



Analysis of the financial impacts of building performance standard penalties on commercial buildings in Aurora, Colorado

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Abstract

Buildings are responsible for 30% of total energy consumption worldwide. To address building energy, jurisdictions in the USA have enacted Building Performance Standards (BPS) legislation. The objective of BPS is to reduce energy consumption in buildings, thereby reducing the energy burden on utility infrastructure and other externalities. This is accomplished by setting mandatory energy use limits coupled with penalties for exceeding those limits. One of the key questions in BPS policymaking is how these penalties might impact the finances of building owners and tenants. This paper presents an analysis of BPS penalties in Aurora, Colorado, specifically targeting buildings impacted by the adopted statewide BPS legislation. Several BPS penalty structures were applied to the affected building stock in Aurora, and the potential impacts on building owner returns and tenant rents were estimated. The results show that for some combinations of building types and penalty structures, potential rent increases due to penalties could match or exceed typical yearly rent increases. The results also show that in most cases, for Aurora, there was no statistically significant difference in impact between buildings located in under-resourced and well-resourced areas.

Keywords Building performance standards · Under resourced · Well resourced · Communities · Aurora · CO · Rent increases · Energy reductions · Split incentive

1 Introduction

Buildings account for 30% of total energy consumption worldwide (International Energy Agency 2023). This large portion of energy makes buildings a key sector of focus to meet energy and emissions reduction goals to limit the externalities associated with energy production. To target building energy, Building Performance Standards (BPS) legislation has been passed across multiple jurisdictions in the USA (U.S. Department of Energy 2024). The goal of BPS is to require certain commercial (and sometimes

multifamily) building owners to bring energy use under a specified limit in an effort to reduce total energy consumption and emissions. This legislation takes several forms and implementations. Colorado recently passed BPS legislation that compares a building's actual reported energy use intensity (EUI)—annual energy use divided by floor area—to a EUI target (EUI_t) (Colorado Energy Office 2022). If a building's EUI is above the EUI_t, then the building is charged a flat penalty on a yearly basis. The City and County of Denver have also enacted similar legislation, where the penalty is proportional to the amount of energy used beyond a building's defined limit (City and County of Denver 2024). These are two examples of legislation types and penalties levied across the USA.

While this type of legislation is relatively new to the USA, similar policies have been in effect in Europe since 2010 (European Commission 2018). The European Union (EU) passed the Energy Performance of Buildings Directive (EPBD), which requires EU countries to implement energy requirements to reduce building energy consumption and GHG emissions. From 2005 to 2018, the EU has seen an overall reduction in total energy consumption of

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5% (273 TWh) as a result of these policies (Zangheri and Ruggieri 2021). It has been noted that this level of reduction does not meet EU efficiency goals, there for a minimum energy performance standard (MEPS) is needed to increase building renovation and savings (European Commission 2023). In response, the EU is recasting the EPBD to include MEPS (European Commission 2024). MEPS will phase out the worst-performing buildings over time, somewhat analogous to the U.S. BPS policies but often stricter. While MEPS does not explicitly require penalties, several EU member states, including France and the Netherlands, have enacted penalties to help enforce these policies (Lexlink 2023; Technis (n.d.)). Many of these policies require buildings to meet energy requirements with penalties levied for non-compliance. BPS legislation in the USA mirrors some of the requirements of these laws and could theoretically serve as a proxy for understanding some of the potential impacts of these types of policies on the building market.

Because the EU is a collection of countries that each must implement the policy, there are different levels of penalties across the different countries to help enforce the energy performance policy (Waide et al. 2021). These have not been studied in an appreciable way to understand the impact on building owners and tenants. While these types of policies can help spur energy savings broadly, it is unclear the impact these penalties have on both the building owners or building tenants and the potential impact to under-resourced areas. It has been noted that these changes in the EPBD come at a time when much of the EU is in a housing crisis and that sufficient financing and programs to assist homeowners are needed to help ensure these policies are implemented in a proportionate manner (Housing Europe 2024).

While much of the existing communities' research has focused on residential housing, the implications of energy performance policies and penalties can extend beyond this sector. Specifically, BPS policies, though primarily targeting commercial and large multifamily buildings, may indirectly influence broader affordability and displacement issues. The connection between these policies and housing must be clearly understood, as penalties can lead to increased operational costs for building owners, which may be passed on to tenants, exacerbating economic burdens in under-resourced areas. In jurisdictions where these penalties could lead to business and tenant displacement, there is potential for long-term shifts in the local economy that may reduce regional affordability.

Therefore, this work aims to bridge the gap between BPS policies and housing policy by examining the broader economic impacts of energy performance penalties. This will inform future updates and policies to ensure that they result in proportionate outcomes, especially concerning the economic burden in underserved areas.

Commercial buildings in the USA are either occupied by the building owner or leased by the building owner (or building management company) to a tenant. The overall floor area of non-government buildings in the USA is 74.7 billion ft²; 28.4 billion ft² (38.0%) is leased; 45.4 billion ft² (60.7%) is owner operated; and the remaining area is unoccupied (Energy Information Administration 2022). The goal of BPS legislation is to increase building performance and meet ambitious energy targets by reducing energy use and emissions in buildings. This is accomplished through incentivizing the building owner to make improvements to their buildings and improve building operations to meet BPS targets. If building owners do not meet the targets, jurisdictions can levy penalties, or fees. Given that 38% of the current floor area is occupied by tenants who do not own the property, this poses a unique challenge for BPS legislation. This challenge comes from the "split incentive" problem, which arises when tenants who lease buildings are responsible for utility bills or other property bills but lack control over improving the building. Building owners in those same properties lack incentive to upgrade their buildings if they do not realize savings associated with improvements because they are not the ones paying the bills.

Similarly, because building owners often do not pay the utility bills, they also do not have an incentive to make buildings more energy efficient. Building owners do have an incentive to make building upgrades to improve the condition of their building and therefore improve the market position of the building. However, the market may not reward energy efficiency with higher rents and therefore might not be enough incentive for these building owners to invest capital into their buildings.

When faced with BPS penalties, building owners might pass on penalties to tenants because of this split incentive problem. Triple net leases are a common leasing structure where building tenants pay all rent, utilities, taxes, and common area maintenance for the building (Foster 2019). With leasing structures such as triple net or others that result in additional building costs being covered by the tenant, BPS penalties could be passed down to tenants. Because building owners are currently the recipients of BPS penalties, passing penalties through to tenants could result in unintended or disproportionate impacts on these tenants.

It has been shown that sustainable building policy can possibly exacerbate existing disparities that are seen across the USA (Mehdizadeh and Fischer 2013). Given this potential, it is important to understand ways that policies can impact underserved areas and ensure that steps are taken to mitigate disproportionate outcomes. This study is a numerical analysis of different penalties in Aurora, Colorado, and the potential impacts of these penalty structures. The analysis utilizes reported data from several different sources as well as modeled energy data. This study was funded by the

U.S. Department of Energy to understand the financial and impacts of these penalties on a smaller scale to inform future studies. An understanding of the effect of BPS penalties on different areas can inform legislative updates or future BPS legislation to mitigate unintended impacts and help ensure BPS penalties are meeting their intended goal of energy and remissions reductions.

2 Analysis methodology

2.1 Summary of buildings in the analysis

This analysis looks at the commercial building stock in Aurora, CO and how BPS applies to these buildings. For this analysis, we down-selected to buildings that required to comply with BPS policies and buildings that exceeded the energy targets set by the policy. Table 1 below summarizes how many buildings were included in this analysis and the breakdown.

2.2 Describing the overall building stock

The primary source for commercial building stock data in the City of Aurora was CoStar (2019), a real estate data provider that describes commercial properties across the USA. The data fields used for this analysis included building location, age, construction, sale price, cap rate, expenses, rent, tenant types, ownership, and market-level average data for similar buildings. Cap rate, or capitalization rate, is a financial metric used to evaluate the potential return on a property investment by dividing the net operating income by the property’s market value.

The dataset contained 2486 properties spanning 71 different property types in the City of Aurora. To simplify the analysis, each property was mapped to one of seven property types: warehouse, hospital, outpatient, small hotel, large hotel, strip mall, and office. Across these 2486 properties, there were 6975 tenants spread across 23 different industries.

The primary source used to describe the area where each property was located was a White House tool to understand under-resourced and well-resourced areas denoted by census tract. This tool was developed under executive order 14,008. (The White House 2021) This tool uses data on energy, health, housing, legacy pollution, transportation, water and wastewater, workforce development, etc. to identify

each census tract in the USA as either “under resourced” or not. The census tract for each of the 2486 properties in Aurora was determined, and the White House data were used to establish whether each property was located within an under-resourced area (URA) or outside of a under resource area also known as a well-resourced area (WRA).

