The Price of Performance: Understanding the Costs to Comply with Building Performance Standards

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ABSTRACT

One of the first and most critical questions that emerges when a jurisdiction is developing a building performance standard (BPS) is how much it will cost building owners to comply. A BPS that places an excessive cost burden on owners risks political opposition, low compliance rates, and ultimately failure of the policy to achieve its goals. To avoid this, jurisdictions need good data on retrofit costs. However, there is currently very limited information about the costs of BPS compliance and no general guidance to help a jurisdiction develop these estimates. To address this gap, this paper provides an outline of the considerations for understanding and quantifying BPS-related retrofit costs in a jurisdiction. First, we present an overall framework that outlines the various types of BPS costs for building owners. Then, we discuss considerations for quantifying retrofit costs, derived from a literature review of prior work. Next, we present results from comparing two different sources of retrofit cost estimates: a professional cost estimator and a database of energy audits. The data shows a substantial difference between the cost estimates from these two sources, with bigger differences at higher retrofit levels. Finally, we share results from a landscape analysis of financing and incentive programs to support BPS. Overall, this paper identifies important discrepancies in existing approaches to quantifying retrofit costs, and provides a framework for developing future cost analysis for BPS.

Introduction

One of the first and most critical questions that emerges when a jurisdiction is developing a building performance standard (BPS) is how much it will cost building owners to comply. A BPS is a policy that requires existing buildings to meet an energy or emissions performance target by a specific date. BPS are typically a long-term policy, with multiple compliance cycles stretching over one or two decades, and targets becoming more stringent with time. Buildings that do not meet their target must undertake retrofits to improve their performance, and these retrofits have financial costs to building owners. A BPS that places an excessive cost burden on owners risks political opposition, low compliance rates, and ultimately failure of the policy to achieve its goals.

To avoid this, jurisdictions need good data on retrofit costs. This key information can enable them to scope a feasible and cost-effective BPS policy, and to develop complementary financing and incentive programs to help building owners cover the costs of BPS. However, there is currently very limited information about the costs of BPS compliance and no general guidance to help a jurisdiction develop these estimates. BPS are still relatively new policies, and the earliest adopting cities are just now reaching their first compliance deadlines. There is not yet broad empirical data from implementing jurisdictions to show the true costs of BPS. In the meantime, jurisdictions need to understand what types of costs they should consider, and how they can develop meaningful cost estimates to inform early-stage policy design.

The goal of this paper is to outline the considerations for understanding and quantifying BPS-related retrofit costs. First, we present an overall framework that outlines the various types of BPS costs for building owners. Then, we discuss considerations for quantifying retrofit costs, derived from a literature review of prior work. Next, we present results from a case study estimating BPS costs in four cities in Ohio. These costs were derived from two different sources: a professional cost estimator and a database of energy audits, and these costs are compared to understand the sensitivity of cost estimates to the data source. Finally, we share results from a landscape analysis of financing and incentive programs to support BPS. Taken together, this paper offers a comprehensive set of considerations for jurisdictions and their technical consultants seeking to develop cost estimates for BPS.

Classifying BPS Compliance Costs

This paper is based on recent work on BPS in Ohio funded by the U.S. Department of Energy (DOE). Columbus, Cleveland, Cincinnati, and Dayton are four of Ohio's large cities, each with a climate action plan with ambitious goals for reducing emissions from existing buildings. But, at the start of the project, only Columbus had a mandatory benchmarking ordinance in place and none of the cities had enacted a BPS. The goal of the project was to support the development and implementation of BPS in these four cities. Questions about costs came up often in early discussions about BPS with city staff and elected officials, and the project was scoped to include several tasks about costs, two of which are the focus of this paper: developing retrofit cost estimates for Ohio and mapping the landscape of available financing and incentive programs. Developing Ohio-specific retrofit costs was especially important, as it legitimized the estimates for local stakeholders. For a more detailed discussion of the overall project, see Webb (2024).

Based on the findings from these tasks, we have developed an overall framework outlining the various types of BPS-related costs and benefits for building owners. This framework is shown in Figure 1. It builds on work by Pulles et al. (2024), who conducted work in Washington State to understand the full range of compliance costs to building owners, and on DGS (2022), Washington DC's Department of General Services Energy Management Plan, which estimated BPS compliance costs for their building portfolio and categorized them by level of retrofit and phase of work (analysis, design and implementation). Here, we synthesize and expand on this prior work by linking all the costs and benefits into an interacting whole, and highlighting how jurisdictions can influence these outcomes through policy and program design. By understanding the scale and scope of potential retrofit costs, local stakeholders can work to shape financing programs according to needs across analysis, design, and implementation.

In Figure 1, each block shows a step in the BPS compliance process, with red indicating typical costs, and green indicating typical benefits. First, a building owner must provide energy data to the jurisdiction to benchmark the building's performance. If it falls below the BPS target, the target is met and the building is considered in compliance. If not, the building must either enact some type of retrofit to improve the building's performance or may be subject to fines or penalties for non-compliance, depending on the jurisdiction. The retrofit process itself can have multiple phases, encompassing an analysis phase, which is typically an energy audit or similar building assessment; a design phase (only if needed) where design documents are developed by architecture and/or engineering professionals; and an implementation phase which involves the materials and labor for installing the retrofit. In theory, the end result of meeting the BPS target is reduced energy use, emissions, and utility bills for the building owner and tenants, as well as the economic value of any non-energy benefits, such as improved thermal comfort for occupants. In most jurisdictions, some financing and incentives are available to building owners to assist with retrofit costs. This process repeats each compliance cycle as BPS targets become more stringent with time. Note that this process is representative of a performance pathway in a BPS and omits any potential alternative compliance pathways that a jurisdiction may have. Note also that there are costs (and benefits) associated with a BPS beyond those to the building owner and which are therefore not shown here, including the cost to the jurisdiction to administer the BPS.

