Building Performance Evaluation Guide

Version 2.0

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February 2025

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1 Introduction

Welcome to the Sustainable Building 2030 (SB 2030) process. In 2008, the State of Minnesota implemented a program called Sustainable Building 2030. State law[1] has required all state-bonded buildings starting Schematic Design since August 1, 2009 to comply with the SB 2030 Energy Standard. SB 2030 is the building energy efficiency requirement of the B3 Guidelines found at www.b3mn.org/guidelines/.

SB 2030 compliance requires that whole-building energy simulation is used to validate the designed energy performance (kBtu/SF/Yr) and carbon emissions (lbs of CO2/SF/Yr) to meet reduction targets. This guide describes requirements, options, key metrics, and best practices for gaining SB 2030 approval. Buildings with less than 20,000 gross square feet of conditioned area have different processes and requirements — refer to the "Small Buildings Method Requirements" documents at https://www.b3mn.org/2030energystandard/ for more information. Contact program administrators at **SB2030@b3mn.org** for guidance on the small building path.

The SB 2030 energy standard takes a reduction (70%, 80%, 90%, etc.) from a baseline performance based on the average performance of a 2003 building of similar function and size. The SB 2030 standard (or target) must be determined using the Energy Standard Tool (EST), which performs a basic energy simulation of the building under consideration. The SB 2030 target may be met with energy efficiency measures, on-site renewable energy, off-site renewable generation, or a purchase of renewable energy credits (RECs). The use of off-site renewable options come with the caveat of an additional on-site performance target that must be established through modeling and met in design plans. This on-site target (OST) functions as a backstop for building energy efficiency and prevents projects from simply employing off-site renewable energy or RECS to meet the SB 2030 target.

1.1 Key Terms

Program

- **SB 2030**: Sustainable Buildings 2030, https://www.b3mn.org/2030energystandard/.
- **B3 Guidelines Tracking Tool:** Tool used to submit and track progress toward SB 2030 certification, https://trackingtool.b3mn.org/.
- **SB 2030 Target**: Maximum EUI and CO_2 Intensity allowed for SB 2030 certification.
    - Also referred to as the "SB 2030 Energy Standard" and "SB 2030 Carbon Standard" in the B3 Guidelines Tracking Tool

[1] Next Generation Energy Act, https://www.revisor.mn.gov/statutes/cite/216b.241

- **On-Site Target (OST)**: Additional SB 2030 target that must be met when off-site resources are used to meet the SB 2030 Target. See 6. On-Site Target for additional details.
- **Baseline Building Performance**: EUI and CO_2 Intensity, reflecting average energy performance in 2003, for reference simulation conditions.
- **Proposed Building Performance**: EUI and CO_2 Intensity for as-designed simulation conditions.
- **On-Site Performance**: EUI and CO_2 Intensity without off-site energy generation included.
- **Off-Site Performance**: EUI and CO_2 Intensity of off-site energy generation.
- **Net Performance**: Combined on-site and off-site EUI and CO_2 Intensity.
- **Small Building**: Projects with less than 20,000 gross square feet in conditioned area. Process documents are at https://www.b3mn.org/2030energystandard/.
- **Procurement Factor:** A coefficient that adjusts the impact (or off-site performance) of renewable energy.