We use the term “Under Resourced” to refer to areas experiencing higher rates of various burdens. We acknowledge that some communities may not identify with the term “under resourced” and respect their self-representation. Nevertheless, we have chosen to use URA in this document for consistency with the White house tool and for simplified communication.

The distribution of property types and tenant industry types are shown in Figs. 1 and 2. The primary property types include strip malls, offices, and warehouses. Of these properties, 53.2% are located in URAs as defined by the White House.

The predominant tenant industries are retail, services, healthcare and social assistance, accommodation and food services, and professional and scientific services.

2.3 Buildings where BPS is applicable

For this study, the Colorado BPS requirement of a floor area greater than 50,000 ft² was applied. Of the 2486 properties in Aurora, only 478 (19.22%) properties exceeded this floor area threshold.

2.4 Building energy consumption

Energy consumption is the key metric evaluated by BPS in Colorado. Therefore, it is a critical input to this BPS analysis. In Colorado, owners of properties larger than 50,000 ft² must report building energy data to the state for benchmarking and BPS compliance. However, at the time of the analysis there was not energy data for all buildings that were required to benchmark their buildings. For this analysis, the available reported energy data were provided by the State of Colorado. By associating this energy data with the respective building addresses, the EUI for each available building was mapped, providing real reported data for use in the analysis.

For properties where energy consumption was not reported, ComStock™ was used to estimate it (National Renewable Energy Laboratory (NREL) 2024). ComStock

Table 1 Breakdown of Aurora commercial buildings included in this analysis

Category	Count
Number of Commercial Buildings available in Aurora dataset	2486
Number Buildings Required to comply with BPS	478
Number of Buildings that did not comply with BPS (i.e., Exceed EUI)	184

Fig. 1 Count of property types in Aurora Under-Resourced status

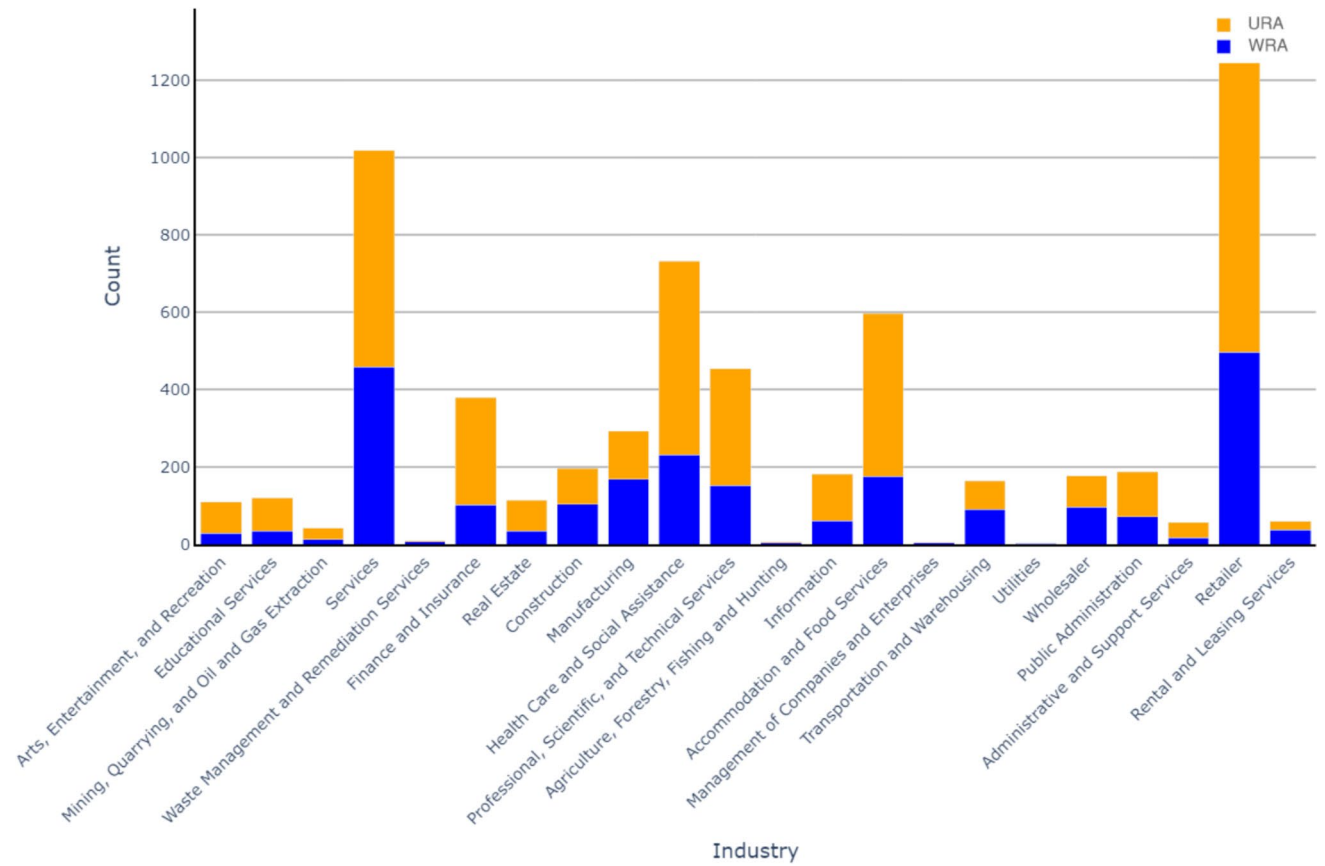
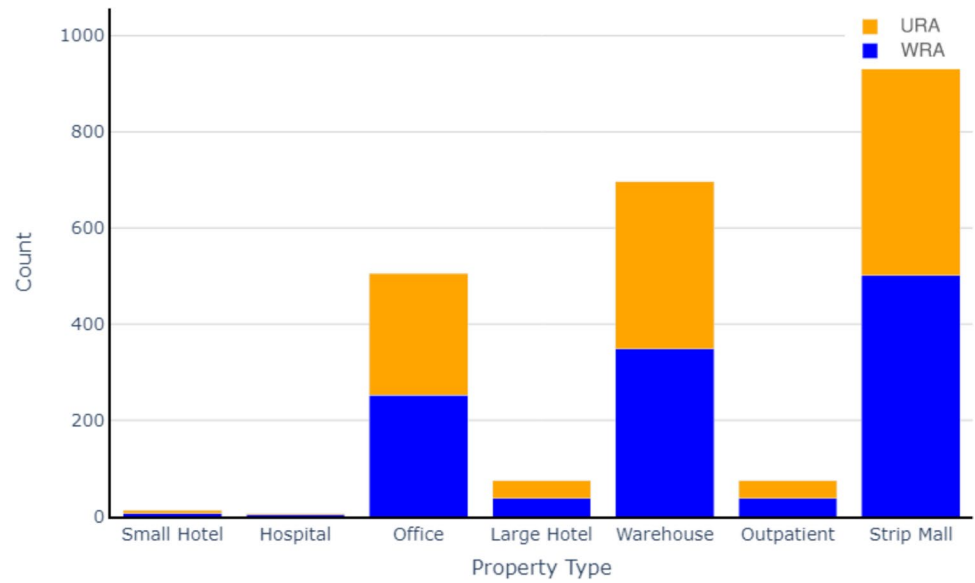


Fig. 2 Count of tenant industry types in Aurora by Under-Resourced status

is a tool funded by the U.S. Department of Energy and developed by the National Renewable Energy Laboratory that utilizes the building characteristic datasets and physics-based energy modeling software to model the

commercial building stock in the USA. For this analysis, ComStock data were filtered to models within the City of Aurora. The energy performance of these models was then averaged based on building type, vintage (i.e.,

2000–2012), wall construction, floor area bin (i.e., 10,000 ft² to 25,000 ft²), and number of floors. This resulted in an estimated energy consumption value for each subset of buildings.

For each of the properties with no energy data provided by the state, the CoStar data attributes were used to find an applicable subset of models from ComStock, and the average energy consumption from that set of models was assigned to the property. In cases where an exact match was unavailable, the EUI sharing the most parameters was utilized. Table 2 shows the percentage of energy consumption that was reported versus the amount that was estimated.

To determine if the Comstock EUIs were representative we performed a comparison of the average reported EUIs to the EUIs estimated from ComStock showed that the average EUIs were typically within 5% of each other. This congruence instills confidence in the accuracy of ComStock models in depicting the commercial building stock in Aurora.