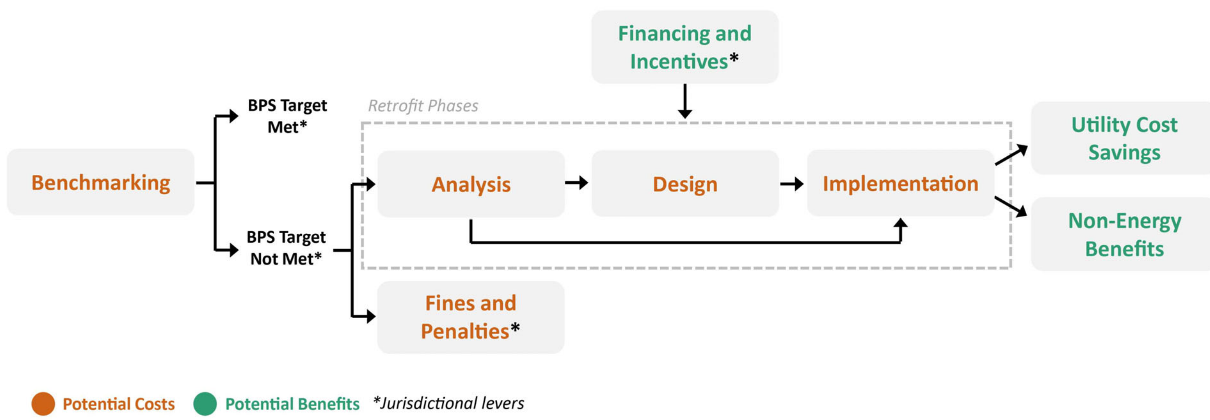


Figure 1. Overall framework of the costs and benefits to building owners in the BPS compliance process

The asterisks in Figure 1 indicate the three key points where a jurisdiction can influence this process and its outcomes for building owners. The BPS targets set by a jurisdiction will strongly influence the resulting costs, with more stringent targets typically meaning that more buildings will be required to retrofit and at greater cost, as deeper retrofits will be needed. A jurisdiction's available financing and incentive programs, and its prescribed fines and penalties for non-compliance represent the proverbial carrot and stick that help ensure compliance with the BPS. They function by creating added costs (fines and penalties) or reduced costs (financing and incentives) for the building owner. Given how integral jurisdictional decisions are to the compliance process, having at least a preliminary sense during the policy development stage for what each of these items might cost can help jurisdictions set achievable targets and plan for effective support programs to assist building owners.

However, one of the difficulties with conducting cost analysis for BPS is that putting quantitative estimates to any one of these steps is highly dependent on the conditions in each individual building and jurisdiction. Prior literature and policy examples provide some potential ranges for these values, but they can be wildly divergent. Amidst this uncertainty, the framework in Figure 1 at least provides some conceptual order, identifying the major parts and how they interact. A complete analysis of BPS costs for building owners would include all of these costs and benefits as an interacting whole. But, to better understand some of these sources of uncertainty, the remainder of this paper focuses on our work understanding two parts of this process in greater detail: the cost of retrofits, and the available financing and incentive programs to offset those costs.

Identifying Cost Estimate Considerations

Literature Review

Our initial work estimating retrofit costs for BPS began with a literature review of prior studies. Only studies conducted in the United States in the last ten years were considered. Papers were sourced from the University of Cincinnati libraries, Google Scholar, and the National BPS Coalition's Resource Library (National BPS Coalition 2025). The search criteria included phrases such as "BPS costs" and "building retrofit costs"; a total of eleven sources were identified. Not all of the sources estimated costs directly stemming from BPS compliance. Of the eleven sources identified, only five of them provide costs directly tied to compliance with a BPS (Steven Winter Associates 2022; Urban Green Council 2019; Pulles et al. 2024; Duer-Balkind et al. 2024; Engelman et al. 2024). The other sources provide methodologies or costs related to building energy or decarbonization retrofits more generally, but were still relevant to our understanding of BPS compliance costs and were therefore included in this review (Schless et al. 2024; Denniston et al. 2022; Tseng et al. 2025; Ye et al. 2023; Lai et al. 2022).

The literature review revealed that the approach to calculating costs varied widely across sources. To illustrate these differences, we identified five major considerations that impact how the costs were calculated in the studies and grouped them into three basic stages of input, process, and output, as shown in Figure 2. The bulleted items list the varying approaches to each consideration observed across the literature review. The input stage includes the source of the cost data. The process considers what types of costs are included and the basis for the calculation. The output stage is how the calculation is presented and can be shown as various metrics and grouped by different categories. Understanding these components is vital as each can influence the final output cost presented to building owners and policymakers.

