2023 TECHNICAL UPDATE

Developments in Building Performance Standards

Preparing for a data-driven built environment

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ABSTRACT

The intent of this technical update is to describe the latest developments in Building Performance Standards (BPS) and showcase their primary implications. A Building Performance Standard is a set of requirements, often enacted as part of climate action plans, for buildings in a certain jurisdiction to report their energy use and/or greenhouse gas emissions (in a process known as benchmarking) and meet reduction targets over a long-term time horizon. Momentum for nationwide adoption of BPS is picking up, with the Federal Government enacting its own electrification-driven BPS and sponsoring a coalition of states and cities pledging to enact their own BPS. A survey of nationwide adoption trends reveals commonalities and divergences but ultimately cements the notion that building performance standards are predictable. Additionally, benchmarking is discussed in detail, with a specific focus on the tools, metrics, and limitations of benchmarking. The detail of data required for practical, continuous compliance is contrasted with that of the data required for bare-minimum compliance with BPS. Finally, a case study is presented, exploring the implications of mass electrification in Seattle. The results of this brief exploratory study show that meeting Seattle's GHG emissions limits through 2050 would result in widespread electrification, causing appreciable peak electric load exacerbation among certain building types, most notably multifamily residential buildings, and indicating where and when the utility can anticipate load growth to inform distribution planning. Ultimately, this study showcases the role of BPS as a driver of other trends, such as electrification, and underlines the importance of proper measurement and verification data in this novel regulatory environment.

Keywords

Building Performance Standards (BPS), Performance Benchmarking, Electrification, Decarbonization, Energy Efficiency, Building Performance Metrics

EXECUTIVE SUMMARY

Deliverable Number: 3002026790

Product Type: Technical Update

Product Title: Developments in Building Performance Standards: Preparing for a data-driven built environment

Primary Audience: Utilities looking to understand the impacts that newly enacted building performance standards will have on their operations.

Secondary Audience: Building operators who will need to take appropriate steps to comply with emerging building performance standards.

KEY RESEARCH QUESTION

What are the most notable trends in the nationwide development of BPS? How will buildings and communities need to evolve with emerging BPS? What depth of data will continuous compliance with increasingly stringent BPS require? What are the implications of BPS on Resiliency and Electrification Readiness?

RESEARCH OVERVIEW

This report summarizes the current state of Building Performance Standards, through an examination of federal initiatives, state and local ordinances, and industry publications. The constituent elements of building performance standards are described to fully clarify the roles of building performance standards in driving certain building decarbonization trends. The implications of those different drivers are discussed, with a special emphasis on electrification and data requirements that are not mandated by law but by practice. Methods of benchmarking most used are discussed and contrasted with the data needs for meeting performance targets. Finally, a case study based on Seattle's building emissions performance standard is presented.

KEY FINDINGS

- Building Performance Standards are predictable, and federal and industry initiatives are helping homogenize local and state laws.
- Benchmarking data, as required for compliance with Building Performance Standards, may not be sufficient for sustained compliance. More data is needed to understand optimal courses of action.
- Compliance with Building Performance Standards will require a greater focus on electrification readiness and grid resiliency, as more buildings adopt electricity for end-uses often served by natural gas.

- Building Performance Standards are a topic of increasing national importance, and policy guidance shows that they may become more complex in the future, with templates suggesting sophisticated metrics such as peak demand.

WHY THIS MATTERS

There are widespread drivers at all levels of government for the adoption of building performance standards, rendering the issue one of national importance. As such, stakeholders will need to think proactively to meet the needs that will be brought forth by standards mandating more complex data reporting and decarbonization measures such as electrification. Building Performance Standards drive other trends in this space and increase the urgency of conversations surrounding electrification readiness and grid resiliency.

HOW TO APPLY RESULTS

This research product is intended to serve as a springboard for further discussion surrounding building performance standards. Next steps are presented at the conclusion of this report, and member utilities are encouraged to contact the Advanced Buildings and Communities Program to voice their thoughts on the directions that research in this sphere should take.

LEARNING AND ENGAGEMENT OPPORTUNITIES

This flagship report is one of three published by the Advanced Buildings and Communities this year. As described within the report, building performance standards are trend accelerators that should encourage a greater focus on electrification and readiness and grid resiliency. Stakeholders who are interested in those topics are encouraged to consult deliverables 3002026791 (Resiliency Hub Implementation for Customers and Communities) and 3002026713 (Building Electrification Readiness Guide).

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ACRONYMS AND ABBREVIATIONS

BPS	Building Performance Standard(s)
BEC	Building Energy Code
BEPS	Building Emissions Performance Standard (Often interchangeable with BPS)
EUI	Energy Use Intensity
GHG	Greenhouse Gas
IMT	Institute of Market Transformation
AMI	Advanced Metering Infrastructure
GHGIT	Greenhouse Gas Intensity Target
EPA	Environmental Protection Agency
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers

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1 INTRODUCTION

What is a Building Performance Standard?