Table 2 Percentage of EUIs reported versus imputed from Comstock by building type

Building type	Percentage of reported EUIs (%)	Percentage of EUIs estimated using ComStock (%)
Hospital	20.0	80.0
Large Hotel	3.1	96.9
Office	5.2	94.8
Outpatient	11.1	88.9
Strip Mall	6.0	94.0
Warehouse	7.5	92.5

2.5 Identifying non-compliant buildings

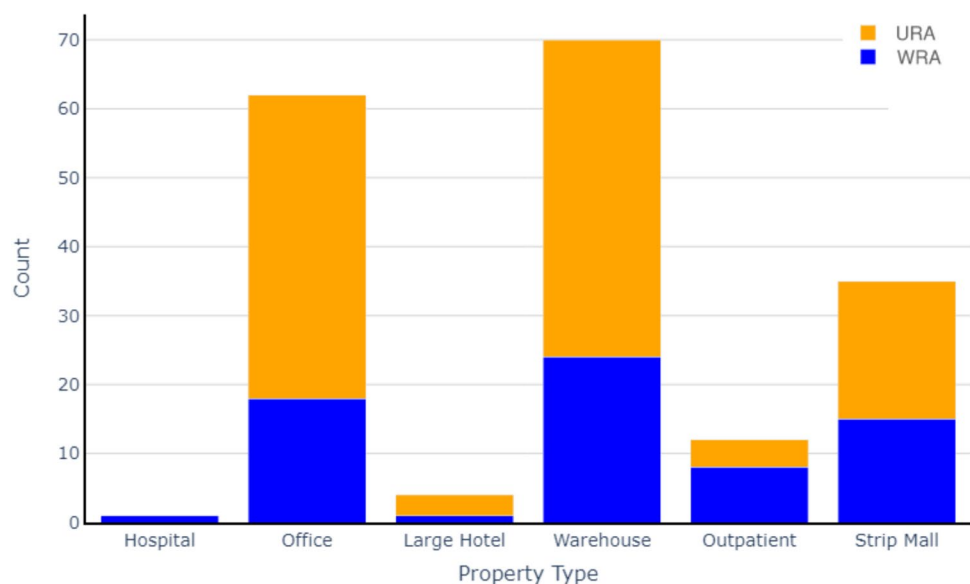
BPS penalties are only levied on buildings that use more energy than the allowable limit. For this analysis, the limits defined in the State of Colorado BPS were used. This reduced the properties from 478 where BPS was applicable down to 184 “non-compliant” properties where BPS penalties would be assessed. Note that non-compliance as assessed in this analysis is in many cases based on estimated energy consumption, meaning that these results should not be interpreted as the true impact of a BPS in Aurora.

Figure 3 reveals that warehouses, offices, and strip malls are the most common property types among the 184 non-compliant properties. Among these non-compliant properties, 94 (51.1%) are situated in URAs, contrasting with the broader market, where 65.2% of buildings are in URAs.

Despite this disparity, the majority of common property types, such as warehouses and offices, are located in WRAs. While there exist a notable number of buildings across each property type and community status, it is crucial to acknowledge that this analysis exhibits a slight bias toward properties in WRAs. This bias could overrepresent the potential impact of penalties on properties in WRAs compared to URAs. To ensure that this bias is not shown in the results, the team utilized *t* tests to analyze the data and ensure trends are significant for different groups in the data. Even though more buildings in WRAs might experience penalties, it is important to understand whether there are proportional differences between the two groups.

To estimate the possible impact of BPS legislation on tenants, the team mapped tenant distributions within non-compliant properties, as depicted in Fig. 4. Among tenants in non-compliant properties, similar trends to property-type distributions emerge. Specifically, there are 915 tenants,

Fig. 3 Count of non-compliant properties in Aurora by Under-Resourced status



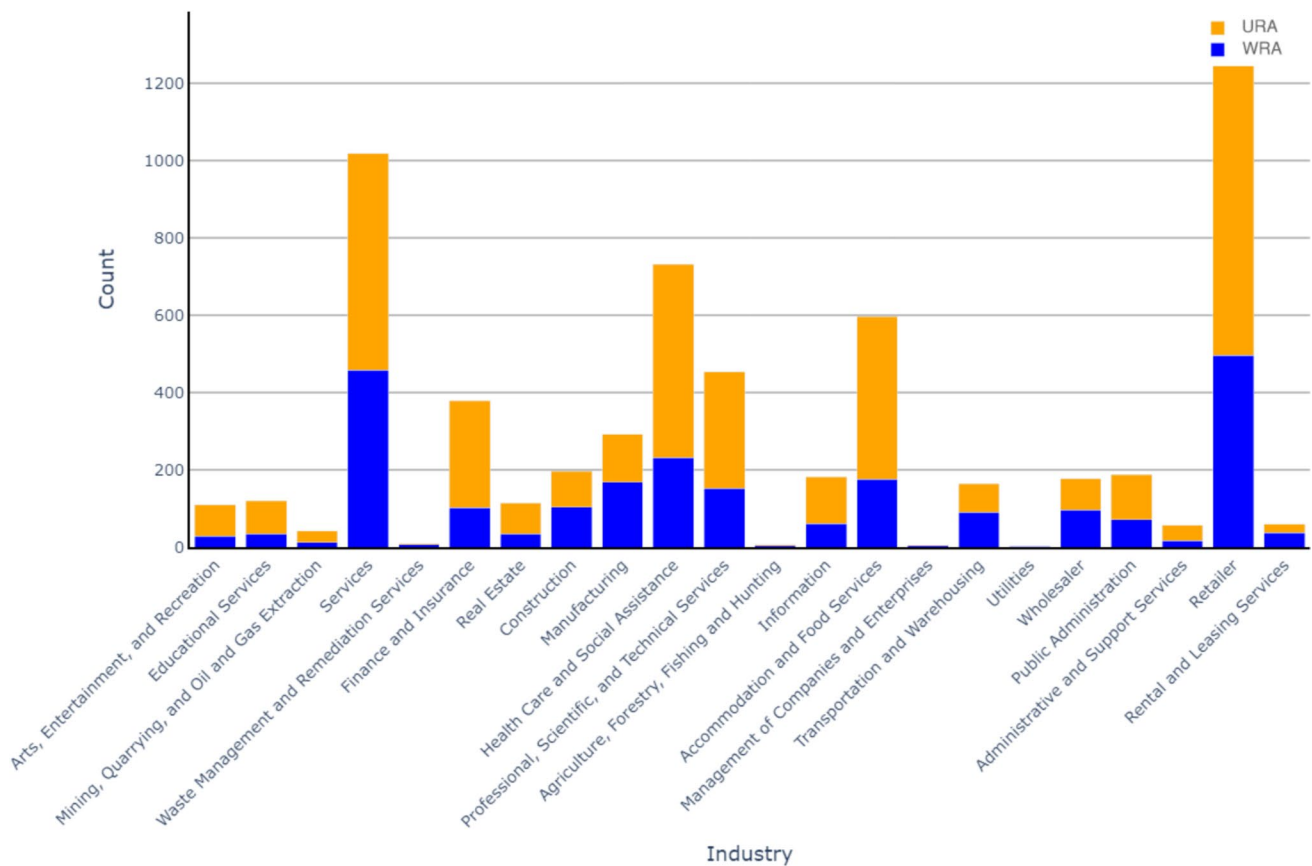


Fig. 4 Count of tenants in non-compliant properties in Aurora by Under-resourced status

with 306 (33.4%) of these tenants located in URAs. This distribution aligns with the broader market, where 38.5% of all tenants are in buildings located in URAs. Most tenants in non-compliant buildings are in WRAs. This indicates a slight bias toward tenants in WRAs, akin to the property-level analysis. Once again to ensure that this bias is not shown in the results, the team utilized *t* tests to analyze the data and ensure trends are significant for different groups in the data.

2.6 Building financial data

CoStar provides financial data for many buildings; the values used in this analysis were as follows: utility cost, total operating expenses, tax expenses, rent, sale price, and cap rate. For some properties, financial data were not available. In these cases, the average market data for Aurora, disaggregated by property type, were used to impute missing values. Table 3 shows the data fields that were used, the percentage

Table 3 Data availability in CoStar

Data Field	% Reported	% Imputed from market average
Cap rate	47.1	52.9
Sale Price/ ft ²	72.4	27.6
Rent/ft ²	96.0	4.0
Vacancy rate	24.6	75.4

reported in CoStar, and the percentage not available and in turn was assumed to be the average market data for that data field. The data fields include.

- Cap rate: a metric used to evaluate the potential value of a real estate investment
- Sale price/ ft²: last sale price per ft² of the property
- Rent/ft²: last reported rent per ft² of the property
- Vacancy rate: % of the building that was unoccupied by tenants.

2.7 Evaluation of Building Performance Standards (BPS) penalty structures

Three potential BPS penalty structures were evaluated as part of this analysis. They are as follows:

- A flat penalty per building (modeled off the State of Colorado’s BPS structure)
- A penalty proportional to the floor area of the building floor area
- A penalty proportional to the energy use beyond the allowance (modeled after Denver’s BPS legislation).