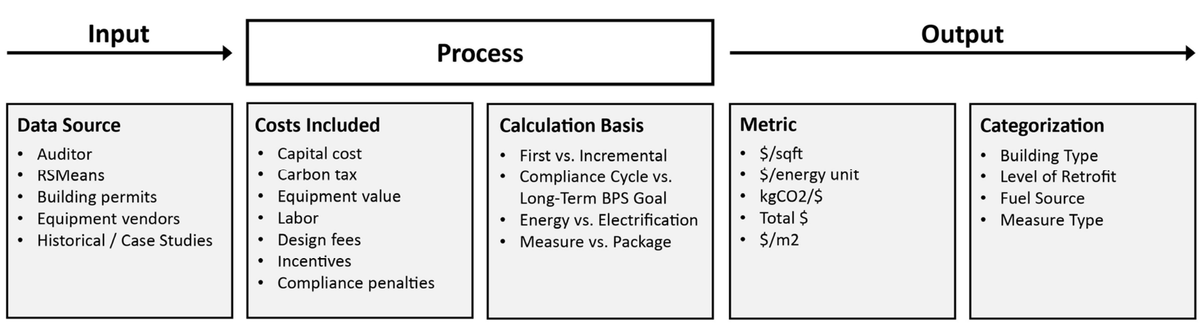


Figure 2. Breakdown of considerations for estimating retrofit costs for BPS

Each data source observed in the literature review reflects a different body of information and expertise about buildings. Understanding the data source is therefore important for contextualizing the resulting cost estimates. The data sources varied widely and included energy audit reports, RSMeans (a database of construction costs widely used in the industry for cost estimation), building permits, vendor pricing, and professional experience or past projects. For example, the cost data used by Lai et al. (2022) came from a database of mandatory energy audit reports in New York City. Steven Winter Associates (2022) used RSMeans to estimate the cost of retrofits to save varying amounts of energy while Denniston et al. (2022) used RSMeans to determine the cost to comply with the New Building Institute's (NBI) Building Decarbonization Code. Colin Schless et al. (2024) used costs from equipment vendors to compare the price to replace gas equipment versus electric equipment. Lastly, many sources referenced historical project data or permits or utilized professional expertise in developing estimated BPS costs (Urban Green Council 2019; Schless et al. 2024; Denniston et al. 2022).

The studies also varied in the types of costs that were included or omitted from the calculation. In addition to the capital costs of equipment, other costs included labor, design fees, compliance and reporting costs, financial penalties for non-compliance, available incentives to offset retrofit costs, and carbon taxes. The 2024 Large Building Decarbonization Price Index (Schless et al. 2024), for example, presents equipment costs only and omits labor and design fees. BPS often require building owners to adhere to benchmarking requirements, establish energy management plans, create operations and maintenance programs, or conduct energy audits which can all incur additional costs for compliance. Pulles et al. (2024) analyzed BPS compliance by surveying building owners and found these additional fees can add up to $4.45/ft^2$. In many jurisdictions, building owners can face financial penalties for failing to meet BPS targets (Duer-Balkind et al. 2024). While the studies reviewed did not consider penalties in the cost calculations, these penalties could be factored in as costs (or avoided costs) in compliance calculations. Tseng et al. (2025) included both incentive savings and a carbon tax in their analysis of financial resources available for decarbonization retrofits. Understanding the types of costs included is critical in framing the cost estimate. For example, including incentives in the cost estimate can emphasize available financial assistance and decrease the potential "sticker shock" of a BPS, while an excluding them would provide a worst-case scenario.

The calculation method determines the time (what time horizon is considered?) and technological (what systems or measures are included?) boundaries of the study. Several variations emerged in the review. A study in Washington DC estimated costs for the first BPS compliance cycle (Steven Winter Associates 2022), which can help building owners budget in the short term, but may not represent the costs of compliance over the total timeframe of the policy. Another methodology used in literature is calculating the incremental cost versus the total cost to comply. In some cases, studies used incremental costs instead of first costs. The incremental cost is the difference in cost to upgrade from one system to another, and this method was used most when comparing the cost to switch to electric systems versus replacing like-for-like gas-fueled systems (Ye et al. 2023; Denniston et al. 2022). Studies that used data from energy audits often combined multiple recommended measures into a package, but did so in different ways. Steven Winter Associates (2022) selected measures with the largest energy impact and combined them until the BPS target was met, while Lai et al. (2022) conducted an analysis of measures stacked from highest to lowest net present value.

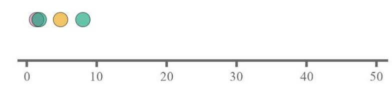
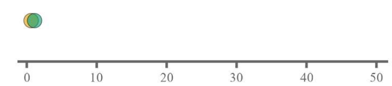
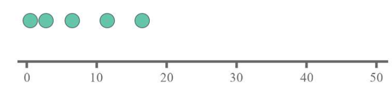
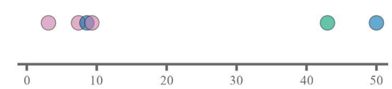
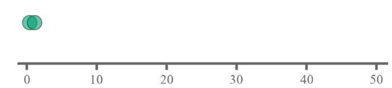
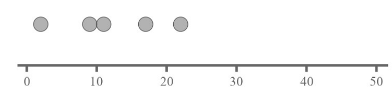
The metric used depended on the study's focus. The most common metric was $/ft^2, which normalizes total costs by building floor area, and allows these costs to be easily used to calculate the total costs for any building based on its floor area. In addition to reporting the $/ft^2, Denniston et al. (2022) reported the total cost per building to comply with NBI's Building Decarbonization Code. Ye et al. (2023) reported the total annual average investment across the nation, which showcases the magnitude of investment required to reach large-scale decarbonization goals. In cases where the goal was to reduce CO_2 emissions, $/energy unit or kg$CO_2$/$ was used to report the costs (Tseng et al. 2025; Duer-Balkind et al. 2024). Some studies paired the costs with savings to compute cost effectiveness using internal rate of return, benefit-to-cost ratio, simple payback, and savings-to-investment ratio (Ye et al. 2023; Steven Winter Associates 2022; Lai et al. 2022).

The costs were categorized according to several variables, including building type, fuel type, and level of retrofit. The categorization of the output is critical because it determines the applicability of the cost estimates to a specific building in a jurisdiction. Categorizing by building type is meaningful because the fuel systems used often differ across building types (Steven Winter Associates 2022; Urban Green Council 2019; Pulles et al. 2024; Lai et al. 2022). Using the level of retrofit, i.e., the percent energy savings resulting from or required by the retrofit, can show the cost for lighter or deeper retrofits (Urban Green Council 2019). Urban Green Council (2019) also categorized costs by building type. By using two categories, building owners are able to see more specific costs that better resemble their own buildings.