General

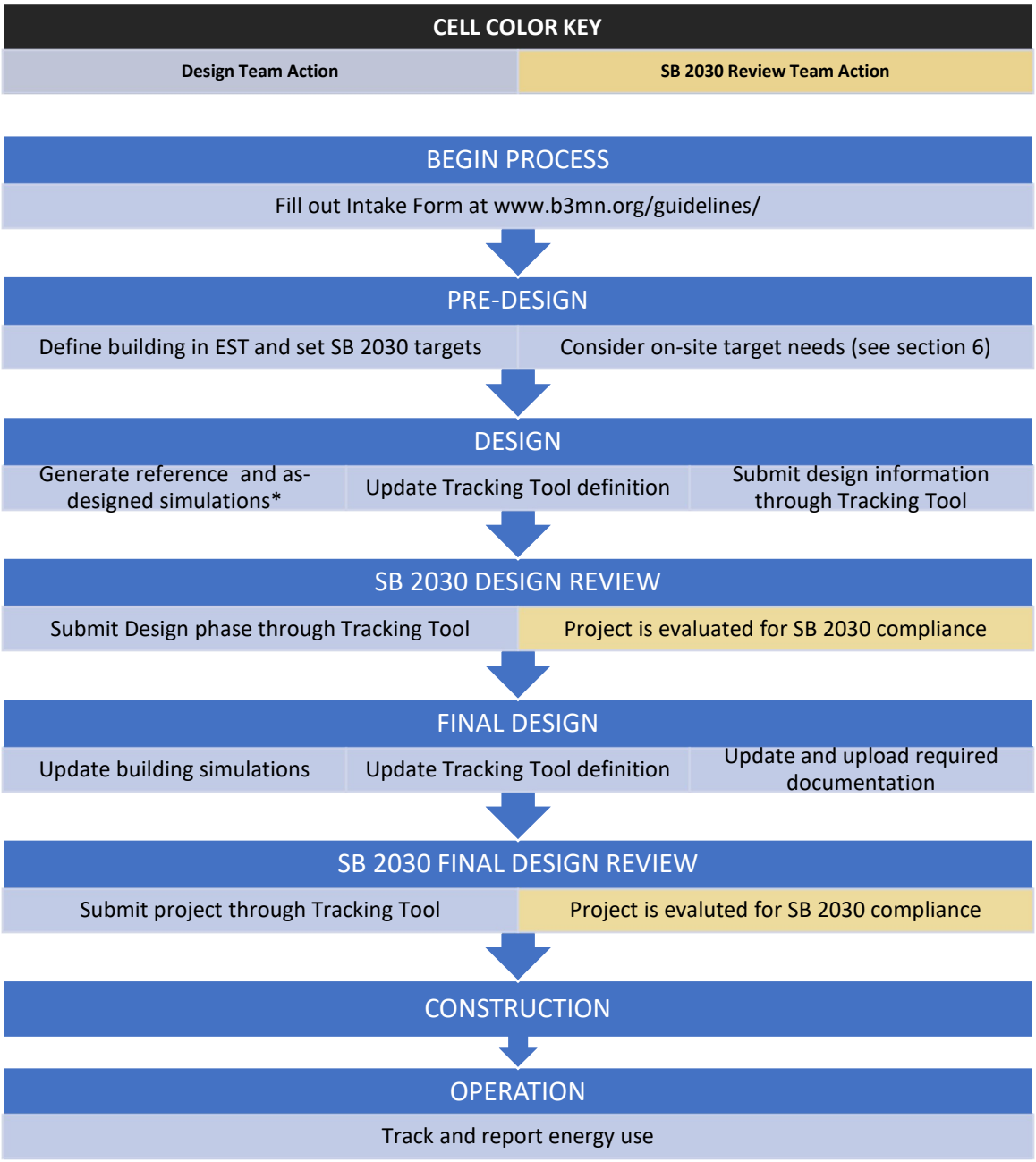
- **EUI**: Energy Use Intensity (kBtu/SF/Yr) – This is a key performance metric for SB 2030 certification.
- **CO_2 Intensity**: Annual CO_2 emissions (lb/ft^2) – This is a key performance metric for SB 2030 certification.
- **RECs**: Renewable Energy Certificates – Market-based representation of property rights to claim renewable electricity generation.
- **LPD**: Lighting Power Density (w/sq ft)
- **ECM**: Energy Conservation Measure