A Building Performance Standard (BPS) is a set of guidelines implemented to optimize the design and operation of new and existing buildings to bring a performance metric (e.g. Site Energy Use Intensity, Scope 1 Greenhouse Gas Emissions) down to a given level by a certain deadline. Typically, a BPS will require building operators to report "benchmarking data"- in other words the data needed to assess the building's performance to a prevailing standard. BPS are a common feature of climate action plans enacted by different jurisdictions at the federal, state, and local levels. Examples of laws that feature BPS include **New York City's Local Law 97 (New York City Council, 2019) , Washington State's Clean Buildings Act (Washington State Department of Commerce, 2019) and Colorado's Energy Performance for Buildings Act (Colorado Department of Public Health and Environment, 2021).**

Building Performance Standards vs Building Energy Codes

Building codes and BPS are complementary tools working towards the same goal – more energy-efficient buildings. However, they also differ significantly, most notably in **three critical respects (International Energy Agency, 2021)**:

1. In terms of applicability, building energy codes are for the most part only applicable to new construction. A design must certify that it complies with the prevailing energy code (e.g., California Title 24) for construction to be approved. Conversely, BPS apply to all existing buildings meeting the criterion for inclusion (e.g., all commercial buildings exceeding a certain square footage). As the standard gets more stringent over the years, all buildings, new and old, must take measures to comply with an improved performance metric.
2. With respect to compliance with the requirements, codes adopt a vastly different approach compared to BPS. A building energy code will *typically* require that different building components comply individually with the code specifications. For example, a building energy code may require that an external wall assembly comply with a certain R-value minimum. BPS are *typically* more rooted in data, rather than specifications. BPS are also holistic, meaning they are unlikely to focus on individual components. Instead, it may require a building's total energy use intensity (total energy use normalized by square footage) to drop by 20% relative to a starting year by 2030, for example. Prescriptive measures may be included in BPS as a compliance pathway in cases where meeting results-oriented BPS may not be practical. Even in those cases, the preference remains for what is called the "performance approach". In short, energy codes largely tend to be **specific and prescriptive**, whereas BPS tend to be **holistic and data-oriented**.
3. Time horizon is arguably the most critical difference between energy codes and BPS. As mentioned, energy codes are largely cited in the context of new construction. At the time of construction, a design must be certified as compliant with applicable energy codes. However, continuous compliance is not required. Buildings built while the 2000

Energy Code was in effect do not have to conduct upgrades to meet the requirements of the 2010 Energy Code. The only common exceptions to this are "significant" renovations. In contrast, BPS require **continuous compliance**. A building meeting certain requirements within an applicable jurisdiction must comply with the BPS through the whole compliance period, with targets that are often set on the order of decades into the future.

Elements of a Building Performance Standard

To understand the implications of BPS, it is critical to discern the different elements that are common across all BPS nationally. The Urban Sustainability Directors Network has identified the following as the main elements of a BPS, along with questions that each element should answer (Urban Sustainability Directors Network, 2021):

- **Scope of Building Typology:** What types of buildings does the BPS apply to?
- **Metric:** What is the metric that is used to determine compliance? How is that metric defined and how is it measured in practical terms?
- **Targets:** What are the long-term compliance targets? How does the target evolve over the BPS's time horizon?
- **Timeline:** When are buildings expected to become compliant? How is compliance phased in and do different building types adopt the BPS at different speeds?
- **Pathways:** What does the BPS say about available performance pathways?
- **Compliance Penalties:** How does the BPS penalize building owners and operators for noncompliance?
- **Supportive Programs:** Does the BPS offer any support to certain demographics for which compliance can be a challenge?

Research Questions

This paper intends to answer the following research questions about BPS:

- What are the most notable trends in the nationwide development of BPS?
- How will buildings and communities need to evolve with emerging BPS?
- What depth of data will continuous compliance with increasingly stringent BPS require?
- What are the implications of BPS on Building Resiliency and Electrification Readiness?

Research Value

An overview of developments surrounding building performance standards and their downstream impacts is highly pertinent to today's utilities landscape for the following reasons:

- **Widespread drivers:** Many jurisdictions nationwide are adopting building performance standards. Critically, federal standards also affect all 50 states.

- **Need for proactive thinking:** Building Performance Standards require a continuous commitment. As such, utilities need to be forward thinking in how they respond to anticipated changes in building operation.
- **Assessing available tools:** It is important to ask how benchmarking data, critical to many BPS, can be leveraged, if at all. Continuous compliance may require a depth of data analysis that may not be practical for all operators.
- **BPS are trend accelerators:** With electrification requirements comes a greater need for electrification readiness. The conversation around resiliency will also shift as BPS compliance comes into play.

2 MARKET SURVEY

Recent Developments at the Federal Level

Federal Building Performance Standard

In December 2022, the Council on Environmental Quality announced the release of a federal BPS applicable to buildings owned and operated by all federal agencies. This standard arose from a requirement set out in Executive Order (E.O.) 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, to reduce federal greenhouse gas emissions by 50% by 2032, and for federal buildings to be net-zero emissions by 2050.

