Updating Minnesota's SB 2030 Program: Paving the Way for Net-Zero

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ABSTRACT

Minnesota's Sustainable Buildings 2030 (SB 2030) program is a set of energy and carbon guidelines on the path to net-zero performance by 2030 for all Minnesota State bond-funded construction projects. Since its inception in 2007, the SB 2030 program design has progressed from broad concepts in the earlier versions of the guidelines to detailed operationalized tools and more stringent program design standards which require considerations related to cost-effectiveness as well as technical limits of energy efficiency and the integration of renewable energy.

As the program moves towards a 90% energy and carbon reduction from a 2003 baseline, future program changes include an updated evaluation hierarchy for in- and out-of-portfolio renewable energy generation, detailed utility carbon intensity calculations in order to better consider the future impacts of electrification, and the integration of shared renewable energy resources at the campus or district scale through the operation phase. Time-of-use considerations and future-focused carbon intensities are planned to be more fully embedded in the program logic. Beyond the immediate impact of the SB 2030 program, the wide range of building types and sizes covered by the program also provides valuable lessons on achieving climate goals for the future of the commercial energy code that is under development in Minnesota.

Introduction

Minnesota's Sustainable Building 2030 (SB 2030) program sets increasingly stringent energy and carbon reduction targets for publicly funded new buildings and major renovations. The program was established by the 2007 Next Generation Energy Act (Hilty et al. 2007) and is modeled upon the Architecture 2030 Challenge's stepped approach, which moves to net-zero energy building design by 2030 (Architecture 2030 2005). Compared to a baseline building in 2003, SB 2030 requires projects to be designed and operated to reduce area-normalized operational energy consumption and carbon emissions by at least: (1) 60 percent starting in 2010; (2) 70 percent starting in 2015; (3) 80 percent starting in 2020; and (4) 90 percent starting in 2025. Figure 1 below showcases these stepped program targets based on their corresponding Zero Energy Performance Indexes (zEPI)[1] and compares them with current and proposed Minnesota Commercial Energy Code (MCEC) trajectory in Minnesota.

[1] The zEPI index is a standardized approach to the comparison of energy codes and other policy measures. In the zEPI scale a building that uses as much energy as a similar building in the year 2000 is assigned a score of 100 and a net-zero energy building's zEPI score is 0 (International Code Council 2015).