Simulations

- **EST**: Energy Standard Tool – This is a simulation tool built into the B3 Guidelines Tracking Tool which is used to set the SB 2030 energy and carbon targets and can be used to model the performance of proposed building designs.
- **Alternative Simulation Software**: Simulation software that is not the EST.
- **Reference Simulation**: Energy simulation that reflects the average energy performance of the building in 2003. In the B3 Guidelines Tracking Tool this is the "Energy Standard Simulation."
- **As-Designed Simulation**: Energy simulation that reflects the actual design of the building.
- **On-Site Target Simulation**: Energy simulation used for setting the building's on-site target.
- **Model**: This is used interchangeably with "simulation" in this document.
- **Exceptional Calculations:** Energy performance calculations performed outside of building simulation software.

2. SB 2030 Process

The following steps outline the process of the SB 2030 Program. Whether you have elected to do this program voluntarily, are required to by the State of Minnesota, or are pursuing SB 2030 as a requirement for a municipal, county, or other policy, the procedure will be the same. A different process may be used for buildings with less than 20,000 gross square feet in conditioned area. Refer to the Small Buildings Method Requirements documents at https://www.b3mn.org/2030energystandard/ and contact program administrators at **SB2030@b3mn.org** for more information.



*An on-site target simulation may be generated at this step, see 6. On-Site Target.

2.1 Process Chart Notes

- **SB2030@b3mn.org:** This email is used to initiate Design and Final Design reviews or submit questions to the review team. The email may also be used to submit documentation of as-designed building performance that can't be uploaded through the B3 Guidelines Tracking Tool (file type, size, or number).
- **B3 Guidelines Tracking Tool:** See 3.1 B3 Guidelines Tracking Tool General Requirements for guidelines and requirements.
- **Building Simulations**: See 4. Simulation Requirements for guidelines and requirements.
- **Design Information:** See 3.1 B3 Guidelines Tracking Tool General Requirements for guidelines and requirements.
- **Required Documentation:** See 3.2 Required Documentation for guidelines and requirements.
- **On-Site Target Simulation:** See 6. On-Site Target for guidelines and requirements.

3. B3 Guidelines Tracking Tool

The B3 Guidelines Tracking Tool is an online portal used to submit documentation and track progress toward SB 2030 approval. It also contains links to the Guideline requirements and descriptions of how to submit appropriate documentation to meet the requirements. The tracking tool is located at https://trackingtool.b3mn.org/Home. Training for navigating the tracking tool is in video format at https://www.youtube.com/watch?v=lnfZFDAeykg.

3.1 B3 Guidelines Tracking Tool General Requirements

SB 2030 Design Review: Submitting design documentation is encouraged at this phase, however the only required information is energy simulations and Predicted Energy Use by Type (see below). All submitted information will be used to improve guidance for final design.

SB 2030 Final Design Review: All information described below is required for Final Design Review. Documents should be submitted while there is still time to make design adjustments.

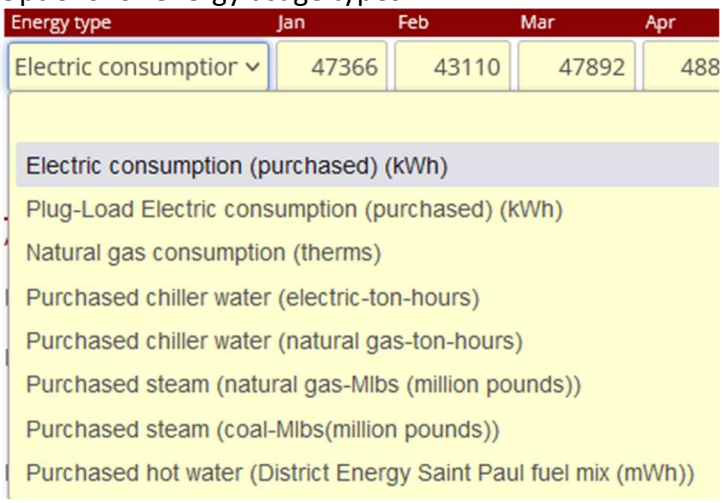
- Section P0D
  - The gross building area subject to SB 2030 entered in section P0D must match the building area used in energy simulations example:

    P0D11. **Gross SB 2030 Project Size (enter entire project gross square footage if entire project is required to meet SB 2030).** 57,225 sq. ft.
- Section E1A&B
  - **Energy Standard Tool:** This tool is built into the Tracking Tool. Launch it from this section. For additional guidance on using this tool refer to 4. Simulation Requirements.
  - **Predicted Energy Usage by Type:** These values establish the Design Energy Use (kBtu/SF/Yr) and Design Carbon Emissions (lbs of CO2/SF/Yr) that must meet or exceed corresponding targets. The energy usage entered must match energy simulation results.
    - Renewable energy is tracked separately from simulation results and must be entered directly. Renewable energy must not be included with the primary building consumption simulation. Renewable thermal energy collection is the one exception to this requirement. Renewable thermal energy should be included in simulations as it may impact the performance of other features of the building.
    - Example predicted energy usage by type:

Energy type	Jan	Feb	Mar
Electric consumptior	47366	43110	47892
Natural gas consum	2030	1232	710
Electric consumptior	-37808.1	-34149.3	-37808.1(

- Note: follow instructions in the tracking tool on whether to input renewable energy values as positive or as negative.

- Options for energy usage types:

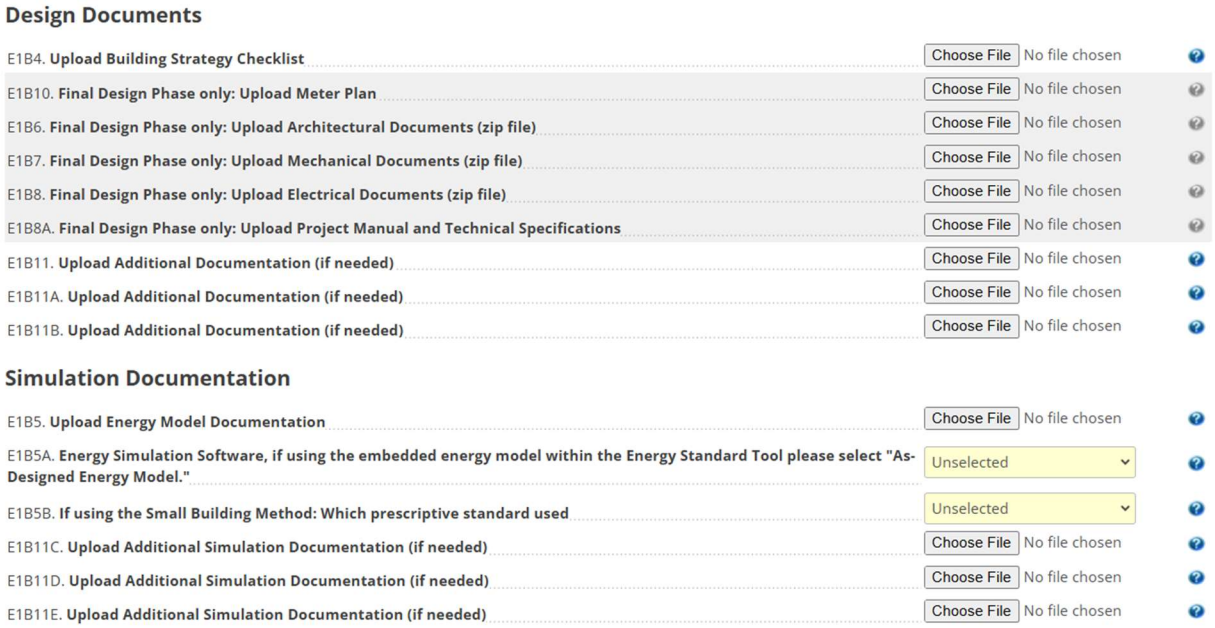


- Energy used to charge electric vehicles (EVs) should not be included as part of project energy use. These loads are excluded from SB 2030 target setting and should be sub-metered.
- Large process loads (e.g. intensive data processing or manufacturing) may be excluded from the scope of SB 2030 upon approval from the program administrators.
    - If approved by program administrators, these loads must be excluded from SB 2030 target setting and energy modeling and must be sub-metered to enable their energy use to be tracked separately from the rest of the project.
    - The conditioning (e.g., heating, cooling, dehumidification) of the space that hosts these process loads is still considered part of the SB 2030 project.

- **Documentation of Predicted Energy Use:** See 3.2 Required Documentation for guidelines and requirements.
    - Documentation of alternative software simulation and exceptional calculations is uploaded to this section of the tracking tool. Refer to 4. Simulation Requirements of this document for guidelines and requirements.

3.2 Required Documentation

SB 2030 Final Design Review requires submission of construction plans and other documentation supporting modeling assumptions. This is required to validate simulated energy performance. Documentation is submitted in the FD phase of section E1A&B of the Tracking Tool.



The following documents are required for approval.

- For projects that submit an as-designed energy simulation with alternative software (using a simulation tool other than the EST), required simulation elements are listed in Appendix A. Sample Simulation Input and/or Output File(s).