In terms of **scope**, the BPS applies to all federally owned facilities covered by the Energy Independence and Security Act of 2007 that have non-zero scope 1 carbon emissions as of October 2021, as well as all facilities constructed after October 2021. Data from the General Services Administration provides an interesting insight into the reach of a federal BPS. Table 1 shows the ten subnational jurisdictions with the largest federal footprint, and whether those have their local BPS in addition to the federal BPS. For seven out of the ten jurisdictions, the federal BPS is the only BPS applicable across the jurisdiction. This pattern demonstrates that BPS are an item of national importance that should be on the radar of every utility in the nation, as federal buildings are present in every state. As mentioned in the BPS itself, the Federal Government's status as the "single largest land owner, energy consumer, and employer in the Nation" (Office of the Federal Chief Sustainability Officer, 2022) allows it to influence building operation practices nationwide. Implications of this BPS, as discussed in this paper, will be pertinent to practically every utility's operations.

Table 1 Ten states with the largest federal footprint, and applicable local BPS (Data from U.S. General Services Administration and DOE Building Energy Codes Program, access in 2023).

Jurisdiction	Federal Footprint (Millions of Square Feet)	Local BPS
District of Columbia	54.42	Present
Maryland	29.93	Present
California	27.89	Absent, Under Consideration
Virginia	25.80	Absent
Texas	23.00	Absent
New York	17.54	Absent

Missouri	15.99	Absent
Florida	11.93	Absent
Pennsylvania	11.67	Absent
Colorado	11.04	Present

The BPS's metric of choice is Scope 1 carbon emissions. Scope 1 carbon emissions are those greenhouse gas emissions that are emitted at the building site, rather than farther upstream. Most Scope 1 emissions in residential and commercial buildings are due to the combustion of natural gas or propane for space heating, water heating, cooking, and other minor end uses. This choice of metric, restricted to Scope 1 emissions, is telling in that it underlines the primary functionality of this BPS. Above all else, the federal BPS encourages electrification.

The BPS's **target** is for buildings representing 30% of a given federal agency's portfolio (as determined by square footage) to achieve zero Scope 1 emissions by fiscal year 2030. The standard, in its current form, states that the **timeline** for an increased percentage for every agency to be compliant will be determined in the future, with the ultimate goal of achieving zero Scope 1 emissions by 2050.

The BPS's **compliance pathways** further reinforce the notion that it may be a driver of electrification. Indeed, the BPS defines two methods of compliance. Under the preferred performance approach, a building's square footage counts towards the 30% goal if it can be shown that Scope 1 emissions have been reduced to zero. If a facility is shown to be incapable of meeting the zero Scope 1 emissions goal, it may pursue the prescriptive approach, which, as stated in the BPS, requires the facility to "implement all practicable electrification for space and water heating as well as fully electrify all cooling, cooking, backup generators used for non-emergency services (e.g., demand response), and laundry energy loads that do not qualify for an exclusion" (Office of the Federal Chief Sustainability Officer, 2022). The example given by the authors for when the prescriptive approach may be an acceptable substitute is that of space heating, particularly in cold climate zones. As cold-climate heat pumps are an emerging technology, the BPS alludes to dual-fuel heat pumps with gas backup as an acceptable option for climates where heat pump performance is significantly degraded.

Ultimately, the main takeaway from the Federal BPS is that decarbonization, rather than energy efficiency, is the favored method of assessing building performance in the eyes of the federal government. The focus on scope 1 emissions is notable, as it points towards an emphasis on electrification even within the framework of decarbonization (as opposed to decarbonization through efficiency upgrades).

National Building Performance Standards Coalition

In January 2022, the federal administration launched the National Building Performance Standards Coalition. This alliance of jurisdictions, spanning a quarter of the national building stock, is founded on the commitment to take the following steps in furtherance of building decarbonization goals (National Building Performance Standards Coalition, 2022):

1. Establish the conditions necessary for the adoption of a BPS and auxiliary policies.
2. Advance legislation and regulation as needed to foster BPS. The coalition sets for itself a goal of adopting the necessary legislation by Earth Day 2024 (April 22, 2024).

3. Engage stakeholders to develop initiatives that "will address […] health, energy, housing affordability, and climate needs in buildings."
4. As an alliance of jurisdictions, develop and share best practices in the realm of BPS adoption.

As with the Federal BPS, this initiative by the Federal Government highlights the geographic reach and national importance of BPS.

Industry Voices and BPS

The two documents discussed within this section are important to examine because they paint a clear picture of the direction in which influential industry organizations are driving the specifics of BPS adoption and benchmarking.

IMT Model BPS Law

In 2021, the Institute for Market Transformation (IMT) published a model BPS law intended to serve as a template for legislators looking to pass a BPS law (Burton et al., 2022). The model ordinance was drafted after the adoption of BPS by multiple jurisdictions and incorporated learnings from those BPS. This model BPS law is particularly important when viewing the issue through a broad, nationwide lens because IMT is an influential player in the National BPS Coalition.