This analysis only explored the situation in which buildings do not comply with BPS regulations; it did not explore the scenario wherein building owners invest in improving buildings and meet energy targets. This omission stems from the complexity of estimating improvement costs on a per building basis and the limited data available on the existing condition of buildings. This analysis assumes that all

BPS penalties are either absorbed by the building owner as increased expenses or passed on to tenants in the form of increased rent, as shown in Fig. 5.

The flat penalty structure includes the following components:

1. Reporting penalty: Assessed on buildings failing to report their building area and energy consumption to the state. Initially set at \$5,100 for the first year, followed by \$2,000 for subsequent years.
2. Performance-based BPS fee: Initially set at \$24,000 for the first year and \$60,000 for each subsequent year. These fees follow a similar BPS fee structure utilized by the State of Colorado for simplicity and to understand the long-term impacts, the fee was averaged out over 10 years. Consequently, the final amount assessed per year is \$58,710 for all non-compliant buildings (Eq. 1).
3. This analysis assumes full non-compliance. This includes not reporting and receiving both the reporting and performance-based penalties. The reporting penalty is only 3.93% of the total penalty.

$$Flat\ Fine\ (\$/Year) = \frac{\$5100 + \$2000 \cdot 9}{10} + \frac{\$24,000 + 60,000 \cdot 9}{10} = \$58,710/Year \tag{1}$$

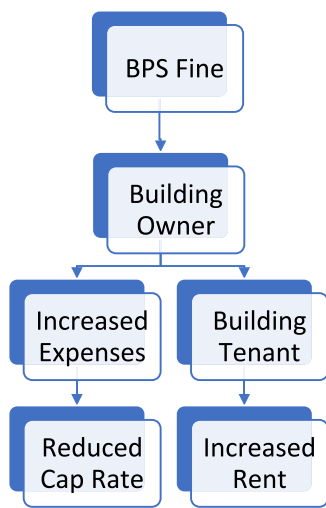


Fig. 5 Graphical representation of how analysis assumes penalties are passed down to different groups

The penalty proportional to floor area (\$/area penalty) includes the following components:

- 1 Assessed at \$2/year per building ft² for buildings exceeding their respective 2030 EUI target. For instance, a building of 50,000 ft² surpassing its EUI target would incur a fee of \$100,000 per year (Eq. 2).

$$Fine\ Prop.\ to\ Floor\ Area\ (\$/Year) = 2 \frac{\$}{ft^2} \cdot Building\ Area\ (ft^2) \tag{2}$$

The penalty proportional to energy use (\$/energy penalty) includes the following components:

Levied at \$0.05/year per kBtu on non-compliant properties. The kBtu amount used for fee calculation is determined by subtracting the EUI target from the current EUI (reported or ComStock), then multiplying by the building area (Eq. 3).

$$\begin{aligned}
 & Fine\ Prop.\ Energy\ Use\ \left(\frac{\$}{Year}\right) \\
 &= 0.05 \frac{\$}{kBtu} \cdot \left(EUI\ Baseline\ \left(\frac{kBtu}{ft^2}\right) - 2030\ EUI\ Target\ \left(\frac{kBtu}{ft^2}\right) \right) \\
 &\cdot Building\ Area\ (ft^2)
 \end{aligned} \tag{3}$$

A penalty was calculated for the 184 non-compliant properties using each of the three penalty structures. The team conducted an analysis of the impact of these penalties under

two different scenarios: The first assumed that all penalties would be handled by the property owner as additional building expenses, and the second assumed that these penalties would be passed through to tenants via increased building rent. These two scenarios were chosen to show the extremes of the possible impacts. In practice, a property owner could choose to use some mix of these two approaches or other financial approaches to handle the penalties.

Due to the limited number of properties, small hotels and hospitals were excluded from the financial impact analysis. Large hotels were excluded from the analysis due to their non-traditional rent structures and limited data on average occupancy or cost per room. These building types accounted for only 33 unique locations, representing 4% of the total floor area in the dataset.

2.8 Penalties handled by the building owner as increased operating expenses

To estimate the investment impact stemming from the rise in expenses, the cap rate was evaluated for each property. Cap rate is a financial metric commonly used in the real estate investment industry. Cap rate is defined as the net operating income divided by the market value of the asset (Eq. 4). A higher cap rate means that a property is more profitable.

$$\text{Cap Rate (\%)} = \frac{\text{Net Operating Income}}{\text{Market Value of the Property}} \cdot 100 = \frac{\text{Gross Revenue} - \text{Operating Expenses}}{\text{Market Value of the Property}} \cdot 100 \quad (4)$$

Net operating income was calculated either from the existing cap rate data available in CoStar or by utilizing the rent and expense data provided in CoStar to calculate the cap rate. The decrease in cap rate was then evaluated across different building types. This evaluation considered both the rent and cap rate for properties, as well as the subsequent reduction or increase in these metrics for each BPS penalty structure. The change in cap rate was calculated for each

property and penalty structure by subtracting the new cap rate from the baseline cap rate.

2.9 Penalties passed through to tenants via increased rent

Following the property-level analysis, a parallel investigation was undertaken for tenants. To evaluate the impacts on tenants, all BPS penalties and the classification of “Under-Resourced” status were extrapolated to the tenant level, assuming that all fees were passed on to tenants in the form of increased rent. To understand the impact across the tenant market, these effects were associated with tenant industry types. To understand the impact to rent for tenants, the percent change in rent was calculated for each property and penalty structure and was assessed on both the property-level rent as well as each tenant associated with those properties.

3 Results and discussion

3.1 Impact on building owner returns

Looking at the first scenario, where penalties were assumed to be absorbed by the property owner as additional operat-

ing expenses, we see a drop in cap rates across the Aurora market. Our examination of cap rates and their reductions, stratified by under-resourced status, is presented in Table 4, Figs. 6 and 7. Across all properties, the flat penalties yield the smallest median reduction in cap rate across the different building types, while the \$/area and \$/energy penalty structures result in larger median cap rate decreases. This outcome is unsurprising given flat-rate BPS penalties have a fixed cost for all building sizes, contrasted with the variable

Table 4 Median cap rate by property type and under-resourced status

Property type	Under-resourced status	Count	Baseline Cap rate	Flat Fee Difference (%)	\$/ft ² Difference (%)	\$/kBtu Difference (%)
Office	Under resourced	18	7.0	-0.3	-0.9	-0.7
Office	Well resourced	44	8.7	-0.5	-0.6	-1.0
Outpatient	Under resourced	8	12.0	-0.5	-1.1	-0.4
Outpatient	Well resourced	4	11.3	-0.4	-1.1	-3.2
Strip Mall	Under resourced	15	6.8	-0.5	-0.8	-0.3
Strip Mall	Well resourced	20	10.0	-0.6	-1.2	-0.6
Warehouse	Under resourced	24	4.4	-0.5	-1.9	-1.6
Warehouse	Well resourced	46	1.9	-0.2	-1.0	-1.4