Prior Cost Estimates

Given the divergence in these considerations across the sources reviewed, it is difficult to draw broad conclusions from prior work. However, in an effort to highlight the quantitative results in prior work, we have compiled the seven sources reporting $/ft^2 as an output metric in Table 1. Table 1 lists the jurisdiction(s) where the cost estimates were developed, the source of the cost data, and the general method used to calculate the results. The $/ft^2 retrofit costs identified in each study are shown along the x-axis in each row and are color-coded by building type when possible. The results show substantial variation in the range of retrofit costs, and few generalizable trends. Costs range from less than $1/ft^2 to around $50/ft^2, with most of the estimated costs ranging between $1/ft^2 and $20/ft^2. Even studies within the same jurisdiction can vary widely, as one study in New York City estimated costs on the lower end of this range, and another estimated costs across this range. Overall, the approach to calculating the cost varied as each study used different methodologies or factors depending on the study or BPS goal. In practice, these prior cost estimates can serve as a reference point to bound potential BPS costs, but do not provide a generalizable methodology for estimating BPS costs in other jurisdictions.

Table 1. Literature review sources using cost per square foot as the output metric

Source	Jurisdiction	Data Source	Calculation Method	Cost per Square Foot ($\$/ft^2$) Commercial, Health Care, Multifamily, Not Specified, Public
Steven Winter Associates	Washington DC	RSMeans	EEM packages for BPS cycle 1	
Lai et al.	New York City	Energy Audits	Median costs from audits	
Urban Green Council	New York City	Professional Experts	Cost by level of retrofit	
Pulles et al.	Washington State	Historical	Stacked EEMs to meet target	
Denniston et al.	New York State	RSMeans, Vendors, Historical	Incremental cost for Building Decarbonization Code	
Duer-Balkind et al.	Washington DC, NYC, Boston, Denver	Historical	Varies by jurisdiction	

Estimating Retrofit Costs in Ohio: A Sensitivity Analysis

Data and Methods

In order to develop credible cost estimates for Ohio, we used two different data sources to generate $\$/ft^2$ retrofit costs by building type and level of retrofit, and then compared them. The first set of cost estimates was sourced by a professional cost estimator located in Ohio (Construction Consulting & Estimating 2025). These estimates were developed specifically for this project and are based on recent industry benchmarks and regional cost data (e.g., RS Means, historical project costs). They were developed using a unit cost per square foot approach, which is a widely accepted approach in the construction industry for estimating costs in the feasibility stages, before detailed designs are available. The costs are represented in 2025 dollars and were broken out by city (Cincinnati, Cleveland, Columbus, and Dayton), building type (Commercial, Health Care, Multi-Family, and Public), floor area thresholds (ranging from 10,000 ft^2 to over 200,000 ft^2), and level of retrofit. The city, building type, and floor area thresholds were determined based on the cost estimator's experience, and we requested that the level of retrofit categories match the categories from DGS (2022), which are listed in Table 2. Five retrofit levels were defined in that document, linking the energy savings required for a building to meet its BPS target to an approximate retrofit scope of work. The Ongoing Commissioning (Cx) category was included for buildings just under the target, since these buildings may need periodic work to ensure they stay in compliance.

Table 2. Level of retrofit categories used to develop cost estimates in Ohio based on DGS (2022)

Category	Retrofit scope of work	Energy savings
Ongoing Commissioning	Optimize controls	≤ 20% below the target
Retro Commissioning	Optimize controls and repair controls components	≤ 20% savings
Component Retrofit	Upgrade of individual components within a system	20% < savings ≤ 30%
Whole System Retrofit	Upgrade of an entire building system	30% < savings ≤ 40%
Whole Building Retrofit	Comprehensive project impacting all systems	> 40% savings

The second set of cost estimates was created from a database of energy efficiency measures recommended in energy audit reports by professional energy auditors. This data was collected through Audit Template (Pacific Northwest National Library 2024). The data includes information from more than 7,000 buildings and nearly 50,000 individual measures collected through mandatory energy audit ordinances in New York City, San Francisco, and Washington DC over the period 2017 to 2024. Variables in the dataset include building floor area, annual energy use, and annual energy cost, as well as individual measure and package information, such as measure name, cost savings, peak demand savings, and implementation cost for the measure.

The Audit Template data was used to develop retrofit cost estimates for Ohio using a series of data cleaning and adjustment steps recommended by DOE. First, projects involving fuel switching were filtered out so that the data was more reflective of energy efficiency measures, rather than electrification. Second, the data underwent geographical cost adjustments. Costs were normalized from their original city costs (e.g., New York, San Francisco) to a national average, and then subsequently adjusted using a local multiplier from RS Means to reflect Cincinnati pricing. Finally, a year adjustment was applied to bring older audit costs up to 2025 cost equivalents. The $\$/ft^2$ cost for each measure was then computed and grouped by retrofit savings.

In order to compare the results from the two data sources, the Audit Template data was mapped onto the cost estimator framework. Each measure was classified based on its estimated savings into a level of retrofit using the same criteria in Table 2. Additionally, a crosswalk was developed to aggregate the individual building types from Audit Template into the four broader building types used by the cost estimator. The final comparison used the Cincinnati cost estimator data to align with the geographic cost adjustments applied to the Audit Template data.