- Full set of architectural drawings
- Full set of mechanical drawings
- Full set of electrical drawings
- Full set of plumbing drawings
- Project manual/specification book
- Metering narrative (see details in item 4)
- Modeling area zoner for EST space asset areas (see Appendix B Example Zoner Diagram for example))
- Renewable energy production estimate (if on-site renewable is planned)

If any items above are not submitted, include an explanation for all missing items. All ECMs included in as-designed simulations need to be clearly shown in submitted documentation. For example, ENERGY STAR appliances in an as-designed simulation need to be specified in CDs or separate documentation.

There are a number of items that are commonly missing from construction documentation in FD phase submissions, but are required for a comprehensive review. Make sure all submissions include the following information (as applicable):

- Wall/roof assembly diagrams
- Wall/roof insulation R-values
- Window U-factor and SHGC values
- HVAC motor brake horsepower and nominal horsepower
- HVAC controls sequences
- Lighting control sequences
- Residential appliance/showerhead model details
- Elevator model details

Detailed simulation documentation requirements can be found in Section G1.3.2 of ASHRAE 90.1-2016, or newer.

4. Simulation Requirements

SB 2030 approval requires whole building energy simulation to demonstrate that design plans meet energy and carbon reduction targets. There are at minimum two simulations required for approval: a reference simulation and an as-designed simulation. A third, on-site target simulation is often submitted as well. Energy calculations outside of simulations (exceptional calculations) are also allowed where practical and as approved by program administrators.

- **Reference Simulation:** This represents average building performance conditions in 2003. The SB 2030 required reduction is applied to this simulation to establish the SB 2030 target.
    - Reference simulations are automatically built into the EST as-designed simulations.
    - The reference simulation must be built with the EST even when as-designed conditions are simulated with alternative software. Exceptions to using the EST for the reference simulation may be considered where the EST is demonstrated to be insufficient in representing building conditions.
- **As-Designed Simulation:** This can be built with the EST or alternative simulation software (described in 4.3 Alternative Software for As-Designed Energy Simulation Guidelines).
- **On-Site Target Simulation:** This simulation is required when off-site renewable energy is claimed in order to meet the SB 2030 Performance Target (see 6. On-Site Target for more information).
- **Exceptional Calculations:** These are allowed in cases where simulation software is not able to sufficiently represent actual performance. Assumptions, calculation methodology, and the impact on building performance must be clearly documented and submitted through section E1 of the B3 Guidelines Tracking Tool.