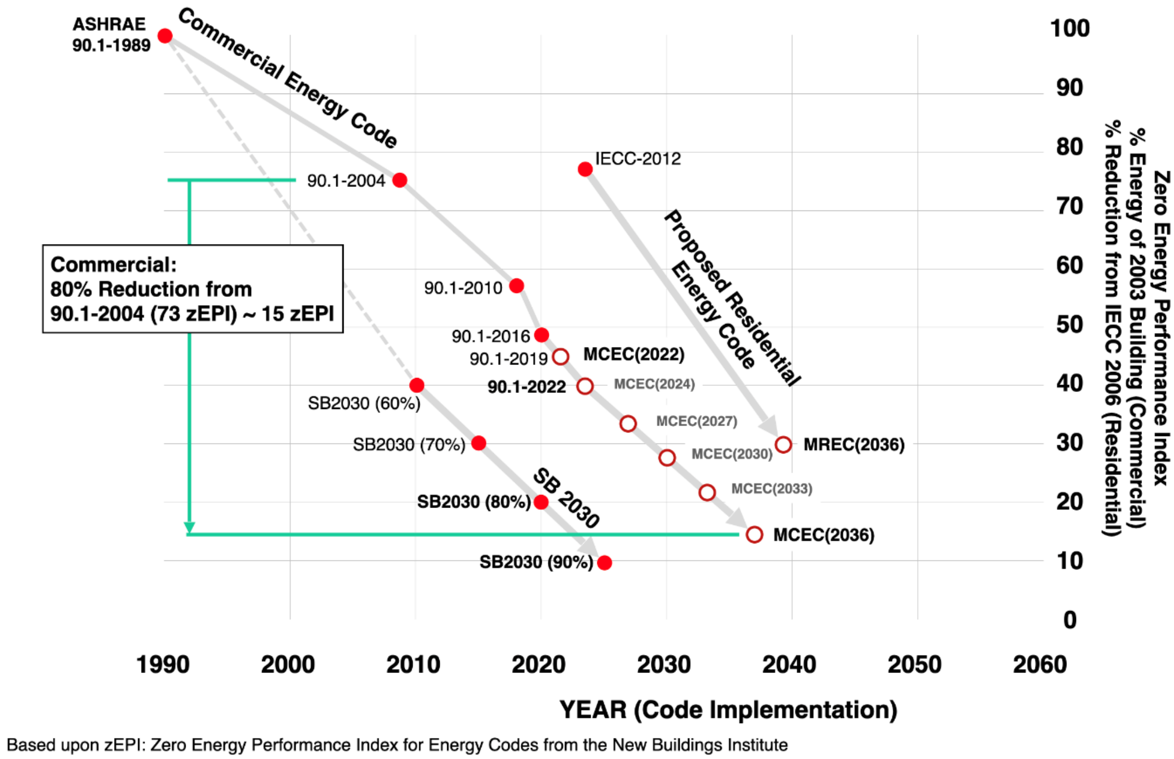

Figure 1. Minnesota Energy Code Trajectory

As highlighted in Figure 1, a zEPI index of 15 (85% better than the baseline noted above as MCEC (2036)) is likely beyond the limit of cost-effective energy efficiency for many buildings and may reflect constraints of project sites for the development of renewables. In accordance with the legislative language, the performance standards set by the SB 2030 program must be achieved for different building types in a cost-effective manner and should account for utility investments in renewable energy (Hilty et al. 2007). Therefore, a strategic approach to the placement and amount of renewable resources is needed and is a consideration of the SB 2030 program's development that occurs beyond the limit of cost-effective energy efficiency measures.

The SB 2030 program is incorporated into Minnesota's Sustainable Building Guidelines (now known as the B3 Guidelines), which holistically address sustainability across the categories of site and water, energy and atmosphere, indoor environmental quality, and materials and waste. These guidelines are primarily required for projects that receive general obligation bond funding from the State, though the SB 2030 program is also being used by a variety of organizations to help meet their energy and carbon goals. Because these funding mechanisms have been applied to a variety of project types, the B3 Guidelines and SB 2030 program have been developed to be broadly applicable and approach each project with consideration of its unique challenges and opportunities. Both the SB 2030 program and the B3 Guidelines undergo periodic revisions and updates to ensure that their intent continues to be met. This paper outlines updates to the SB 2030 program that are proposed to accompany the shift in 2025 to 90%-better and outlines some of the topics and considerations necessary to inform these updates.

Program Description

Projects participating in the SB 2030 program are engaged in a structured process to set project-specific energy and carbon targets, incorporate energy efficiency and renewable energy strategies into project design, model predicted energy use, and undergo a third-party review.

During pre-design, building design project teams set net energy use and carbon emission targets using the SB 2030 Energy Standard Tool (EST) (SB 2030 Program 2024). This tool is a web-based application that models the energy use of an average, comparable baseline building in 2003 based on a limited number of project characteristics, such as location, program, and size. The EST tool is calibrated to the energy data reported in the 2003 Commercial Building Energy Consumption (U.S. Energy Information Administration 2003) and the 2001 Residential Energy Consumption Survey (U.S. Energy Information Administration 2001). The associated carbon emissions in EST are calculated using eGrid's regional emissions factors from 2003 (U.S. Environmental Protection Agency 2003). Then, the reduction schedule discussed previously is used to set energy and carbon targets for the project based on the performance of the identified baseline building. These performance targets can then be met through a combination of energy efficiency and renewable energy generation.

In the design phase, project teams use energy models to inform architectural, mechanical, and electrical design decisions which includes testing out the impacts of different strategies and ensuring the project design meets the performance standards set by the program. Teams are required to submit their energy model once as the design is being developed and again after the construction documents are completed. This two-step process helps ensure that significant energy use drivers such as mechanical system selection and enclosure design are engaged early. Major renovations follow the same evaluation process, though most will see different measures determined to be cost-effective—reflecting the constraints and opportunities of these project types.

The submitted documentation undergoes a thorough review in the final design phase to ensure the program requirements are being met. After construction is complete, the building owner must report annual energy use for a period of ten years, updating the SB 2030 Energy and Carbon Standards as needed to reflect any major shifts in occupancy or program. If the building does not meet its performance standards in operations, the owner is required to develop and implement an SB 2030 Energy Efficient Operations Manual and a plan for corrective action. As this requirement trails the work of the design and construction project team, there has been variation in the extent of compliance. Some owners have trained building operators, benchmarked performance, and taken corrective action to exceed performance targets. Others have provided very limited engagement with building operations, and there is currently limited accountability for owners who are not achieving performance. These challenges have been addressed by proposed changes to the program and presented to legislature and administration; though these changes are outside of the program updates presented herein.

Cost-Effectiveness

The governing legislation for the SB 2030 program requires that any performance standard set by this program must be supported by "a conclusive engineering analysis that it is cost-effective based upon established practices used in evaluating utility conservation improvement programs" (Minnesota Legislature 2023). To address this, the SB 2030 program designers periodically evaluate a large sample of buildings to determine the threshold for cost-effective energy efficiency and renewable energy measures from a societal, participant, and utility perspective. The most recent round of analysis conducted for the 2020 program updates found that the cost-effectiveness limit is equivalent to a 12-year simple payback (Center for Sustainable Building Research 2019). Accordingly, within the SB 2030 program, energy efficiency and renewable energy measures that pay back in less than 12 years—without accounting for rebates or other incentives—are considered to be cost-effective. This metric is updated over time as energy, carbon, and economic conditions shift.