The model BPS, in its role as a template for legislators to use, is designed in a formulaic manner with sections covering all of the pertinent elements of a BPS as described in this paper.

In terms of content, the three most notable elements of the law are the following (Burton et al., 2022):

1. The explicit mention of **ENERGY STAR Portfolio Manager**, a building utilities benchmarking tool developed by the Federal Government, cements it as the prime tool for collating the data required for reporting energy and emissions under different BPS. For this reason, a more in-depth look at the functionalities offered by Portfolio Manager and their limitations is in order.
2. The comprehensive delineation of possible compliance metrics is valuable because it homogenizes BPS. When state and local codes are homogenized, BPS becomes predictable. The model law specifies the following compliance metrics in the template: **Site Energy Use Intensity, Onsite and district thermal greenhouse gas emissions, Water usage,** and **Coincident peak electric demand.**
3. The inclusion of peak demand as a possible compliance metric is especially noteworthy. While this metric is currently rare, its inclusion in future BPS would require more complex solutions than fuel switching or efficiency upgrades, for example. With electrification being an important focus of many BPS, the future inclusion of peak demand as a compliance metric cannot be ruled out, as electrification is known to increase peak demand, leading to adverse impacts to grid reliability. One caveat stated in the model law's summary (Institute of Market Transformation, 2021) is that reporting and determining coincident peak demand can be challenging, particularly for utilities

which do not have the communication systems available to send out peak signals to customers. Ultimately, the potential inclusion of peak demand as a compliance metric is interesting because it may require solutions like demand flexibility in addition to efficiency or electrification upgrades.

ASHRAE Standard 228-2023

Released in 2023, ASHRAE Standard 228-2023 (ASHRAE, 2023) is an interesting resource to examine within the context of BPS. While it is not a BPS, the standard provides a highly flexible and broadly applicable method of assessing building performance based on two highly relevant metrics: **Source Energy** and **GHG Emissions**.

The preference for source energy over site energy is important because it echoes the preferences of another important benchmarking resource: ENERGY STAR Portfolio Manager. The prime difference between what is known as “site” energy and “source” energy is that source energy considers the generation mix of the grid in valuing the energy that is saved. The conversion from site to source is achieved through a conversion factor. Standard 228-2023 provides annual site to source conversion multipliers for all grid balancing authorities in North America. That is the baseline application method of the standard. However, the standard recognizes that the factor that influences source energy the most, namely the generation mix providing electricity within a balancing authority’s territory, is not constant throughout the year, in particular for locations with very high renewables penetration.

Similarly, ASHRAE Standard 228-2023 provides annual energy-to-emissions conversion factors for every balancing authority in North America for different types of fuel.

One interesting aspect of this standard is that it also allows for the use of hourly multipliers when the prerequisite data is available, and the balancing authority deems their use appropriate. This process involves determining the generation mix at every hour for a given balancing authority. In grids with a high percentage of generation coming from intermittent renewables (such as wind or solar power), there can be significant differences in the carbon intensity of grid electricity between two different hours of the same day. While it is a building code, not a BPS, California’s Title 24 is the most notable reflection of this reality. As part of the performance approach to the code, California has been requiring building designers to assess modeled building performance based on Time-Dependent Valuation, a metric assessing different factors including transmission and distribution costs and GHG emissions. More recent cycles have included long-run marginal GHG emissions as another metric due to the rising emphasis on decarbonization rather than plain efficiency (California Energy Commission, 2019). ASHRAE Standard 228-2023 echoes Title 24 in this respect.

Ultimately, ASHRAE Standard 228-2023 is interesting because it offers a perspective not only into what a BPS that is legally binding might look like but also into what voluntary participation programs or decarbonization incentives may require operators to comply with.

Comparing and Contrasting State and Local BPS

Table 2 Taxonomy of State and Local BPS (selection), adapted from the Building Energy Codes Program (Department of Energy, 2023)

Jurisdiction	Scope (Simplified)	Metric
New York City, NY	Commercial, Multifamily, Industrial buildings.	Scope 1 and 2 GHG Emissions Intensity
State of Washington	Commercial Buildings. Voluntary adoption for Multifamily Buildings.	Site Energy Use Intensity
City of Seattle, WA	Commercial and Multifamily Buildings.	Scope 1 and 2 GHG Emissions Intensity
City of Boston, MA	Commercial and Multifamily Buildings.	Scope 1 and 2 GHG Emissions Intensity
State of Maryland	Commercial and multifamily residential buildings	Scope 1 GHG Emissions, Site Energy Use Intensity
City of Reno, NV	Commercial, Multifamily, and Municipal Buildings	Site Energy Use Intensity, ENERGY STAR Score
City of Chula Vista, CA	Commercial and Multifamily Buildings	Site Energy Use Intensity, ENERGY STAR Score
Washington, DC	Commercial and Multifamily Buildings	Site Energy Use Intensity
City of Cambridge, MA	Commercial and Multifamily Buildings	Scope 1 and 2 GHG Emissions
City of St. Louis, MO	Commercial and Multifamily Buildings	Site Energy Use Intensity

A dichotomy between energy efficiency and decarbonization can be seen in the methodologies employed by different BPS. Certain BPS require energy use to meet a certain benchmark, whereas other BPS require carbon intensity to meet a certain benchmark. A taxonomy of local and state initiatives reveals commonalities and divergences in terms of the scope of buildings covered, and metrics used. In the next chapter, the data behind compliance with BPS will be discussed in greater detail.