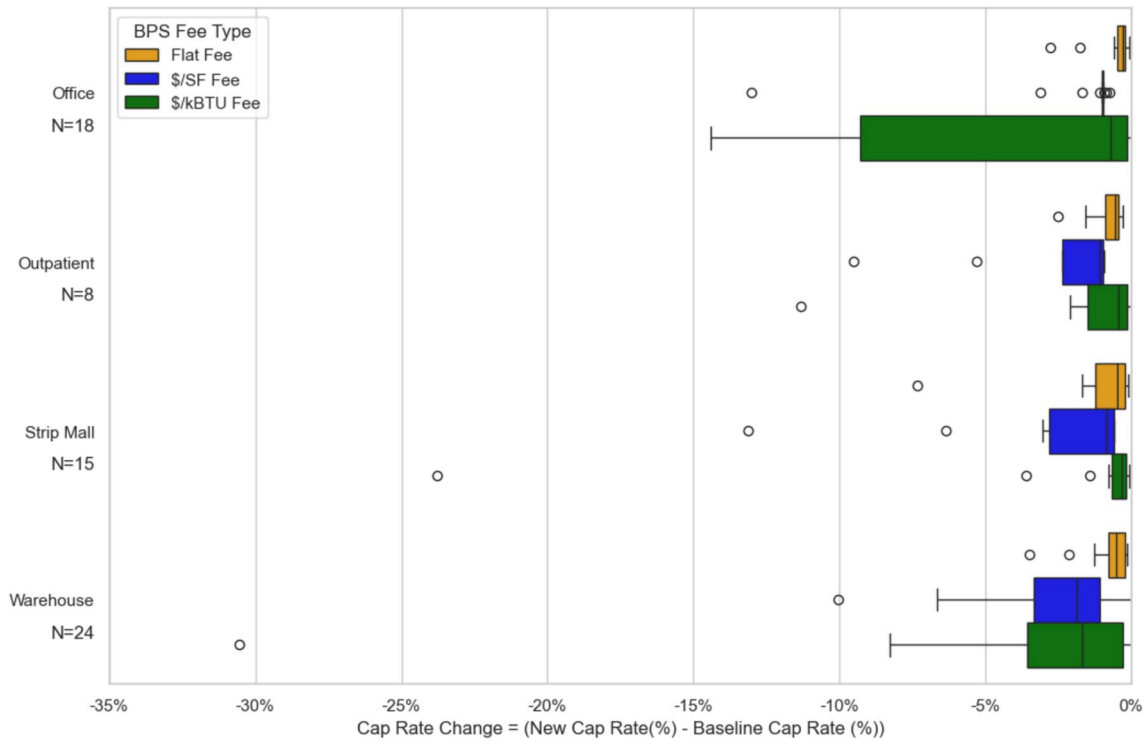


Fig. 6 Cap rate reduction in under-resourced areas

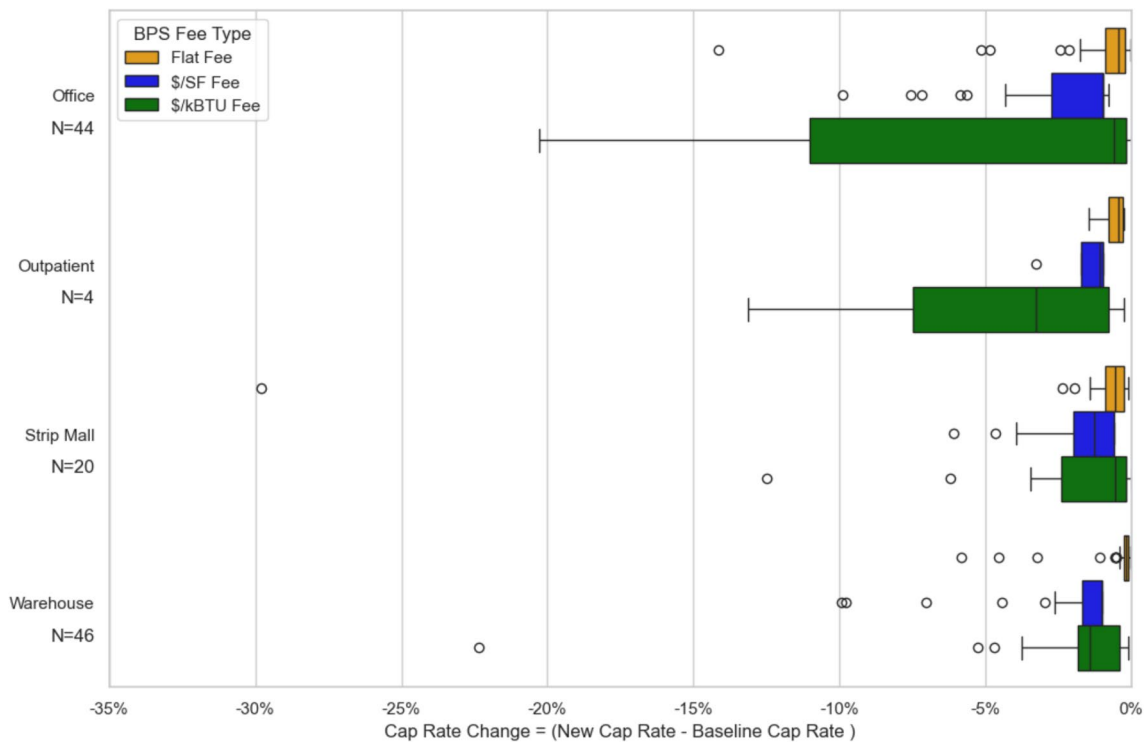


Fig. 7 Cap rate reduction in well-resource areas

Table 5 Results of independent *t* test comparing cap rate decreases between URAs and WRAs

Property type	Variable	<i>t</i> -statistic	<i>p</i> value	Confidence interval lower bound	Confidence interval upper bound	Result
Aurora market	Flat Fee BPS Cap Rate	0.703	0.483	-0.007	0.012	No significant difference
Aurora market	\$/SF BPS Cap Rate	1.090	0.278	-0.025	0.069	No significant difference
Aurora market	\$/kBTU BPS Cap Rate	0.980	0.329	-0.025	0.052	No significant difference
Office	Flat Fee BPS Cap Rate	0.891	0.376	-0.012	0.023	No significant difference
Office	\$/SF BPS Cap Rate	1.094	0.279	-0.037	0.088	No significant difference
Office	\$/kBTU BPS Cap Rate	0.570	0.571	-0.050	0.074	No significant difference
Outpatient	Flat Fee BPS Cap Rate	-0.589	0.572	-0.020	0.015	No significant difference
Outpatient	\$/SF BPS Cap Rate	-0.842	0.421	-0.063	0.042	No significant difference
Outpatient	\$/kBTU BPS Cap Rate	0.921	0.406	-0.108	0.168	No significant difference
Strip mall	Flat Fee BPS Cap Rate	0.688	0.498	-0.031	0.052	No significant difference
Strip mall	\$/SF BPS Cap Rate	0.928	0.365	-0.145	0.338	No significant difference
Strip mall	\$/kBTU BPS Cap Rate	0.882	0.387	-0.102	0.203	No significant difference
Warehouse	Flat Fee BPS Cap Rate	-0.341	0.734	-0.009	0.007	No significant difference
Warehouse	\$/SF BPS Cap Rate	-1.367	0.179	-0.024	0.008	No significant difference
Warehouse	\$/kBTU BPS Cap Rate	-0.502	0.618	-0.053	0.037	No significant difference

penalties of other structures prioritizing larger, higher-consuming buildings.

To test if there were statistically significant differences in the cap rate decreases between properties located in under-resourced and well-resourced areas, we used a standard *p* value threshold of 0.05 to assess the significance of the results. Based on these tests, there was not a statistical difference between the decrease in cap rates between URAs and WRAs. This holds true for the broader Aurora market and by building type. These tests also showed no statistical difference between each penalty structure; the results are summarized in Table 5.

While these lower cap rates might discourage investor activity due to diminished return on investment on assets, they could also serve as incentives for investors to enhance their buildings to restore their investment value. A 1% drop in a properties cap rate equates to 1% reduced value for the investor. This is to say that a \$1,000,000 property would be worth \$10,000 dollars less to a real estate investor. If the costs to retrofit the building exceed the lost value the investor might be incentivized to just take the penalty or pass it on to tenants to recoup lost income. Real estate properties are often classified using a standard rating system that reflects their risk profile, investment potential, and overall quality. These ratings, typically categorized as Class A, Class B, and Class C, help investors assess property value and expected returns.

- Class A properties are considered the highest quality, offering modern amenities, prime locations, and superior construction standards. These properties are typically newer, well-maintained, and attract tenants willing to pay

premium rents. As a result, they present the lowest risk but generally provide lower returns due to their stability and desirability.

- Class B properties are slightly older and may require minor updates or maintenance. They often occupy decent locations and provide moderate returns. These properties involve moderate risk and can be attractive for investors seeking value-added opportunities.
- Class C properties are older buildings, often located in less desirable areas or in need of significant repairs or upgrades. While they present higher risk, they also offer higher potential returns for investors willing to invest in improvements or repositioning.

This classification system helps investors, lenders, and real estate professionals quickly assess property characteristics, risks, and investment potential.