Renewable Energy Hierarchy

The SB 2030 program accommodates projects with limited opportunities to fully meet their performance standards with on-site efficiency and renewable energy—whether due to the limits of technical feasibility or cost-effectiveness. These projects may establish an "On-Site Target," which is the net energy use intensity achievable using all cost-effective efficiency measures in combination with renewable energy generation on the project site[2]. This performance target setting process enables cost-effective decarbonization and electrification efforts to take advantage of emerging technology while recognizing the diversity of projects subject to this program. To set this On-Site Energy Target, the project team meets with the SB 2030 review team during the early design phase to reach agreement on which on-site measures should be evaluated for cost-effectiveness. The project team then determines the simple payback period of each measure by comparing its up-front costs to its annual operational savings. All measures that meet the program's definition of cost-effective, as described in the previous section, are then incorporated into the energy model and the resulting energy use intensity is proposed as the on-site energy target. Once set, the On-Site Target must be met using on-site measures, though these are not limited to the measures used to set the target. For example, the team may decide to exclude a strategy with a 9-year payback in favor of a strategy with a 20-year payback that also provides occupant comfort benefits.

The remaining gap between the On-Site Target and the SB 2030 Standard Target can be addressed with off-site renewable energy. Project teams must first utilize all cost-effective renewable energy generation opportunities in the building owner's portfolio of sites and can then use green power or unbundled Renewable Energy Credits (RECs) for the remainder.

Figure 2 shows an example of using the SB 2030 renewable energy hierarchy. The first bar on the left shows the typical building in existence in 2003, which is used to calculate the SB 2030 Standard. Minnesota's current energy code requires efficiency measures that achieve about a 50% reduction from the 2003 average building. This example project then uses a combination of beyond-code efficiency measures and on-site renewables to get as close to the SB 2030 Standard as is possible cost-effectively, which is represented by the "SB 2030 On-Site Target." The project shown here then uses off-site renewables to get the rest of the way to the SB 2030 Standard. Some projects may have more or less opportunity to leverage on-site resources to meet their target and may need to use more off-site resources.

[2] In the SB 2030 program renewable energy that is provided on a larger campus is considered to be equivalent to that provided on the project site.

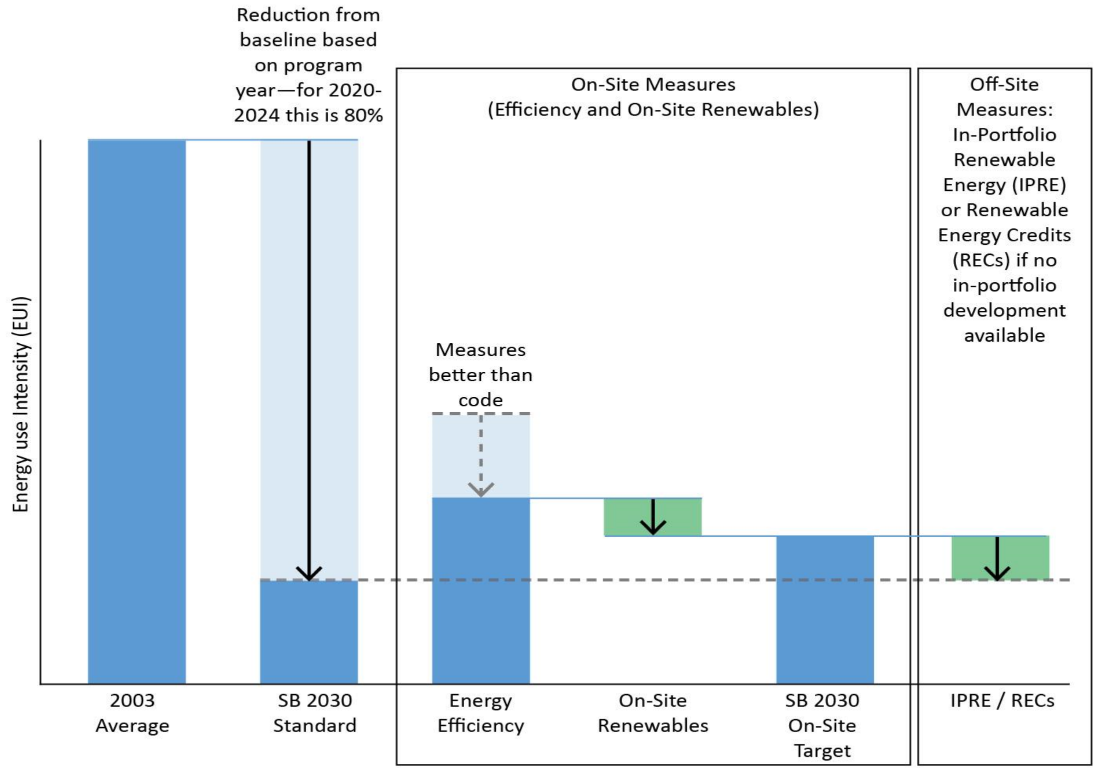

Figure 2. Renewable Energy Hierarchy for A Sample SB 2030 Project

Moving to a 90% Reduction Target

Projects starting schematic design after January 1, 2025 are required to meet energy and carbon standards that are 90% better than the program's 2003 baseline (Minnesota Legislature 2023a). The transition from 80% better to 90% better entails an incremental 50% reduction in the energy and carbon targets for SB 2030 projects (moving from a 20 on the zEPI scale to a 10) and will require programmatic updates to continue to meet SB 2030's legislative intent within the rapidly evolving energy and carbon landscape.