Potential combinations of the above options include:

- Scenario 1: The EST is used for reference and as-designed simulations.
    - 1 simulation
    - For projects that are using the EST for the as-designed simulation the reference simulation is automatically provided by the tool.
- Scenario 2: The EST is used for reference simulation and alternative software used for as-designed simulation.
    - 2 simulations
    - Guidelines for aligning the building definitions of reference and as-designed simulations are in section 4.3
- Scenario 3: The EST is used for reference and as-designed simulations, exceptional calculations are also included.
    - 1 simulation if external calculations only impact as-designed performance (e.g., on-site renewable energy).

- 2 simulations if exceptional calculations change reference building performance.
- EST simulations can be cloned, making it easy to match building definitions across the 2 EST simulations.

4.1 General Simulation Requirements

Evaluation standards are outlined in the *Proposed Building Performance* column of Table G3.1 in ASHRAE 90.1, Appendix G (2016 or later). *Section G2.4.1 On-Site Renewable Energy and Site-Recovered Energy* is also applicable when such systems are present. Section *G2.5 Exceptional Calculation Methods* may be applied where necessary. The Building Performance Evaluation Guide (this document) takes precedence over the above noted standards where any differences exist.

These requirements apply to all building simulations:

- Weather data must come from a nearby location.
- Final simulations must not have more than 300 unmet load hours.
  - Exception: Unmet load hours may exceed 300 where it is demonstrated that the project meets the SB 2030 energy standard regardless, i.e. the impact of unmet load hours has been shown to be smaller than the gap between the simulated performance and the SB 2030 standard performance.
- Electric vehicle (EV) charging must be excluded from simulations. EV loads are excluded from SB 2030 target setting as well.

4.2 Energy Standard Tool Guidelines

There are several inputs and model settings in the EST that must be adjusted from the default to match the building design and align with SB 2030 requirements. Below is a list of guidelines describing how to set up the EST model for determining the SB 2030 target values and the as-designed model. Models that do not meet these requirements will not be approved for compliance with the SB 2030 guidelines.

Training videos on using the Energy Standard Tool are available at https://netenergyoptimizer.com/resources/training-videos.

Detailed Inputs

- Detailed inputs must be enabled in the EST. To do this, navigate to the Menu button in the upper right corner of the EST and check the Enable Detailed Inputs box. If this option is not selected, many of the parameters detailed below will not be available to edit.

Space Asset Areas

- The EST uses Space Asset Areas (SAAs) to define the building. SAAs are groups of building areas that share an occupancy type, schedule, HVAC system, and other general characteristics. SAAs will often be larger and less detailed than typical energy model spaces, as they are designed to provide a general overview of an area's usage; for example, an SAA representing an office area should include corridors, restrooms, storage spaces, and any other support areas associated with the office space that are served by the same HVAC system.
    - The project should be modeled with the smallest number of SAAs needed to accurately represent the building. This means that smaller spaces such as storage areas, mechanical and electrical areas, vestibules, stairwells, and other support spaces should be combined with larger areas rather than split into their own SAAs unless doing so would cause a significant change in the building's energy performance. **Note that defining too many SAAs can cause the tool to crash and corrupt the simulation file.** As a rule of thumb, most projects should not use more than 10 SAAs or have any SAAs that comprise less than 1% of the gross floor area.
- When creating an SAA, the modeler will be prompted to enter a Space Asset Type (SAT), the SAA's area, the number of floors included in the SAA, and the arrangement of the SAA. The SAA should be named to clearly indicate the areas of the building it includes.
    - The SAT of the SAA sets the reference building values assumed for the SAA's characteristics such as lighting power density, equipment power density, operation schedule, ventilation rates, and more. There are a number of SATs to choose from based on the occupancy type of the SAA.
    - The gross area of all SAAs combined should equal the total gross building area defined at the top of the Building tab. **This total area must match the area defined in entry P0D11 of Guideline P0D; if these numbers do not match, the EUI for guidelines E1B and E1A will not calculate correctly.**
    - There are three options for SAA arrangement: adjacent/grade, hosted, and stacked.
        - The stacked definition is used for SAAs that are on top of another SAA, such as a multifamily unit block stacked on a parking garage or an office area stacked on a tenant retail area. Stacking an SAA on another SAA results in a reduction of the assumed roof area for the lower SAA. Note that SAAs can only be stacked on top of one other SAA; if there are multiple SAAs that an SAA could be stacked on, please choose the one with the largest area.
        - The adjacent/grade definition is used for SAAs that are not on top of other SAAs, such as an office on grade or a multifamily