Results

The estimates from the cost estimator suggest that depth of retrofit and building type are the two primary cost drivers. Figure 3 compares the $\$/ft^2$ costs obtained from the cost estimator, with each panel showing a different building type, the clusters of bars representing retrofit levels, and each bar color representing a different city. The label above each cluster lists the average $\$/ft^2$ cost for that retrofit across the cities. The square footage category had a minimal impact on the cost estimates and is not shown here for simplicity. Figure 3 shows that there is a strong, non-linear relationship between the level of retrofit and the cost. Across all building types and cities, Whole Building retrofits are substantially more expensive than other levels of retrofit. The distinction between Whole System and Component retrofits is marginal, and the costs for Retro-

Cx and Ongoing-Cx are comparatively very low. Translated into real dollars, a 200,000 ft^2 commercial building requiring a 40% reduction in energy use to meet the BPS target would require a $48 million retrofit, while the same building requiring only a 10% reduction would require only a $120,000 upgrade. Building type is the other major cost driver, with retrofit costs for health care buildings highest across all retrofit levels, followed by public buildings (e.g., schools, libraries, fire/police stations), commercial buildings, and then multi-family buildings. This trend is not entirely surprising, as hospitals and clinics require specialized and redundant systems for patient safety, while multi-family buildings utilize simpler systems and standard floor plans (Construction Consulting & Estimating 2025). Geographic location in Ohio has a relatively small impact on costs compared to the other factors. In general, Columbus has slightly higher costs as it is the state capital and has more rapid growth and stronger market demand than the other cities (Construction Consulting & Estimating 2025).

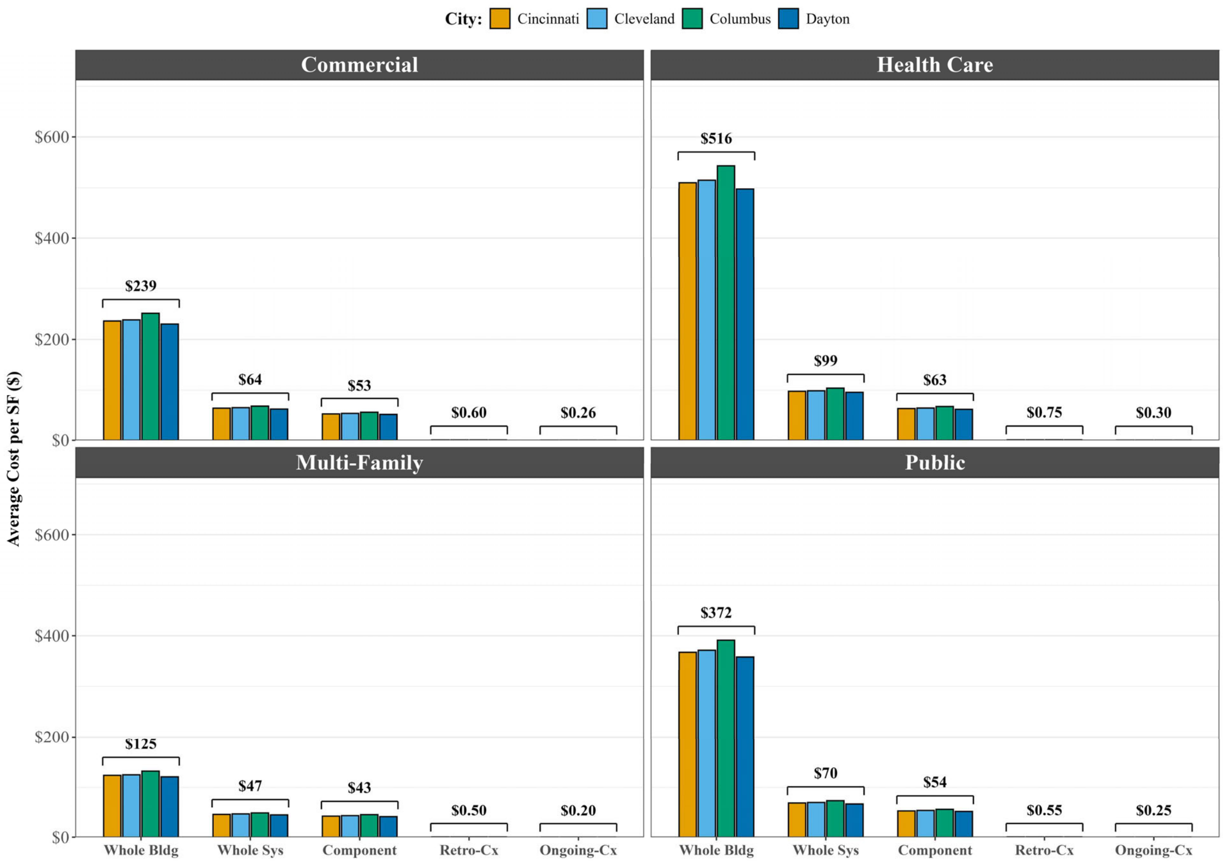


Figure 3. Retrofit cost per square foot for Ohio cities sourced from a professional cost estimator

The estimates from the Audit Template data also show a relationship between depth of retrofit and costs, but the relationship appears to be much weaker than in the cost estimator data. Figure 4 shows the $/ft^2 estimates computed from the Audit Template data. The data are binned by percent energy savings, and the observations in each bin are represented by a boxplot, with the median value represented by the middle of the box, the 25th percentile as the bottom of the box, and the 75th percentile as the top of the box. Outlier values are shown as individual points. Similar to the cost estimator data, Figure 4 also shows an increase in retrofit costs per square foot with increasing energy savings. However, the magnitude of this increase is much smaller than the one shown in Figure 3. Most of the observations in the Audit Template data are below $40/ft^2, with all of the median values well below $20/ft^2, even for the highest retrofit savings categories. Figure 4 also reveals two important points about the dataset itself. First, there appear to be far fewer observations in the higher energy savings categories. Second, there is unequal variance in the data; as the energy savings increase, the spread of the cost data widens.