The SB 2030 management team has identified several key areas of consideration for program updates, informed by experience with program participants, the evolving dynamics of the electrical grid, advancements in technology, and the emergence of regulatory and programmatic approaches to energy and carbon accounting. More detail on specific considerations is provided in each of the sections below.

Optimizing Building Grid Interactions

Buildings in the SB 2030 program's 90% energy and carbon reduction category will be high-performance buildings that are at the cost-effective and technological limits of energy efficiency. In addition, these buildings will also be deploying some amount of in-portfolio renewable energy production on the building, its site, and/or campus. This positions the program to include many of the components of the Department of Energy's Building Technology Office

Grid-interactive Efficient Buildings Program which is schematically represented in Figure 3 (U.S. Department of Energy 2019).

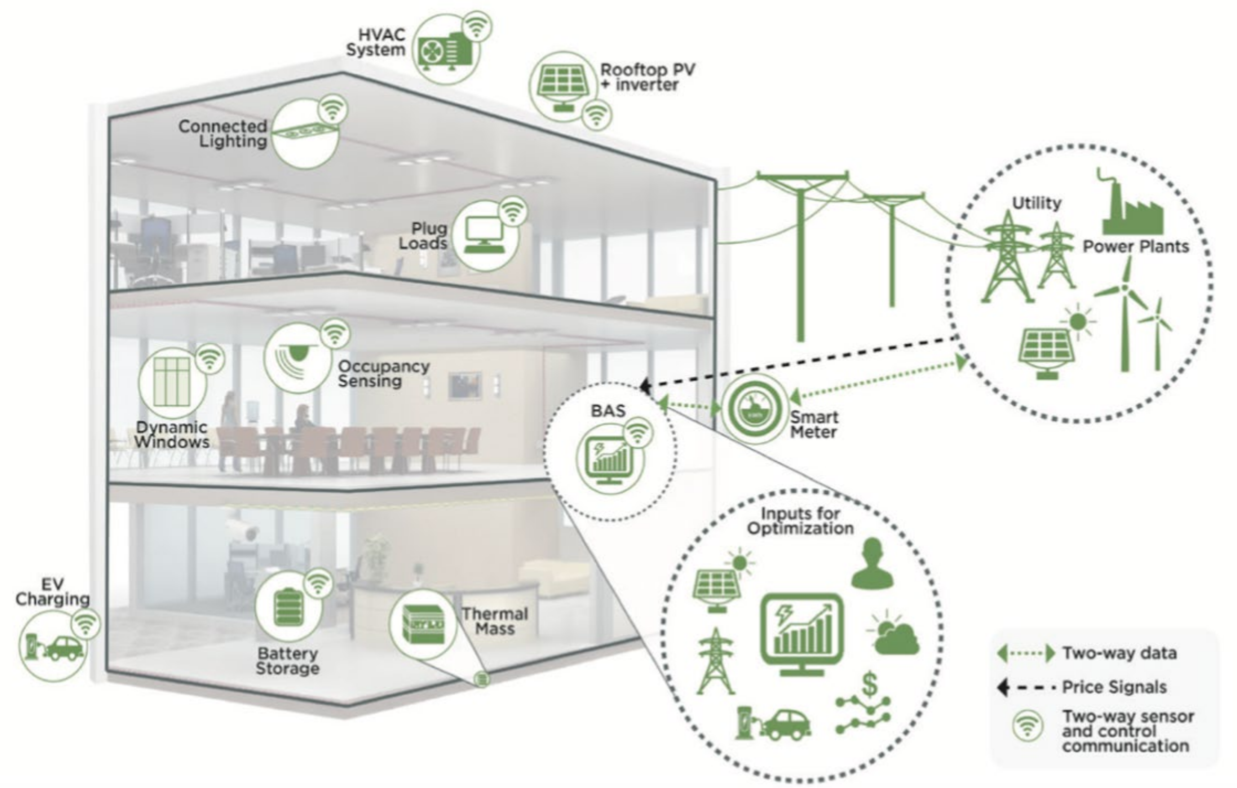

Figure 3. Grid-Interactive Efficient Building (U.S. Department of Energy 2019)

Further development of the SB 2030 program will investigate the interaction of buildings and the grid to achieve the state of Minnesota's 2025 Energy Action Plan (Minnesota Department of Commerce 2024b) and Climate Resilience Goals (Minnesota Department of Commerce 2024a). This will require the reframing of building projects within the larger energy system. As a result, additional strategies beyond energy efficiency, such as storage in addition to on-site energy generation, smart controls, thermal storage, and refinements to EV charging, may be integrated into the program requirements.