Between different classes of properties, there is approximately a 2–3% difference in cap rate for each rating bump (Common Loan 2022). Looking at the differences in median cap rates of the different BPS policies, we see that for both the flat fee and \$/area penalty structures, there are no changes that exceed the 2–3% change for different property classes. However, for the \$/energy penalty structures, we see a difference that could potentially move a property's cap rate into a lower classification of property. Notably, the utilization of the \$/area penalty structure results in approximately 0.5% greater reductions in cap rates compared to the flat fee penalty structure. Similarly, for the \$/energy penalty structure, we observe a comparable decrease in cap rate but with greater variance between building types. Both of these penalty structures levy higher fees compared to the flat fee

Table 6 Median rents by property type and under-resourced status

Property type	Under-resourced status	Count	Baseline Rent/ft ²	Flat Fee Increase (%)	\$/ft ² Increase (%)	\$/kBtu Increase (%)
Office	Under resourced	18	\$23.65	2.69	8.46	6.13
Office	Well resourced	44	\$22.96	2.60	8.71	1.94
Outpatient	Under resourced	8	\$29.00	3.08	6.90	1.31
Outpatient	Well resourced	4	\$29.00	2.48	6.90	18.19
Strip mall	Under resourced	15	\$24.29	4.18	8.24	2.98
Strip mall	Well resourced	20	\$25.08	3.09	7.97	3.87
Warehouse	Under resourced	24	\$6.93	6.46	28.88	24.74
Warehouse	Well resourced	46	\$8.29	3.68	24.17	24.04

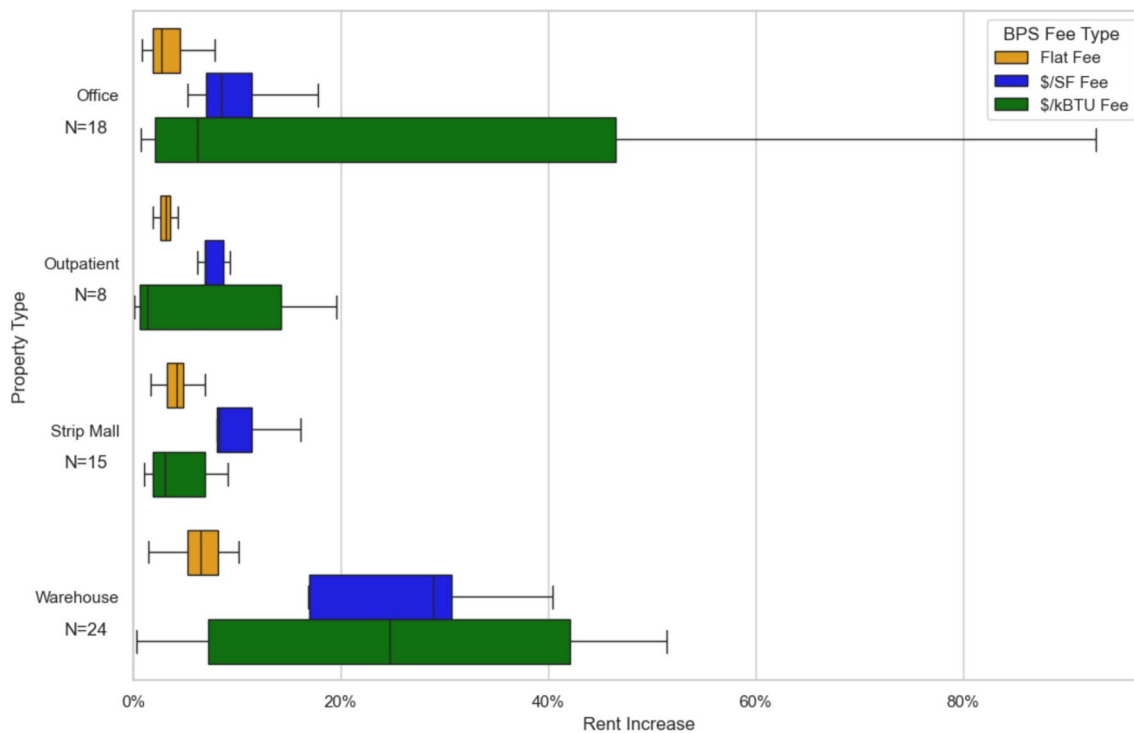


Fig. 8 Rent increase in under-resourced areas

while also penalizing larger buildings and those with higher energy use.

3.2 Impact on tenant rents

Next, the team looked at the second scenario, where penalties were assumed to be passed through to the tenants as increased rents. Our examination of rents and their increase, stratified by under-resourced status, is presented in Table 6, Figs. 8 and 9. We observed that the flat fee penalty yields the lowest rent increase among all BPS penalty structures. The \$/area and \$/energy fees result in greater rent increases overall and a larger distribution of median increases. When comparing these changes with typical year-over-year rent

increases, the median increase for buildings approximates the average increase of 4%–6%. This year-over-year median increase was based on rent data from CoStar from 2018 to 2024 for the overall Aurora market. Yet, specific property types and combinations of penalty structure lead to significantly larger rent increases. Warehouses experience a much greater increase in rent compared to other property types with both the \$/area and \$/energy penalty structures. This is likely due to the much larger floor areas and potential for manufacturing or other large energy consuming devices to be present within the facility. Outpatient facilities in well-resourced areas have an outsized median potential rent increase in the \$/energy penalty structure, which could be explained by more complex equipment and electrical loads

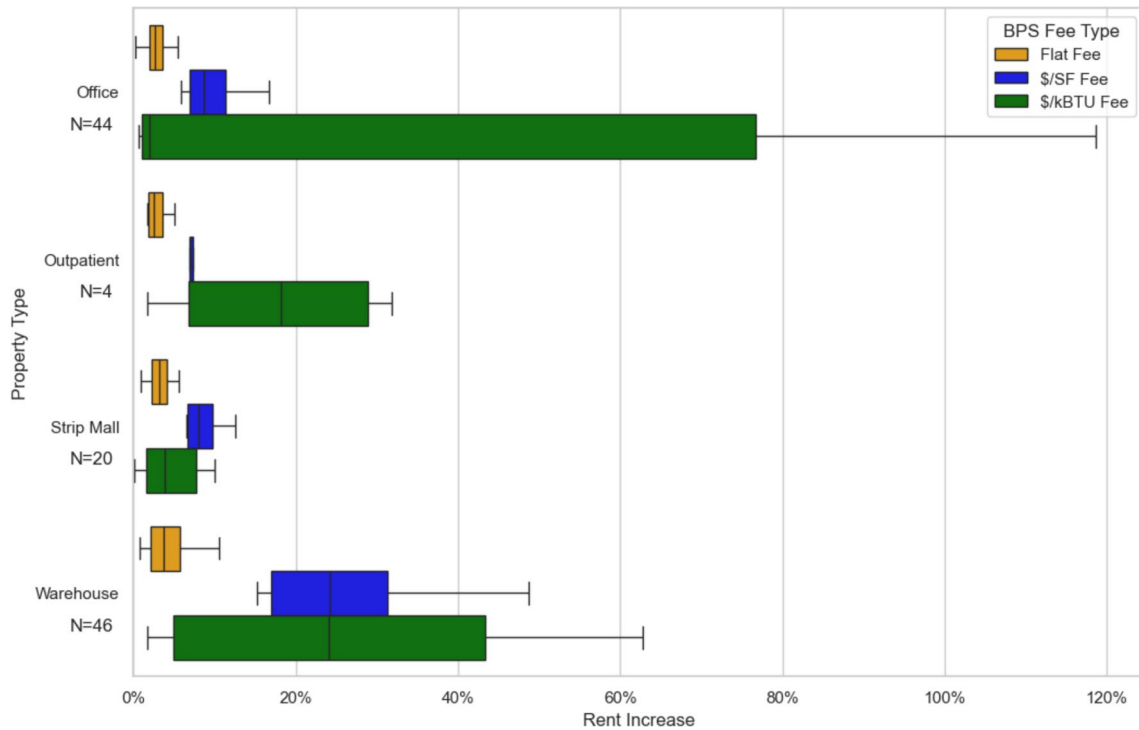


Fig. 9 Rent increase in well-resourced areas

present in these facilities causing a greater fee under this structure. While the average values align closely with year-over-year increases, this additional cost could be financially untenable for some tenants, particularly those from under-served areas.

To test if there were statistically significant differences in the rent increases between properties located in under-resourced and well-resourced areas, the team utilized an independent *t* test. These *t* tests used a standard *p*-value threshold of 0.05 to assess the significance of the results. Based on these tests, there was not a statistical difference

Table 7 Results of independent *t* test comparing rent increase between URAs and WRAs by property type

Market/property type	BPS fee type	<i>t</i> -statistic	<i>p</i> value	Confidence interval lower bound	Confidence interval upper bound	Result
Aurora market	Flat Fee BPS	3.116	0.002	0.002	0.025	URAs have a larger increase in rent
Aurora market	\$/SF BPS	0.191	0.849	-0.039	0.045	No significant difference
Aurora market	\$/kBTu BPS	-1.823	0.070	-0.308	0.064	No significant difference
Office	Flat Fee BPS	0.931	0.361	-0.005	0.015	No significant difference
Office	\$/SF BPS	-0.370	0.713	-0.032	0.021	No significant difference
Office	\$/kBTu BPS	-0.835	0.408	-0.470	0.182	No significant difference
Outpatient	Flat Fee BPS	0.209	0.845	-0.015	0.019	No significant difference
Outpatient	\$/SF BPS	0.358	0.730	-0.012	0.017	No significant difference
Outpatient	\$/kBTu BPS	-1.349	0.248	-0.276	0.063	No significant difference
Strip mall	Flat Fee BPS	2.015	0.053	0.001	0.019	No significant difference
Strip mall	\$/SF BPS	1.827	0.085	0.002	0.046	No significant difference
Strip mall	\$/kBTu BPS	-1.236	0.229	-0.148	0.023	No significant difference
Warehouse	Flat Fee BPS	3.123	0.003	0.011	0.041	URAs have a larger increase in rent
Warehouse	\$/SF BPS	1.084	0.284	-0.015	0.057	No significant difference
Warehouse	\$/kBTu BPS	-0.649	0.519	-0.169	0.080	No significant difference