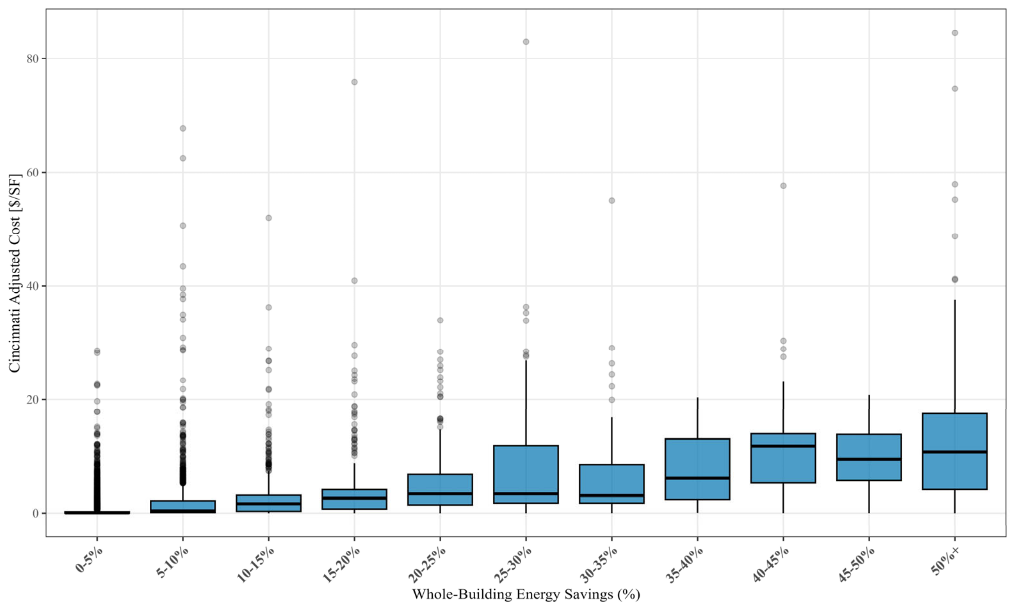


Figure 4. Retrofit cost per square foot for Cincinnati sources from Audit Template data

To better illustrate the differences between the two datasets, Table 3 shows the count of Audit Template measures mapped onto the categories used by the cost estimator. Since the logic of the Ongoing-Cx category did not have savings associated with it, this category could not be mapped to Audit Template. The results show that a majority of the Audit Template data falls within the Retro-Cx category, meaning that it corresponds to energy savings of 20% or less. Table 3 also shows an uneven distribution across building types: the majority of the Audit Template data is from multi-family buildings, with far fewer observations in the other categories. This likely reflects that most of the data was collected in New York City, which has a large population of multi-family buildings subject to its mandatory energy audit ordinance.

Table 3. Count of measures from Audit Template mapped onto cost estimator categories

	Whole Building	Whole System	Component	Retro-Cx	Totals
Public	77	15	40	3,543	3,675
Multi-Family	137	119	276	21,391	21,923
Health Care	1	3	5	483	492
Commercial	44	20	72	3,668	3,804
Totals	259	157	393	29,085	

Comparing the cost estimator and Audit Template estimates shows a substantial gap between the two data sources that increases with retrofit level. Figure 5 compares the retrofit cost estimates for Cincinnati for all retrofit levels across all four building types averaged across all four size categories. The results show that there is a small difference between the two data sources at lower energy savings, but a very large gap at higher energy savings, with a difference of more than $100/ft^2$ for Whole Building Retrofits. In practical terms, this means that for a 100,000 ft^2 multi-family building requiring a 40% retrofit to meet the BPS target, there would be an $11.19 million difference in the cost estimate derived from the Audit Template data and the estimate from the cost estimator. Even for a cost analysis during the early stages of BPS policy development, this large discrepancy between data sources is problematic for a jurisdiction.