3 A CLOSER LOOK AT BENCHMARKING

ENERGY STAR Portfolio Manager: An Ubiquitous Tool

ENERGY STAR Portfolio Manager (U.S. Environmental Protection Agency, accessed 2023) is a benchmarking tool designed by the Federal Government to assist building operators in managing the energy use of buildings in their portfolio. Because Portfolio Manager is mentioned in most BPS as well as the model BPS law, and because a benchmarking mandate is often a prerequisite of BPS adoption, it is important to go over the metrics available within it and how they come into play within the realm of BPS compliance.

How it works

Portfolio Manager's benchmarking is based on the data used to calculate a building's utility bill i.e., total energy consumption for a given time. Energy managers may populate data manually, although many utilities nationwide now allow for automated transfer of data to portfolio manager (U.S. Environmental Protection Agency, accessed 2023). Essentially, benchmarking hinges on data provided by the local electric utility.

Meet the Metrics

Energy Use Metrics

Energy Use Metrics are metrics that are derived from the total energy use of a building over a given period, typically a year. In Portfolio Manager, energy use is described using three metrics:

- **Site Energy Use Intensity:** Site EUI is given by the total energy use of a building for a period (typically a year) divided by the building's square footage (U.S. Environmental Protection Agency, accessed 2023).
- **Source Energy Use Intensity:** Source EUI differs from Site EUI in that it accounts for the fuel that was consumed upstream of the building to provide electricity or heat. To compute source energy, a conversion factor is applied depending on the type of secondary energy that is consumed on-site (meaning electricity, natural gas, and district heat). It is an efficiency metric at the core. For example, source energy for grid-purchased electricity is based on a ratio of the primary energy used at the point of generation to Portfolio Manager's source energy metric is unique from other understandings of source energy in that it is based on nationwide averages (ignoring the diversity of electricity generation across the United States) (U.S. Environmental Protection Agency, accessed 2023).
- **ENERGY STAR Score:** The ENERGY STAR Score for a building is computed by comparing the building's source EUI to other buildings with similar characteristics (e.g. typology, square footage, vintage) and determining where the building ranks relative to the best and worst buildings of its class. This metric is periodically updated as it is based on data

collected by the Energy Information Administration through the Commercial Building Energy Consumption Survey (CBECS) (U.S. Environmental Protection Agency, accessed 2023).

All three of those metrics are related, with ENERGY STAR Score a function of Source EUI, itself a function of Site EUI. Interestingly, IMT (Burton et al., 2022) and the EPA (U.S. Environmental Protection Agency, 2022) both recommend Site EUI as the metric of choice for energy-based BPS. Regardless, many state and local EUI's list ENERGY STAR Score as a compliance metric, so Source EUI (both as understood by ENERGY STAR, and source energy in general) and ENERGY STAR Score should not be ignored when discussing BPS.

GHG Metrics

GHG metrics go a step beyond energy use, attempting to estimate the GHG emissions of a building due to its energy use. The most important types of GHG emissions due to energy use in a building are (U.S. Environmental Protection Agency, accessed 2023):

- **Primary, or Scope 1 Emissions:** These are emissions resulting from the on-site use of fossil fuels such as propane or natural gas. The end-uses most associated with those emissions are space heating, water heating, and cooking.
- **Secondary, or Scope 2 Emissions:** These are emissions originating further upstream, that are attributable to the use of electricity or district heat by a building. All end-uses produce scope 2 emissions, although certain BPS tend to disregard them. The calculation of Scope 2 emissions requires the use of a conversion factor that describes the carbon intensity of a certain fuel. In Portfolio Manager, conversion factors are specific to different balancing authorities across the U.S. Different local BPS assign different conversion factors to specific types of fuels, with the differences being primarily attributable (for electricity) to the generation mix of every jurisdiction.

What about peak demand?

It is important to ask the question of whether EnergyStar Portfolio Manager currently provides information related to a building's peak demand. Peak demand, and especially peak coincident demand (i.e. peak demand that coincides with overall peak grid demand), is an important data point is an important data point about when the electricity demand of a building impinges on grid reliability. For this reason, peak coincident demand has been included in IMT's model BPS law as a potential performance metric.