Grid Carbon Emission Factors and Time-of-Use Impacts

Greenhouse gas emissions from SB 2030 projects are currently calculated using average emissions factors for the Midwest region during the most recently published year, with the option to use utility-specific emission factors when available. However, this approach does not realistically estimate the lifetime emissions of a new building, especially with the rapidly decarbonizing grid, load growth from electrification of buildings and vehicles, and variable renewable energy generation throughout the year (Minnesota Legislature 2023b).

After reviewing different approaches to determine future emissions factors, the SB 2030 program design team proposes using the long-run, hourly, marginal emissions factors for Minnesota published in the National Renewable Energy Laboratory's Cambium database for the mid-case scenario averaged over even years from 2036-2044 (National Renewable Energy Laboratory 2024). This aligns SB 2030 with New Building Institute's GridOptimal initiative (New Buildings Institute 2021) which is currently used by LEED (U.S. Green Building Council 2024) and ASHRAE Standard 189.1 (ASHRAE, 2023). The mid-case scenario in Cambium selected by the team accounts for existing policies and uses central estimates for variables like technology costs, fuel prices, and demand growth. The database is updated annually to reflect the rapidly changing electric power sector.

Using long-term marginal emissions rates rather than averages reflects the new generation resources that would need to be built to serve the new, long-term loads from SB 2030 buildings. Cambium provides hourly emissions factors that reflect typical generation variability for wind, solar, and other resources based on the season and time of day. This allows projects to claim carbon reduction for strategies like energy storage and demand flexibility measures that shift the load to less carbon-intensive times.

Renewable Energy Credits

RECs come into play in two areas under SB 2030. The first is the requirement that any RECs associated with on-site or in-portfolio renewable energy used as part of meeting the SB 2030 standard should be assigned to the project owner and not be sold separately. This prevents the same renewable energy generation from being counted both as an offset in order to meet SB 2030 and counted towards other renewable energy requirements, such as the utility renewable energy portfolio requirements, which obligate the electricity utilities to include a specified amount of renewable energy in their mix. The second manner in which RECs can be used as part of SB 2030 program is to meet the SB 2030 Standard after on-site and in-portfolio renewable energy generation have been exhausted or evaluated and found to be not cost-effective. To date, this has been a 1-for-1 exchange, meaning that 1 MWh of RECs can be used to offset 1 MWh of energy consumption in a project. The SB 2030 program to-date has not distinguished between unbundled RECs purchased from the open voluntary market, RECs that are included as part of a green energy product, or RECs that would be associated with the project through a power-purchase agreement.

The primary requirement for renewable resources, including RECs, used towards satisfying SB 2030 is that they align with the definition of renewable energy present in Minnesota statute; which generally allows wind, solar, as well as certain hydroelectric and biomass with limitations (Minnesota Legislature 2023b). SB 2030 to-date has permitted an up-front purchase of RECs to offset the full 10-year term that SB 2030 compliance is evaluated, based on the difference between the project's anticipated energy use and the SB 2030 target.

As more programs have included considerations related to RECs in their compliance methods, an approach has emerged that applies a multiplier to the procurement of RECs to distinguish between off-site energy procurement approaches. This approach is essentially requiring more or less off-site resources to be used for meeting program requirements depending on how they are associated with the project. Such approaches from several energy efficiency and net zero programs are summarized in Table 1 below.

Table 1 outlines an emerging differentiation to the contributions of RECs and other renewable energy sources to projects pursuing "Net-Zero". These varied approaches permit better distinction between methods of renewable energy development based on proximity, timeline of development, and ownership.

Similarly, the SB 2030 management team proposes a multiplier, also known as a discount or procurement factor, to be applied to off-site resources contributing to meeting the SB 2030 Standard and aligning that procurement factor based on type with the 2021 IECC (International Code Council 2021). As noted in more detail below, the current structured hierarchical approach to renewable energy procurement is proposed to be retained and reinforced by differentiation of RECs. The inclusion of a multiplier also allows for other, not yet considered approaches to renewable energy to be included as part of future updates.