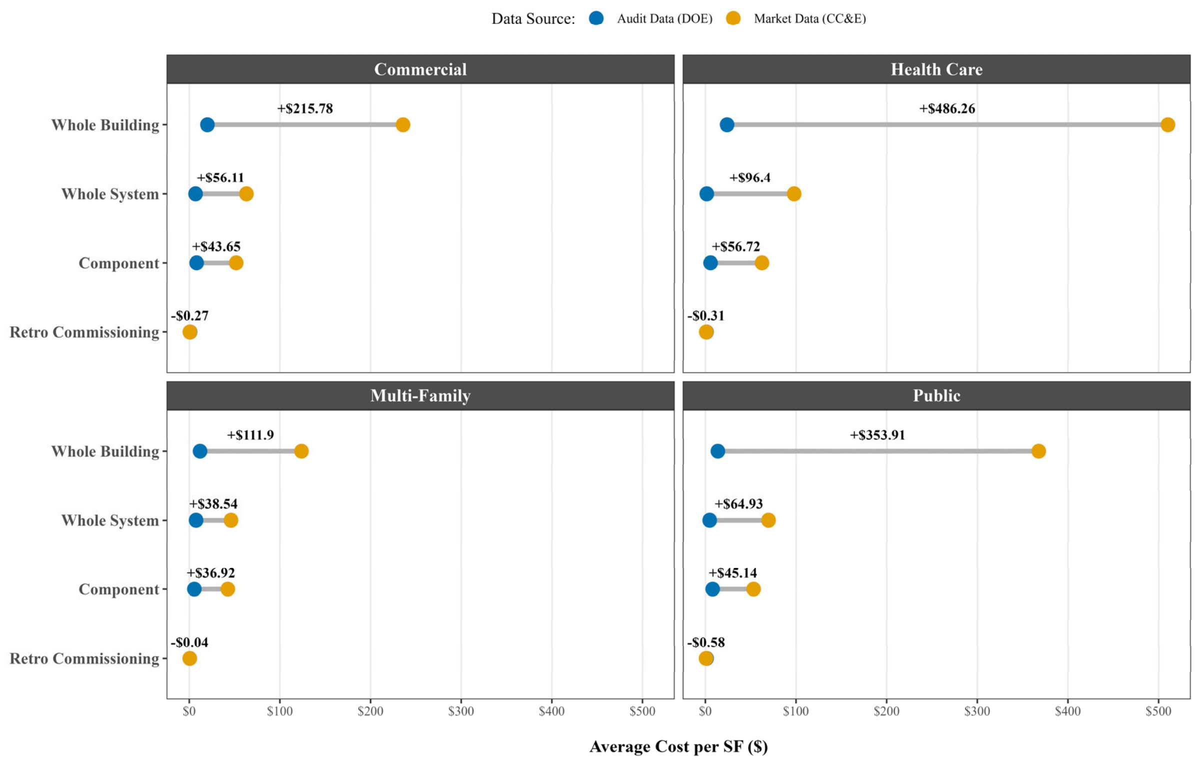


Figure 5. Difference between retrofit costs sourced from the cost estimator and from Audit Template

Overall, this analysis suggests three broader implications for BPS cost analysis. First, the source of the cost data matters, and jurisdictions should carefully consider where they source their cost estimates. Different sources represent different domains of expertise: a cost estimator is trained to quantify construction costs, while an energy auditor is trained to identify energy efficiency improvements. Using multiple sources would be more effort, but could provide a range of possible values. Second, energy audits are probably not a reliable source of cost data for BPS, especially at higher retrofit levels. While an ASHRAE Level 2 energy audit requires an auditor to estimate costs, they are not trained cost estimators. Moreover, most of the measures recommended by energy auditors resulted in relatively low energy savings (20% or less), which may be insufficient for meeting BPS targets for many buildings. Energy audits, which are typically focused on identifying cost-effective retrofits, may simply be the wrong tool to support the deeper retrofits needed under BPS. Emerging tools that focus on deeper savings, such as a Strategic Decarbonization Plan (SDP) (Hinge et al. 2025), may be needed instead of or in addition to an energy audit. Third, cost data should be collected as part of BPS compliance. The best data for understanding BPS retrofit costs is data from actual buildings that have gone through the compliance process. Jurisdictions that have already enacted a BPS should collect and share this data to inform other jurisdictions about the true costs of a BPS.

Mapping BPS Financing Programs

In addition to understanding potential retrofit costs for a BPS, jurisdictions also need to be aware of what support can be provided to building owners to help meet those costs. Cost estimate data can tell us: What is the full scale of investment needed to meet BPS targets in our jurisdiction? But policymakers next need to understand the gap between needed investment and existing financing and incentive programs. This can illuminate the need for the jurisdiction to create additional support programs for building owners. As shown previously in Figure 1, financing and incentive programs are one of the key points where a jurisdiction can influence costs for building owners. To explore this gap, we mapped the current landscape of financing programs available in Ohio and used this information in discussions with stakeholders.

The project team started by interviewing city staff in our four partner cities to learn about which incentives were available and used. These conversations suggested that building owners and developers in these cities—at least anecdotally—rely more on local and state financial incentives than federal ones. Unlike many other states, Ohio has not had utility-sponsored energy efficiency programs since the passage of House Bill 6 in 2019, making state and local programs even more important. Incentives commonly cited across cities included: tax credits related to redeveloping historic buildings and renovating properties; financing through two state agencies, the Ohio Air Quality Development Authority (OAQDA) and the Ohio Department of Development (ODOD); local port authorities, which can issue bonds and loans to finance economic development projects, including construction and renovation; Commercial Property Assessed Clean Energy (C-PACE) financing, a project-funding mechanism that enables renewable energy and energy efficiency projects to be repaid and secured through special assessments on property taxes; and local property tax abatements.

To understand how these programs related to the types of costs faced by building owners, we mapped these programs onto a matrix like the one shown in Figure 6 below. The matrix lists the level of retrofit, and the stage of the retrofit process that it applies to, using the stages from the DGS (2022) that were shown in Figure 1. The mapping allowed us to see what scopes and phases of work currently had funding available for building owners, and where funding was missing. Our mapping shows that most state programs specifically fund "Implementation" work, leaving a gap for local jurisdictions to fill for analysis and design work. To access "Implementation" funding from many of these state programs, building owners must have an up to date (no more than two years old) ASHRAE Level 2 energy audit. Ironically, though, an energy audit itself and any work under the "Analysis" and/or "Design" stages of retrofit work pose a cost to the building owner, who must engage specialized consultants to perform this work. Our discussions with jurisdictions and stakeholders also revealed that not all of these sources are used equally across the state. In particular, some Ohio cities have been more successful than others in scaling C-PACE financing. Our overall finding from this mapping exercise was that even in the absence of utility-sponsored energy efficiency programs, ample state and local programs are well-known and used, but need to be streamlined, simplified, and expanded to increase adoption and support building owners under a BPS.