Peak demand may be included in an EnergyStar report when it is available in a property's utility bills (U.S. Environmental Protection Agency, accessed 2023). That is most commonly the case under tariffs that have demand charges i.e. tariffs that charge both total electricity use as well as maximum electricity demand for the billing period. Such tariffs are typically commercial tariffs, and as such residential building operators would typically not have access to the data required to benchmark peak demand. In addition, the peak demand reported in utility bills is different from peak coincident demand, which IMT defines as "a property's electric demand when total electric demand from all sources on the entire electric utility's system is at its highest" (Burton et al., 2022). This data point is much more complex to collect as it is not typically reported within an energy bill. The IMT summary of the model law points to that, stating that including peak demand as a performance metric may only be practicable for jurisdictions where the local utilities have the requisite infrastructure to provide the requisite data as well as peak demand warnings (IMT, 2021).Therefore, utilities should assess whether it is likely that their local jurisdiction will require building operators to comply with peak demand requirements (whether for benchmarking or performance purposes). Grid reliability concerns may become more acute as more intermittent renewables enter the generation mix, as exemplified in California's "Canyon Curve" (EPRI, 2023).

Is Benchmarking Data Sufficient?

One strong argument for the adoption of BPS, especially as a complement to BEC, is that the benchmarking requirement would provide evidence that the building is performing at the intended level of energy/emissions efficiency. In this respect BPS are superior to BEC as BEC only assess the performance of designs, but not of actual buildings. A building may diverge significantly from its energy model.

EPA, in describing Portfolio Manager and its flagship ENERGY STAR score, asserts that the score "does indicate the level of performance" but "does not explain why a building performs well or poorly" (U.S. Environmental Protection Agency, accessed 2023). This description is broadly applicable to whole building data, meaning data describing a building's total energy use without any further disaggregation. More granular data, describing the energy consumption of individual pieces of equipment and individual end-uses, would be an order of magnitude more useful in determining appropriate measures of energy use/emissions mitigation. Within the context of BPS, this additional layer of understanding is critical, in light of the "tapering off" approach common to many BPS, wherein the full-time horizon covered by the BPS is divided into "compliance/reporting cycles" with increasingly stringent targets. As compliance targets become more stringent, energy conservation measures will need to be more judiciously chosen as the lowest hanging fruit, perhaps identified through more traditional methods such as energy audits, is addressed. With this approach, granular data of the different building systems' energy use would help operators determine the costs and benefits associated with potential energy conservation measures and accordingly make the most cost-effective decision.

With respect to electrification, more in-depth data, describing peak demand (when not accessible through Portfolio Manager) and daily load profiles for specific end uses (especially those that are candidates for electrification) would be vital for understanding the peak load exacerbation that would be caused by a potential electrification measure. Infrastructure upgrades can be a costly side effect of electrification, especially for disadvantaged communities.

4 CASE STUDY: COMPLYING WITH SEATTLE'S BEPS

Background

The City of Seattle's ambitious Buildings Emissions Performance Standard is designed around GHG reduction. Seattle City Light—the publicly-owned utility that provides electricity service to Seattle and surrounding communities—relies on renewable and non-emitting generation resources, including hydropower. Therefore, Seattle's BEPS is anticipated to results in substantial electrification as the most cost-effective and technologically feasible pathway to zeroing out building emissions. With increasing electric demand come concerns surrounding the utility's infrastructure to properly support compliant buildings.

Data Set

The data set used for this case study consists of benchmarking data collected over three years (2019-2021) for 3,730 commercial and multifamily residential buildings located in Seattle. This benchmarking data is the result of Seattle's Energy Benchmarking Law that has required owners of non-residential and multifamily buildings 20,000 square feet or larger to track energy performance and annually report to the City of Seattle since 2014. The buildings in the sample represent 68 different building types as defined by the U.S. Environmental Protection Agency. This initial data set was then reduced to only include buildings with a mixed-fuel energy profile i.e., those buildings that used electricity and district heat and/or natural gas, as all-electric buildings are exempted from the emissions reduction requirements. The reduced data set included 2,379 buildings, with a plurality (1,082 i.e. ~45%) being multifamily buildings of different sizes. More information on this reduced dataset is presented in Table 3.

Table 3 Characteristics of the Seattle City Light Benchmarking Dataset (reduced to only include mixed fuel buildings)

Number of Buildings	2379
Most Represented Building Types (number)	Residential Multifamily (1081), Office (298), K-12 School (134), Mixed Use Property (110)
Median Age of Buildings in Set	45 (Corresponding to 1978)
Mixed Electricity-Steam Buildings (percentage)	48 (2.01%)
Mixed Electricity-Natural Gas Buildings (percentage)	2255 (94.78%)
Mixed Electricity-Natural Gas-Steam Buildings (percentage)	76 (3.19%)

Case Study Goal

This case study aims to understand the need for electrification in meeting the Seattle BEPS during the different cycles of the compliance period. Such an understanding is vital in estimating the peak load exacerbation that may result from complying with BEPS.