Table 1. Review of Program Approaches towards Renewable Energy Procurement

Program	Off-Site Renewable Energy Procurement Type					Approach [2]	Multiplier (Discount Factor)	Contract Period
	Self-Generation	Community Facility	RECs		PPAs			
			Bundled	Unbundled				
ASHRAE Standard 228 (2023)	x	x	x		x		0.75 to 0.85	15 Years
LEED Zero (2020)	x	x	x	x	x	Hierarchical		3 Years[2]
Phius ZERO (2021)	x	x	x	x	x		0.20 to 0.75	15 Years
ZERO Code 2.0 (2020)	x	x	x	x	x		0.50 to 0.90	15 Years
Zero Carbon Standard 1.0 (2020)	x	x			x			15 Years[3]
Zero Energy Standard 1.0 (2021)	x	x			x	Hierarchical		15 Years
IECC (2021)	x	x	x	x	x		0.20 to 0.75	15 years

1 The Approach listed here refers to whether off-site renewable energy is required to be implemented in a specific order (i.e. a hierarchy).

2 The amount of renewable energy needed is based on the project's actual energy performance for that year and can vary from year to year.

3 This program allows a one-time procurement of RECs equal to the total amount needed over the 15 years of operation.

Hierarchical and Multi-Scalar Approach for Renewable Energy Procurement

SB 2030's hierarchical approach to renewable energy generation options was initially put forward as part of the 2020 revisions, which allowed projects to use off-site renewable energy but required a prioritization of energy efficiency and on-site renewable energy generation above off-site measures. The program also asks projects that could feasibly develop renewable resources in other locations in their portfolio to do so prior to using green power purchases or RECs to fully meet their SB 2030 target.

Although off-site measures could be considered in a more nuanced manner, such as by using the discount factors discussed in the previous section, this structured hierarchical approach has been useful in prioritizing on-site measures. A review of other programs suggests that permit off-site renewable energy measures to be included in net-zero buildings most typically include a building performance requirement before renewable energy can be used (refer to the Approach column in Table 1 for more details). However, since the SB 2030 program has a large amount of variation in project types; using a similar approach with a limited number of performance targets may not be the ideal approach for future updates. Accordingly, the SB 2030 program proposes to continue using a hierarchical approach using a cost-test mechanism to govern project teams ' ability to access off-site resources for meeting program requirements. This approach prioritizes on-site renewable energy generation over off-site, accommodates the large number of different building types participating in the program, and accommodates a cost-effectiveness consideration. This aligns in concept to many of the emerging approaches where a specified level of efficiency must be achieved before renewables, but provides flexibility by the development of a project-specific approach.

Cost-Effectiveness Testing

The statute establishing the SB 2030 program requires that the performance standards must be determined to be cost-effective based on how the state considers cost-effectiveness for utility programs. Rather than trying to do up-front analysis of the wide variety of building types and measures that can be applied, the program has operationalized this cost-effectiveness requirement by developing a process to establish project-specific on-site targets that are determined by performing an energy simulation run that includes all measures that are practical and cost-effective.

Adhering to Minnesota's previous policies of limiting utility conservation program analysis to a 20-year life-cycle and focusing on societal benefit to cost ratio as the primary cost-effectiveness test, the long-standing test that the program has used as a proxy for project teams to determine cost-effectiveness of measures has been whether the simple payback period (without considering any incentives or tax credits) of 12 years or less. This limit has prevented the program from fully taking into account the benefits of long-lasting improvements (e.g., most envelope upgrades) when establishing each project's on-site target. This limitation leads to a greater gap between the On-Site target and SB 2030 target, a gap which is typically made up for with some form of renewable energy. A combination of State policy changes and changes to inputs into utility program cost-effectiveness tests have provided the SB 2030 project team with the opportunity to revisit the cost-effectiveness test threshold and how it is applied.

The SB 2030 project team underwent a systematic evaluation of the utility program cost-effectiveness tests, as well as a review of numerous issues that have an impact on the threshold of life-cycle cost-effectiveness. The most impactful on these tests was the enactment of Minnesota's ECO Act in 2021 (Stephenson et al. 2021) and a resulting policy development which led to a new Minnesota Test replacing the societal test as the key focus for utility program cost-effectiveness testing. Unlike the societal test, the new Minnesota Test completely ignores the building owner's first costs and energy cost savings which hinders its usefulness in the evaluation of specific energy conservation measures. In order to continue to provide a test usable for an individual project's evaluation, the SB 2030 program is proposing to shift to focus on the participant test as the only remaining relevant indicator of the cost-effectiveness of energy saving and fuel-switching measures. This not only simplifies the program team's analysis process but also leads to a higher simple payback threshold during the previous analysis.

Other key factors that the project team included in their evaluation of the cost-effectiveness threshold and methodology that impact an appropriate cost-test mechanism are listed below:

- measure life variations from 10 year to 50 years
- the savings ratio between fuels and the impact of electrification
- utility rate variations, including discounted electric heating rates and the elimination of meter charges with electrification
- discount rate variations based on different utility program testing and customer classes
- the importance of having a simple proxy test for use by design and development teams

Figure 4 shows that this analysis indicates that extending the measure life has the most dramatic impact on the simple payback for the threshold of life-cycle cost-effectiveness—the simple payback increases nearly 30% or more when the measure life is extended from 20 years to 30 years and increases to over 60% when the measure life is modeled at 50 years. Note also that the fuel type has a more modest impact at shorter measure lives that increases substantially as the measure life increases, due to the current policy guidance which uses energy cost escalation factors that are much higher for natural gas than for electricity. To implement this evaluation into SB 2030 the most appropriate estimates for the effective life of various measures is needed and work is underway on refining the best source for these values.