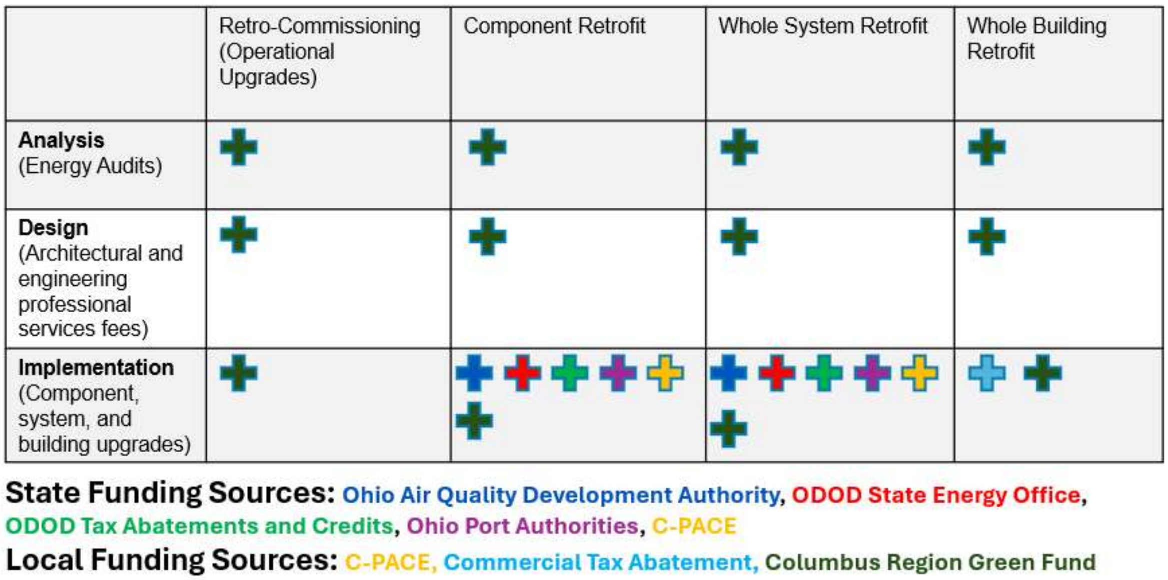


Figure 6. Example of matrix used to map existing financing and incentive programs by retrofit stage.

As an additional exercise, we also reviewed examples of BPS support programs in peer jurisdictions that have already adopted BPS. We arranged them on a spectrum, as shown in Figure 7, showing the level of support provided by the jurisdiction, from disseminating information about other financing programs or utility incentives on one end, to allocating actual jurisdictional resources to administering public grants, loans, or other incentives on the other.

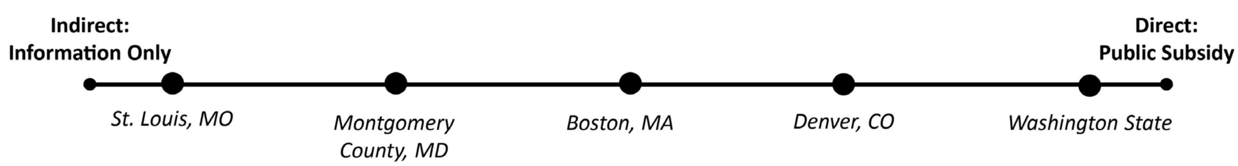


Figure 7. Spectrum of available BPS support in peer jurisdictions

On the information-only end of the spectrum, we put St. Louis, MO, who partners with the Building Energy Exchange St. Louis (BE-Ex STL) as a technical assistance provider for compliance with its BPS. The City of St. Louis does not directly fund the retrofits required by its BPS, but BE-Ex STL offers guidance on accessing utility rebates and other available financing options. On the direct subsidy end of the spectrum, the State of Washington Early Adopter Incentive Program funds measures identified from an approved list of energy audit providers and utilities to conserve energy at $2.00/ft^2$ using state funds. The state incentive can be used in tandem with utility incentives. Between these were Montgomery County, Maryland, which offers a property tax credit incentive for BPS compliance; the City of Boston, which provides business loans through the Boston Industrial Development Financing Authority and has an Equitable Emissions Investment Fund that was seeded by the City but will accrue funding through alternative compliance payments and BERDO fines; and the City of Denver, which offers rebates for energy audits and electrification feasibility reports, as well as incentives for district energy and steam to electric conversion. These City rebates and incentives are funded through the voter-approved Denver Climate Protection Fund. These examples provided inspiration to stakeholders and facilitated visioning and collective prioritization about what new programs might be feasible and worthwhile in Ohio.

Conclusions

Overall, this paper has identified important discrepancies in existing approaches to quantifying retrofit costs, and provided a framework and considerations for developing future cost analysis for BPS. Taken together, this work suggestions two broad conclusions. First, the actual estimates from prior work have limited value. The variations in data source and methodology across the studies we reviewed make it challenging to compare to other sources or jurisdictions. At present, in the absence of reliable and generalizable estimates, each jurisdiction will need to develop its own cost estimates. However, what is valuable to take away from previous work is the methodology and framing used. Here, we have summarized those into a useful framework to aid future cost analysis for BPS. Second, clarity is key. Retrofit costs can mean and include many different things. It is critical for jurisdictions and their technical consultants to be clear about the purpose and scope of the cost estimates. Where possible, these should be reported as $/ft^2 and categorized by building type and level of retrofit, as this makes them most applicable for additional analysis using building stock data.

This paper also highlights the need for future work on BPS costs. First, while we reviewed a range of sources, this is not intended to be a comprehensive meta-analysis or review paper, and applicable sources may have been omitted. No doubt there are also relevant cost estimates that exist but are not publicly available, emphasizing the need for greater transparency on this topic. Second, the focus here was on understanding only two cost components: retrofit costs and financing. More analysis is needed linking all of the parts shown in Figure 1 and evaluating the overall economic effectiveness of BPS with all of its constituent value streams. Finally, and perhaps most useful, would be the development of guidance on best practices for BPS cost analysis, so that jurisdictions have a recommended starting point, and the results from different jurisdictions can be compared.

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This research used Anthropic's Claude and Google's Gemini AI tool to assist with code development for generating figures. No project datasets were shared with or processed by the AI tool; all guidance was limited to code logic. The authors reviewed and verified all code generated.

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