Approach

The following approach is being developed to complete this case study, which is currently in progress and for which we provide preliminary results below:

1. Characterize the sample stock based on the publicly available energy benchmarking data by typology, vintage, and heating fuel.
2. Assume load shapes and end-use makeup based on EnergyPlus Prototypes developed as part of a prior study conducted by EPRI (EPRI, 2022).
3. Scale the composite load shapes in Step 2 based on the obtained benchmarking data, to develop a unique composite for every building in the set.
4. Apply energy conservation and electrification measures to the benchmark load shapes.
5. Assess impacts on electric infrastructure, costs, and emissions based on the final, resultant load shape for each building.

Seattle's Building Emissions Performance Standard

Seattle's BEPS employs a GHG-based methodology for assessing building performance. BEPS has an initial reporting compliance period for commercial and residential multifamily buildings in 2026-2030, and compliance with Greenhouse Gas Intensity Targets (GHGITs) will be required starting in 2031, with exceptions for certain multifamily buildings. These targets are shown for a selection of building types in Table 4 (Seattle Office of Sustainability and Environment, 2023). Greenhouse Gas Intensity is defined by the BEPS as the total CO2 equivalent emissions that a building's energy use results in during a given year, divided by the building's square footage.

Table 4 Seattle Greenhouse Gas Intensity Targets by compliance interval for a selection of building types

Building Type	GHGITs (KGCO2e/SF/YR) by compliance interval			
Compliance Interval	**2031-2035**	**2036-2040**	**2041-2045**	**2046-2050**
Multifamily	0.89	0.63	0.37	0
Hotel	2.06	1.2	0	0
Office	0.81	0.47	0	0
Restaurant	5.73	3.34	0	0
Hospital	4.68	2.73	0	0

Table 4 shows that for this selection of buildings, the BEPS tapers off until requiring net-zero building emissions in 2041 for all buildings except for residential multifamily. Therefore, one intent of this case study is to determine for different buildings in the sample the point in time when compliance with the BEPS will likely result in electrification. As a starting point, the "business as usual" scenario was run, to determine which buildings had to take any kind of action to comply in future years. The results of this scenario are discussed in the next section.

Business as Usual Scenario

Table 5 Results of the "business as usual" scenario for a selection of building types. Note that no building complies beyond 2040.

Building Type	Number of Buildings in Sample	Percentage that complies in 2031	Percentage that complies in 2036
Lowrise Multifamily	454	53%	34%
Midrise Multifamily	521	71%	48%
Highrise Multifamily	103	55%	28%
Hotel	75	71%	25%
Office	298	62%	56%
Hospital	10	0%	0%
Restaurant	8	62%	25%

Table 5 shows the results of the "business as usual" scenario for a selection of building types. Interestingly, for all but one building type, most buildings (though by a small margin in certain cases) comply. Even still, in 2031 hundreds of buildings will require action to comply with BEPS. Though not represented by a large sample size, the fact that none of the hospitals considered here comply within the first compliance cycle is notable. The main takeaway from those results is that certain building types may require more attention to achieve compliance with BEPS than others, which may help grid planners understand where their vulnerabilities lie in terms of exacerbated electric loads. Come 2036, most of the buildings within this sample are predicted to be out of compliance. The exception are office buildings, where 56% of buildings are predicted to remain compliant should their fossil fuel energy use remain in line with what it was in the 2019-2021 benchmarked period. One factor that may affect the results for office buildings is the COVID-19 pandemic, which led to a substantial increase in telecommuting. It remains to be seen whether office occupancy will return to pre-pandemic levels, but it is important to caveat the results seen here for office buildings.

Grid Impacts of Electrification in Applicable Buildings

Table 6 Incremental Peak Demand, as modeled in a prior EPRI study for a selection of building types in Seattle.

Building Type	Electrification Measure	Incremental Peak Demand (%)
Residential Multifamily	Unitary 120V HP	39%
	Unitary 120V HPWH	33%

	Unitary 120V HP+HPWH	48%
	Unitary Mini-Split HP	39%
	240V HPWH	33%
	Unitary 240V HP+HPWH	48%
Hospital	HVAC Electrification	2%
	WH Electrification	0%
	HVAC+WH Electrification	2%
Large Hotel	HVAC Electrification	1%
	WH Electrification	11%
	HVAC+WH Electrification	12%
Restaurant	HVAC Electrification	17%
	WH Electrification	6%
	HVAC+WH Electrification	23%
Large Office	HVAC Electrification	1%
	WH Electrification	0%
	HVAC+WH Electrification	2%

Table 6 shows incremental peak demand modeling results for the set of building types as estimated in a prior study by this research group referenced above. Those results are preliminary and do not represent the final product of this case study on a building by building basis but are solely presented to provide some insight into general expected impacts at this stage. The next steps of this case study will leverage the models from the prior value framework study to determine the impacts on electric infrastructure of the different types of measures that specific buildings may implement to meet BEPS requirements.

