.90	12.30	38.54	2.40	404.93	38.54	2.40
Cambridge, MA	668	2050	63.30	38.70	24.60	18.18	0.90	1,347.31	18.18	0.90
Colorado	8,300	2030	8.6	1.20	7.40	33.86	6.02	725.30	165.28	7.08
Denver, CO	3,004	2030	20.50	2.50	18.00	7.74	1.53	509.32	38.34	1.53
Federal Program	300,000	2045	16.80	16.80	0.00	101.35	8.63	28.77	144.48	8.63
Montgomery County, MD	2,823	2035	11.30	2.40	8.90	11.84	1.48	524.26	32.56	1.48
New York, NY	11,800	2050	10.30	2.00	8.30	97.06	5.32	450.85	97.06	5.32
Washington, D.C.	5,113	2032	17.60	3.00	14.60	7.81	1.11	217.09	29.06	1.21
Total	**337,635**					**337.63**	**27.39**		**563.52**	**28.55**

Appendix C: Policy Matrix

Policy & Jurisdiction	Compliance Metric	Economy-wide Goal	Building count and size	Avoided Emissions Over Policy Lifetime (MMT CO_2e)	Notes
Boston, MA; Building Emissions Reduction & Disclosure Ordinance (BERDO)	Net-zero GHG emissions by 2050	Net-zero by 2050	Buildings ≥20,000 sq. ft. #: 5,927 covered buildings	36.14	Buildings over 35,000 square feet are currently required to report; buildings between 20,000 - 35,000 square feet are not subject to BERDO until 2030.
Cambridge, MA; Building Emissions Reduction & Disclosure Ordinance (BERDO)	Net-zero GHG emissions		Buildings ≥100,000 sq. ft.. by 2035; <100,000 sq. ft. by 2050 #: 668 covered buildings	17.28	Policy passed in July 2023.
Chula Vista, CA; Building Energy Saving Ordinance (BESO)	ENERGY STAR Score & Site EUI Achieve verified ENERGY STAR score or submit ASHRAE audit; alternatively achieve ENERGY STAR score or Site EUI by property type.		Buildings ≥ 20,000 sq. ft.		The policy includes an audit requirement for low-performing buildings.
State of Colorado; Energy Performance for Buildings Statute	Site EUI targets by property type or percent reduction target 7% reduction in GHG emissions in 2026 and 20% reduction in GHG emissions in 2030 compared to 2021 baseline	50% reduction in GHG emissions by 2030 compared to 2005 baseline	Buildings ≥ 50,000 sq. ft..	25.83	Final rules and regulations will be published by September 2023.

Denver, CO; Energize Denver Ordinance	Site EUI by property type	30% site energy savings across all covered properties by 2030	Buildings ≥ 25,000 sq. ft. #3,000 buildings	7.74	Prescriptive requirement to upgrade lighting or install solar for 20% energy use for all buildings 5,000-24,999 SF by 2027 (6,000 buildings).
Federal Building Performance Standard (BPS)	Scope 1 GHG Emissions	Net-zero emissions from Federal operations by 2050	All federal facilities #300,000 buildings	101.35	Net-zero emissions from federally operated buildings by 2045; 30% reduction in GHG emissions by 2030 from 2008 levels. By the year 2030 at least 30% of an agency's buildings (measured by square footage) will achieve zero scope 1 emissions.
State of Maryland; Building Energy Performance Standard (BEPS)	Direct GHG Emissions: 20% reduction by 2030 from average 2025 levels; net-zero direct GHG emissions by 2040 Site EUI by property type	Net-zero emissions by 2045	Buildings ≥ 35,000 sq. ft.		Full rules and regulations will be presented to the Maryland Air Quality Control Advisory Council (AQCAC) in September 2023.
Montgomery County, MD; Building Energy Performance Standard (BEPS)	Site EUI by property type	Net-zero emissions by 2035	Buildings ≥ 25,000 sq. ft. #2,823 covered buildings	1.50	Final rules and targets are still being developed. Regulations will be passed by December 31, 2023
New York, NY; Local Law 97 (LL97)	Emissions intensity limits (GHGI) by property type 40% reduction in GHG emissions from covered buildings by 2030; 80% reduction by 2050 relative to 2005 levels	40% reduction in GHG emissions by 2030; 80% reduction by 2050. Relative to 2005 baseline	Buildings ≥ 25,000 sq. ft. #11,800 covered buildings	64.00	
State of Oregon					Policy passed in July 2023

Reno, NV; Energy and Water Efficiency Program	ENERGY STAR or ENERGY STAR Water score of 50 or higher; or EUI or WUI above median for property type; or 10% EUI reduction from baseline year; or ENERGY or Water STAR Score of 15 points higher than baseline year.		Municipal buildings ≥ 10,000 sq. ft.; Private properties ≥ 30,000 sq. ft.		First reporting cycle begins in 2026.
St. Louis, MO; Building Energy Performance Standard (BEPS)	Site EUI requirement by property type		Buildings ≥ 50,000 sq. ft.		
Washington, D.C.; Building Energy Performance Standard (BEPS)	ENERGY STAR Score or Site EUI reductions of 20%; median ENERGY STAR Score or Site EUI; or audit requirement.	50% reduction in GHG emissions by 2032	≥10,000 sq. ft. #5,113 buildings	5.41	
State of Washington; Clean Buildings Act	Site EUI targets by property type		Buildings ≥ 50,000 sq. ft. #15,202 buildings		First compliance cycle begins in 2026. Early Adopter Incentive program began July 2021.

Appendix D: Converting Energy Use Intensity to Greenhouse Gas Emissions

The following process was used to estimate GHG emissions from BPS buildings in future years.

1. Gather electric and natural gas consumption data from benchmarking information and/or GHG inventories for a baseline year
2. Convert the electric and natural gas consumption data into MMBtu metrics
3. Find the percent of energy consumption attributed to electric consumption
4. Apply future policy targets to the EUI of each building
5. Multiply projected EUI of each building by its square footage to get energy use
6. Sum the energy use to find total energy use
7. Multiply energy use by the percent electric and percent natural gas to find the new electric and gas consumption
8. Convert new electric and gas consumption into GHG metrics using future emissions factors (same as when creating the business-as-usual scenario)