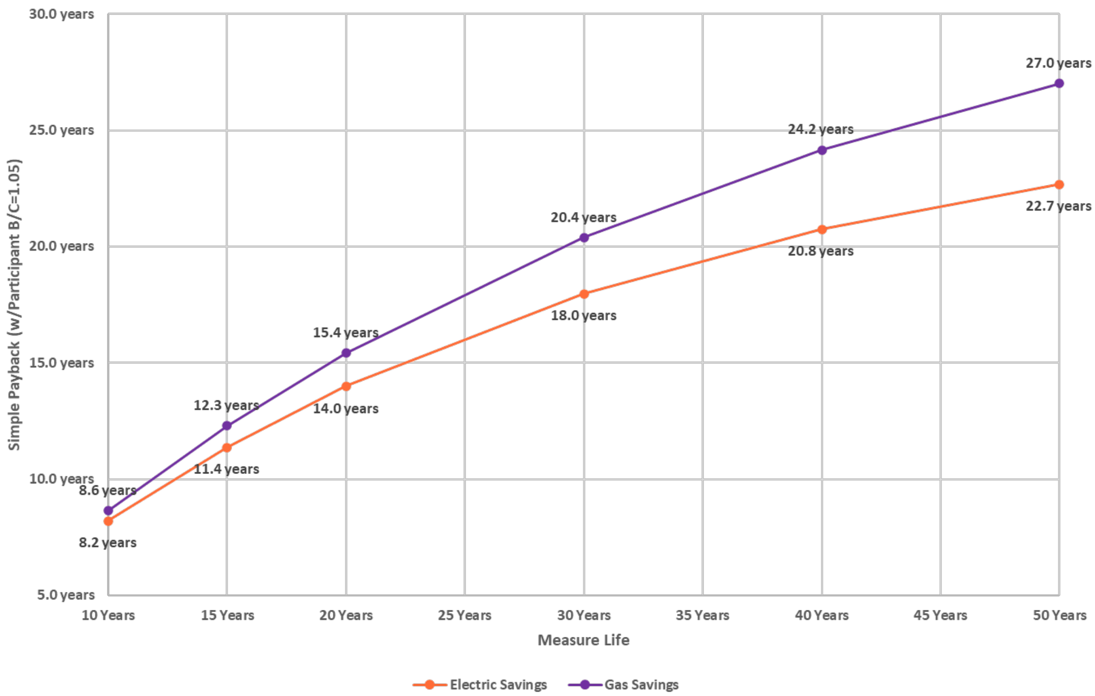

Figure 4. Cost Effectiveness Limit Variations based on Measure Life and Fuel Saved

Table 2 below shows that a simple payback proxy for analyzing electrification is quite sensitive to numerous factors, including to changes in assumed electric rate. This makes the program's policy regarding the use of a single state-wide utility rate assumption versus consideration of a specific project's expected utility rates very important. Without other factors considered and using regular utility rates, this analysis produces a large negative simple payback despite being cost-effective on a life-cycle basis. This is also due to the much higher assumed natural gas escalation rates used in Minnesota. It is also noteworthy that consideration of non-fuel utility costs billed to the building occupants can similarly have a large impact. For example, elimination of the monthly natural gas meter charges for every dwelling unit in a multifamily building was considered and shifts the simple payback to less than 20 years.

Table 2. Sample Simple Payback Variation under Different Utility Cost Circumstances

Utility Cost Circumstance	**Simple Payback using a benefit/cost ratio of 1.05 and a 20-year measure life**
Regular Utility Rates	-294 years
Utility Rates using a 6% Electric Heating Discount	40 years
Utility Rates Considering Meter Charge for Multifamily Housing	19 years

Lastly, Figure 5 shows that the impact of the discount rate has a bigger impact than the type of fuel saved (as noted in Figure 4), while as above the simple payback also increases as the measure life is lengthened.