Table 8 Median rent change by tenant industry type and under-resourced status (Top 10 industry by count)

Industry	Under-resourced status	Baseline Rent/ft ²	Flat Fee Change (%)	\$/ft ² Change (%)	\$/kBtu Change (%)
Accommodation and food services	Under resourced	\$27.00	1.78	7.97	20.97
Accommodation and food services	Well resourced	\$25.08	2.10	7.41	0.94
Construction	Under resourced	\$18.98	4.07	16.89	1.63
Construction	Well resourced	\$25.08	4.41	11.43	1.94
Finance and insurance	Under resourced	\$29.00	3.23	7.97	14.45
Finance and insurance	Well resourced	\$25.08	2.30	10.53	1.94
Health care and social assistance	Under resourced	\$20.50	2.79	6.90	2.98
Health care and social assistance	Well resourced	\$25.08	2.78	10.54	1.94
Information	Under resourced	\$19.00	1.98	6.90	14.38
Information	Well resourced	\$25.08	2.30	10.79	1.94
Manufacturing	Under resourced	\$18.98	3.23	15.87	6.27
Manufacturing	Well resourced	\$29.00	2.30	16.89	5.48
Professional, scientific, and technical services	Under resourced	\$18.61	3.52	8.45	6.27
Professional, scientific, and technical services	Well resourced	\$29.00	2.78	10.54	3.11
Public administration	Under resourced	\$16.00	2.09	7.53	3.52
Public administration	Well resourced	\$26.75	4.84	12.50	1.94
Retailer	Under resourced	\$25.08	3.52	7.97	11.75
Retailer	Well resourced	\$25.08	3.07	7.97	1.94
Services	Under resourced	\$18.98	4.13	7.97	6.51
Services	Well resourced	25.08	3.60	10.54	1.94

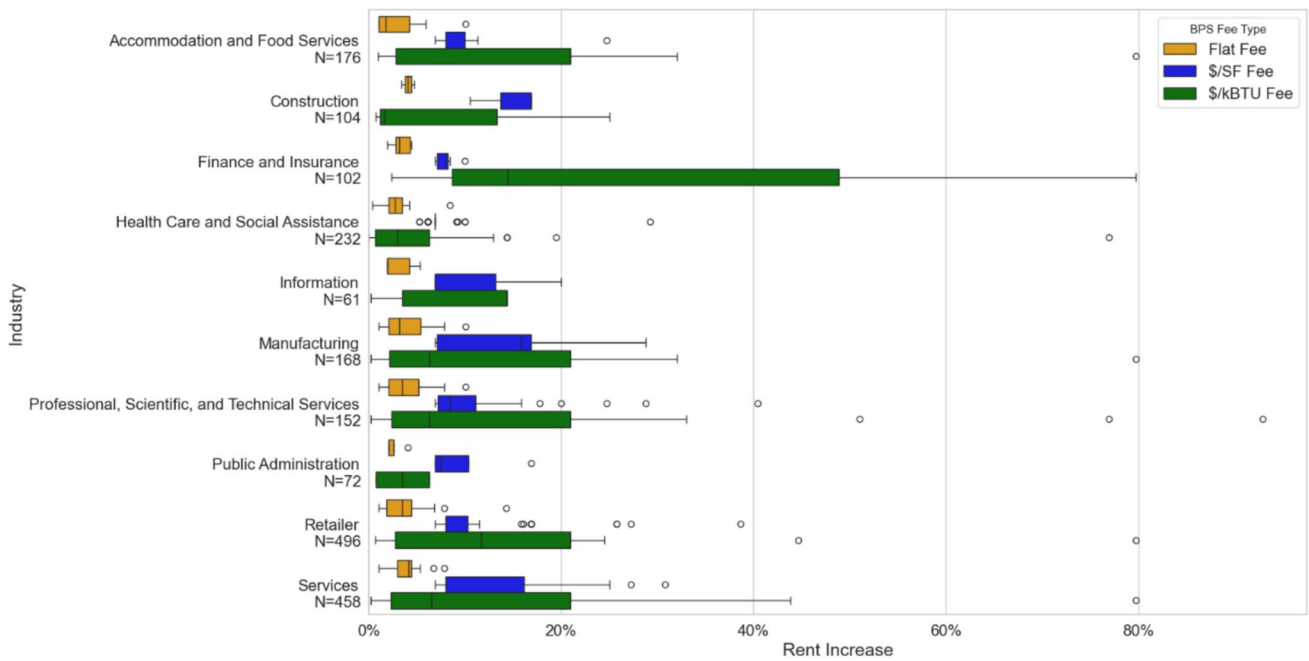


Fig. 10 Rent increase by tenant industry type in under-resourced areas (Top 10 Industry by Count)

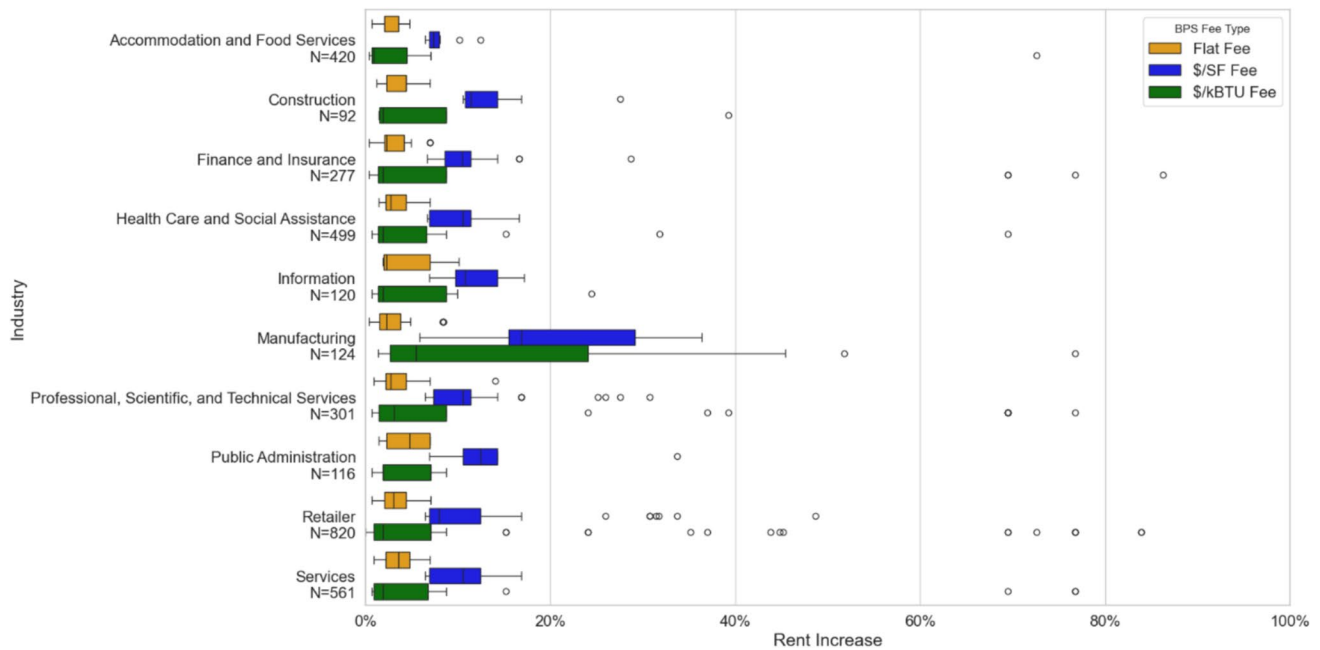


Fig. 11 Rent increase by tenant industry type in well-resourced areas (Top 10 Industry by Count)

between rent increases in URAs and WRAs except for a few cases. This test showed that for the overall Aurora market, there is a larger increase in rent for URAs than for WRAs when utilizing the flat fee BPS penalty structure. Similarly, for warehouses in URAs, we also see a significantly higher increase in rent; the increase is more than four times the annual average increase in the market. Warehouses are the most common property type in Aurora, which drives the overall market effect. The other property types and penalty structures did not show any statistical difference for URAs and WRAs. The results of this *t* test are summarized in Table 7.