Those results, when combined with those from Table 5, offer an important glimpse into the future that grid planners may expect when compliance is achieved primarily through electrification. Under the assumption that electrification is the primary way of meeting the BEPS (throughout the compliance period, not just post-2040), 47% of low rise residential buildings would need to implement electrification measures resulting in estimated peak load exacerbations ranging from 33% to 48%, along with substantial costs to the building owner. The impacts are less pronounced for commercial buildings, though still substantial for restaurants (up to 23% peak load exacerbation) and large hotels (up to 12% peak load exacerbation).

5 TAKEAWAYS

Given this survey of the state of BPS, benchmarking, and a case study showcasing the choices that operators will have to make in light of a specific BPS, multiple conclusions can be drawn surrounding the impacts of BPS adoption.

Not all data is created equal

Data needed to meet reporting requirements may fall short of the granularity necessary for continuous compliance.

For BPS based on energy efficiency, data from energy audits and sub-metered data would be vital to understand which end-uses constitute the most promising grounds for capturing energy savings through various measures. The results of submetering can be employed to calibrate energy models that may not accurately reflect true building operation for various reasons such as commissioning faults, load diversity, and behavioral divergences from code. Furthermore, many BPS adopt a “tapering off” approach in setting their targets, requiring a certain reduction for initial compliance but then progressively requiring further reduction for continuous compliance. Sub-metered data would also be critical for latter stage BPS compliance, as the low-hanging fruit is addressed in the earlier stages.

For BPS based on minimizing GHG emissions, particularly through electrification, increased data granularity would be vital for determining peak loads and the end-uses that drive them. Knowledge of those items would help engineers estimate peak exacerbation due to the electrification of end-uses such as space and water heating.

In short, when it comes to data, the letter of the law may fall short of successful compliance.

Electrification Readiness is paramount

With the remarkable emphasis on electrification nationwide, both in the federal BPSand in many of the state and local BPS, the need for utilities to prepare for substantial increases in electric loads is important. As shown in the case study discussed in this paper, the electrification upgrades required under certain codes may entail impactful increases to peak load. Such increases would require wholesale upgrades to transmission and distribution infrastructure. Outside of the realm of BPS, T&D cost exacerbation due to electrification is already being felt by utilities and regulators.

BPS and Grid Resiliency

Winter Storm Elliott caused record electricity shutdowns across the nation towards the end of 2022 (Howland, 2023). In the wake of such events, grid resiliency has moved to the forefront of the utilities discourse. With electrification being an important feature of many BPS, electric demand is expected to increase, as end-uses traditionally met through gas or district heat are transitioning to electricity. Understanding this increase will be vital for parties looking to increase their building’s resiliency, as the additional demand, and the end-uses which it would encompass must be accounted for in any discussion surrounding resiliency.

This is just the tip of the iceberg

With jurisdictions representing over a quarter of the building stock pledging to enact laws adopting BPS, more and more utilities and building operators nationwide will need to familiarize themselves with the different types of BPS and the templates that have come to dominate the BPS space. Those templates, and studies and surveys surrounding them, reveal an ever-evolving environment with increasingly complex data demands. As instantaneous data collection and transmission, as exemplified by initiatives such as real-time price signaling, enter the mainstream and continue to be refined, BPS may evolve to include more sophisticated elements of such programs.

6 WHERE DO WE GO FROM HERE?

In the near term, the Advanced Buildings and Communities program plans to explore several topics that build upon the material presented in this report. Stakeholders are encouraged to voice their preferences for a given research pathway.

Building Performance Analysis Playbook

Continuous decreases in energy use and/or emissions will require building operators to understand their greatest opportunities for conservation. This effort requires a full understanding of the baseline performance of a building and the different end-uses within, to properly identify opportunities for savings that may not be apparent through energy audits or modeling. Proper collection of building performance data at the circuit level is vital, given the large emphasis that BPS place on data reporting and a building's actual performance.

Generalized modeling of BPS-driven scenarios

The methodology developed for the Seattle case study partially shown in Chapter 4 could potentially work for any BPS compliance exercise if there is a mandated objective i.e., the BPS is finalized. Generalized grid impacts are especially important in the case of jurisdictions which require electrification either through GHG-driven performance approaches or alternative prescriptive approaches where a performance approach is not practical. Even energy-driven BPS may cause large scale electrification, as heat pumps are more energy efficient than fossil fuel equivalents. Large scale electrification can have a large impact on the electric grid, due to exacerbated electric demand. Infrastructure planners have a vested interest in accurately predicting the impacts that these policies will have on the electric grid. Modeling studies, coupled with field data, can also help inform cost-optimal operation of novel systems installed to meet BPS requirements, such as heat pump water heaters.

Feedback from builders and operators

From the perspective of builders and operators, BPS pose brand new challenges. The push towards the adoption of novel efficiency and/or electrification measures raises questions regarding workforce familiarity, costs, maintenance issues, and barriers to market adoption. As such, utilities would benefit from understanding the perspectives of their customers as they consider their options for complying with increasingly stringent BPS. A clearer understanding of customer pain points would be vital to the development of programs that are valuable to all stakeholders.

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