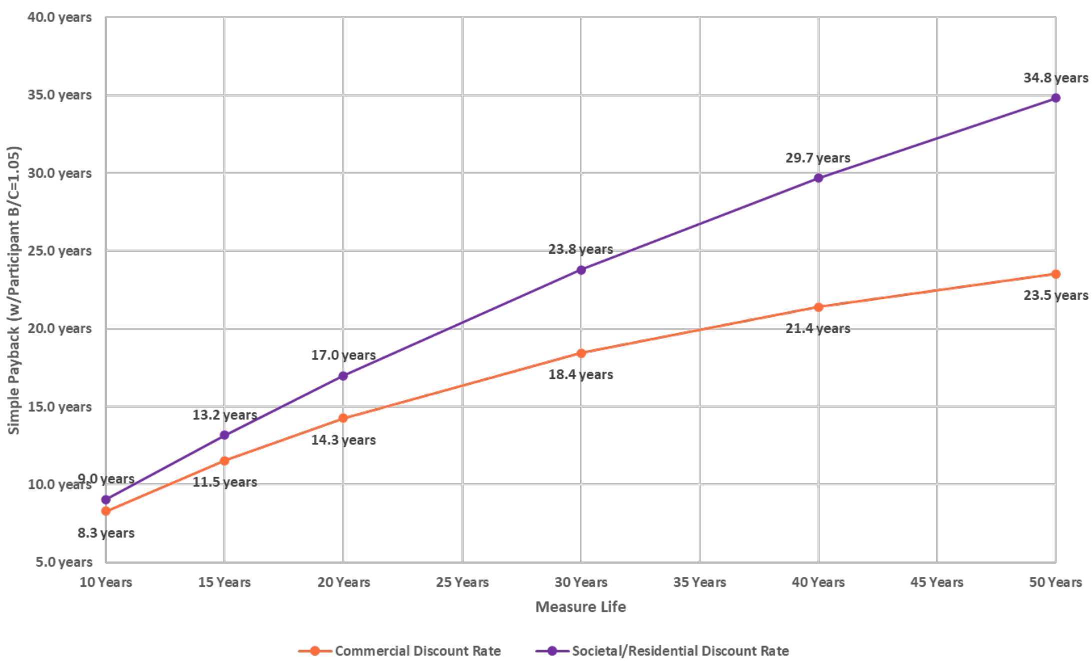

Figure 5. Cost Effectiveness Limit Variations based on Discount Rate Variations (for Savings Proportional to Education and Multifamily Baseline)

The project team is continuing to refine an updated cost test which considers the above-noted factors in order to continue a project-specific approach to measure evaluation that maintains program goals and which uses a more comprehensive assessment.

Other Program Considerations

Other changing factors needing consideration include the lowering carbon intensity of the grid as more renewable energy is put online, increasing use of renewable energy utility programs. The SB 2030 program has excluded from these targets the energy use from outside of the building sector, including electric vehicle charging and some atypical industrial or other processes; this exclusion is expected to be continued as an approach in order to maintain SB 2030 as a program primarily concerned in building-related energy and carbon. Embodied carbon has been to-date excluded from contributing to the SB 2030 Standard but is under evaluation for future updates given its significant impacts on the overall global warming impact of building projects. The impact of refrigerants have similarly been excluded but it is noted that a full global warming impact assessment would include the impacts of refrigerant selection, monitoring, use, and disposal.

Conclusions and Next Steps

The program updates outlined in the previous section are important to ensure that the SB 2030 program continues to be a model approach to accommodating changes in the built environment and energy supply and emerging patterns of practice. Informed by working with project teams these measures will enable the planned step to 90%-better and continue to achieve program goals while accommodating the wide array of projects that are required to comply with SB 2030.

In addition to those outlined above, the SB 2030 program is continuously evolving in other areas as well. These include better support and guidance for projects navigating the program and specifically addressing the bridge between design and construction into operation. As more advanced systems and enclosures are brought forward to meet increasingly stringent targets, more care is needed to ensure that modeled operational performance is achieved in operation. Other program update areas include more detailed requirements relating to the timeline of renewable energy development, which can ensure that the renewable energy used towards meeting the SB 2030 target is derived from additional supply.

Climate change considerations are integral to implementing a future looking energy target and work is underway to determine the best use of future weather data in SB 2030's energy modeling efforts. Implications of this possible integration are currently being investigated; in particular how future weather interacts with code compliance efforts.

Though future updates will be needed to continue to adapt the SB 2030 program, the changes considered here represent a valuable step in program development that is a part of the SB 2030 program's broader focus on adapting to the complex interactions between buildings, the electrical grid, and the landscape of regulations, policies, and programs. Such considerations are essential in maintaining the SB 2030 program's role in driving carbon emissions reductions in Minnesota's publicly funded buildings. Ultimately, the goal of the Sustainable Buildings 2030 program is to understand and contribute to a net zero carbon building sector in Minnesota that integrates with other sectors (i.e. energy, transportation, materials, etc.) to meet the State's climate change goals. As of 2023, Minnesota state commercial energy code trajectory of performance targets align with SB 2030. Future research is needed to integrate the lessons learned about technology, capacity building, and the relationship between building efficiency and distributed energy generation inclusion in the energy code.

The SB 2030 program in Minnesota can serve as a model for green building policies and code development elsewhere. The lessons learned from implementing the program across a diverse array of building types in a challenging climate with low energy costs extend beyond the definitions of cost-effective and technical limits of energy efficiency. The updates outlined here serve to find the balance between energy use reduction and the development of renewable energy production. Powering the built environment on renewable energy at a variety of scales is an essential part of accomplishing climate goals.

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