Examining the types of tenants within various building categories provides a more nuanced perspective on the impact of BPS penalties. Analyzing the top 10 tenant industry types reveals consistent trends in rent increases across Table 8, Figs. 10 and 11, where flat fee penalties demonstrate the least impact. Table 8 illustrates that, on average, flat fee penalties exhibit the lowest disparity in rent increases. Correspondingly, both the flat fee and \$/area fee and \$/energy structures lead to higher potential rent increases.

To test if there were statistically significant differences in the rent increases between properties located in under-resourced and well-resourced areas, the team utilized independent *t* tests. Based on these tests, there was not a statistical difference in rent increases for URAs and WRAs except for a few cases. These tests showed that the flat fee penalty structure has smaller increases in rent for manufacturers and retailers in URAs. However, we do see a greater

increase in rent for healthcare and social assistance tenants in URAs when utilizing a \$/ft² fee. The other tenants and penalty structures did not show any statistical difference for URAs and WRAs. The results of the *t* tests are summarized in Table 9.

4 Conclusion

Through our analysis, several common trends emerge regarding the impact of BPS penalties on both the building owner and tenant markets. Notably, the flat fee exhibits the lowest impact across all groups despite smaller buildings facing higher penalties on a per square foot basis. This makes the flat fee structure the most conservative penalty structures having the least impact to both rents and cap rates resulting in less impact to the overall market. Both the \$/area and \$/energy penalty structures demonstrate a more pronounced potential effect on both cap rates and rents, with a wider distribution of potential impacts due to variations in penalties based on building area and energy consumption. Upon closer examination of the effects on building investors and under-resourced areas, a discernible trend emerges, driven by building type, with outpatient and warehouse buildings experiencing a comparatively higher potential impact. Further studies and analysis are warranted to understand the potential follow-on implications of these shifts in cap rates on the investor market.

The analysis of various penalty structures within the Building Performance Standards (BPS) framework indicates

Table 9 Median rent increase by tenant industry type and under-resourced status (Top 10 industry by count)

Industry	BPS Fee	<i>t</i> -statistic	<i>p</i> value	Confidence interval lower bound	Confidence interval upper bound	Result
Accommodation and food services	Flat Fee	0.550	0.589	-0.027	0.044	No significant difference
Accommodation and food services	\$/ft ²	0.975	0.341	-0.115	0.310	No significant difference
Accommodation and food services	\$/kBtu	0.997	0.330	-0.072	0.185	No significant difference
Construction	Flat Fee	1.612	0.136	-0.028	0.049	No significant difference
Construction	\$/ft ²	0.946	0.393	-0.087	0.120	No significant difference
Construction	\$/kBtu	-0.108	0.923	-0.064	0.061	No significant difference
Finance and insurance	Flat Fee	-0.241	0.817	-0.033	0.028	No significant difference
Finance and insurance	\$/ft ²	0.040	0.970	-0.052	0.054	No significant difference
Finance and insurance	\$/kBtu	-1.971	0.094	-0.156	0.027	No significant difference
Health care and social assistance	Flat Fee	1.005	0.318	-0.006	0.015	No significant difference
Health care and social assistance	\$/ft ²	3.460	0.001	0.005	0.034	URAs have a greater increase in rent
Health care and social assistance	\$/kBtu	0.013	0.989	-0.014	0.014	No significant difference
Information	Flat Fee	0.348	0.733	-0.040	0.050	No significant difference
Information	\$/ft ²	1.149	0.273	-0.031	0.071	No significant difference
Information	\$/kBtu	-0.677	0.508	-0.059	0.039	No significant difference
Manufacturing	Flat Fee	-2.781	0.008	-0.003	0.000	URAs have a smaller increase in rent
Manufacturing	\$/ft ²	-0.135	0.894	-0.007	0.006	No significant difference
Manufacturing	\$/kBtu	-0.302	0.764	-0.021	0.017	No significant difference
Professional, scientific, and technical services	Flat Fee	1.664	0.100	-0.006	0.025	No significant difference
Professional, scientific, and technical services	\$/ft ²	1.462	0.148	-0.028	0.123	No significant difference
Professional, scientific, and technical services	\$/kBtu	0.459	0.647	-0.049	0.068	No significant difference
Public administration	Flat Fee	1.261	0.251	-0.058	0.104	No significant difference
Public administration	\$/ft ²	1.598	0.163	-0.068	0.146	No significant difference
Public administration	\$/kBtu	0.911	0.399	-0.064	0.097	No significant difference
Retailer	Flat Fee	-2.687	0.008	-0.032	0.000	URAs have a smaller increase in rent
Retailer	\$/ft ²	0.102	0.919	-0.046	0.050	No significant difference
Retailer	\$/kBtu	-1.007	0.315	-0.055	0.026	No significant difference
Services	Flat Fee	0.815	0.417	-0.018	0.033	No significant difference
Services	\$/ft ²	1.506	0.136	-0.044	0.177	No significant difference
Services	\$/kBtu	0.231	0.818	-0.077	0.090	No significant difference

that flat fee penalties result in the lowest overall potential rent increases, with both \$/area and \$/energy fee structures leading to greater potential increases in rents across different property types. While the median increase approximates the typical year-over-year increase in the Aurora market, specific property types and penalty structures could result in significantly larger rent increases, up to four times the typical year-over-year increase, potentially making the additional costs financially challenging for some tenants, particularly those from economically under-resourced areas.

Although statistical tests did not reveal significant differences in rent increases between under-resourced and well-resourced properties in most cases, there were exceptions. For instance, flat fee penalty structures showed smaller potential rent increases for manufacturers and retailers in under-resourced areas, while \$/area fee structures resulted in greater potential rent increases for health care and social assistance tenants in under-resourced areas. Overall, the choice of penalty structure within the BPS framework can have a notable impact on potential rent increases.

The goal of BPS is to drive investment in the building stock to achieve energy reductions, not to penalize building owners. Jurisdictions may want to carefully consider a range of factors when setting fines, fees, or penalties. Engaging stakeholders—especially those from under-resourced areas—throughout the decision-making process is crucial to ensure that the outcomes are reasonable and proportional. Future research should extend the scope of this investigation to encompass a broader market scale and assess whether similar trends are found across the USA.

5 Limitations and future work

This analysis is specific to Aurora, Colorado and is subject to certain limitations. Notably, actual energy consumption data were only available for a small portion of the building stock (less than 10%). As a result, estimated energy consumption values were used for the remaining buildings. These estimates may not fully capture variations in real-world energy use. If actual energy consumption trends differ significantly from the estimates, the number of buildings identified as non-compliant could be overestimated or underestimated. Consequently, the results should be interpreted with caution, as the estimates may not accurately reflect the true distribution of non-compliant buildings. This analysis utilized a dataset that did not include building types, such as supermarkets, stand-alone convenience stores, and churches. This results in limits on the understanding of the impacts of these policies on other building types.

The next step would be to understand whether similar results would be found in other parts of Colorado and other parts of the country. A larger geography would be preferable, because the low sample size for some building types in Aurora may have masked trends that would have been statistically significant with a larger sample.

Another useful next step would be to speak with both building owners and tenants to understand the possible implications of the various levels of financial impact to understand how these penalties might drive their behaviors—for example, cause them to move their businesses or invest in properties in jurisdictions without BPS policies, or upgrade their building to comply with the legislation to avoid penalties. Analyzing these findings in other locations could be explored to see if similar trends or new trends are seen in a more typical metropolitan area that also includes a greater sample size of buildings to reference.

Lastly, the goal of BPS is to drive investment in the building stock to achieve emissions reductions, not to penalize building owners. A comparison of various penalty structures and levels in context with the costs of

building upgrades necessary to meet the BPS targets could be valuable for policymakers looking to design BPS in new jurisdictions.

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Author contributions LT performed the analysis that is the basis for research in this article, as well as developed all tables and figures. AP provided primary review of the analysis methodology and provided input for the analysis workflow and process. LT and AP wrote and edited the manuscript text. NL, and IL provided editing and support on manuscript development. All authors reviewed the manuscript.

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Data availability The research data supporting the results of this manuscript were primarily sourced from CoStar, a real estate data provider that offers comprehensive information on commercial properties across the United States, including the City of Aurora. CoStar data used in this study include building location, property types, financial data, and tenant information. Access to CoStar data is restricted and requires a subscription, which can be obtained at the following link: <https://www.costar.com>. Additional energy consumption estimates for buildings were generated using ComStock™, a publicly available tool developed by the National Renewable Energy Laboratory (NREL). ComStock can be accessed at <https://comstock.nrel.gov>. For properties where energy consumption data was not reported, estimates were derived based on building characteristics. The Climate and Economic Justice Screening Tool (CEJST) was also used to determine whether properties were located within disadvantaged communities. This tool is publicly available and can be accessed at <https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5>. For inquiries regarding access to specific data used in this analysis, please contact the corresponding author.

Declarations

Conflict of interest The authors declare no competing interests.

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