common area on top of an out-of-scope parking garage or retail area.
        - The hosted definition is used for SAAs that are entirely within another SAA, such as multifamily corridors in an apartment SAA or laboratories in a classroom SAA. These areas are modeled as having no exterior walls and will have their shape defined by the SAA in which they are hosted.
    - Shell spaces must be modeled with their expected steady-state operation characteristics; for example, a space designed as a shell space that will eventually be used for tenant retail space must be modeled as a retail SAA.
- The grouping of areas into SAAs should be documented in a project zoner such as the one shown in Appendix B and submitted alongside the rest of the project documentation.

HVAC Systems

- HVAC systems are defined in the EST in a similar manner to SAAs, to group similar systems into one larger general system. Multiple SAAs can be assigned to the same HVAC system; for example, if an office area and retail area are both served by a DX cooling system with gas furnace heating, they can be modeled as sharing an HVAC system while still being modeled as two separate SAAs to maintain their unique characteristics.
    - Like SAAs, HVAC systems should be condensed wherever possible. This means that smaller systems that serve support areas, such as small unconditioned spaces and those served by small unit heaters, do not need to be modeled in a separate HVAC system unless they significantly impact the total building energy performance.
- When creating an HVAC system, the modeler will be prompted to enter the conditioning type (heating and cooling, heating only, cooling only, ventilation only, or unconditioned), whether or not the system utilizes the project's DOAS (detailed below), system type, system heating source, cooling source, and zone heating source (for multi-zone systems).
    - Due to the limitations of the EST's simulation engine, SAAs with refrigeration (such as commercial kitchens and refrigerated retail areas) cannot be served by anything except a single zone air handler system. For guidance on how to model other systems serving these spaces, please contact CSBR.
    - In the Modify Details section for individual HVAC systems, there is an option to override the default fan static value. If this value is overridden, the modeling team should provide documentation in their submission showing how these values were calculated.
- Dedicated Outdoor Air Systems (DOAS) can be modeled in the EST by changing the DOAS option from Not Installed to Installed.

- In addition to individual HVAC systems, heating and cooling plants, such as chillers and boilers, can be defined in the HVAC tab. These can be selected as a heating and cooling source for systems.

Building Definition - General

- Exterior lighting zone type, exterior lighting areas, elevators, and snow melt slab area must be defined to match the building design. These parameters can be adjusted by selecting the Modify Details button in the Building Definition section of the Building tab.
- Detailed inputs for individual SAAs can be accessed by clicking the Edit button on an SAA, then selecting the Modify Details button.

Building Definition - Operations

- Occupancy schedules must be detailed for all SAAs. This includes occupied people density, weekly occupancy levels (full, partial, or none), hours of core use per full day and partial day, core use start time, daily fan hours, and fraction of use during partial days.
    - If a SAA has only transient occupancy (such as mechanical rooms, parking garages, or corridors), it should be set to Unoccupied using the Area Occupancy option.
    - The daily fan hours cannot be modeled lower than the daily occupancy hours, and lighting hours cannot be set independently of the occupancy hours. For projects where this causes significant issues in accurately representing a SAA's operation, please contact CSBR for guidance.
    - For areas with separate summer and winter operating hours (such as schools), a second schedule can be added to the model by selecting the Add 2nd Schedule button. The modeler should select the correct months for each schedule using the Applicable Months radio button options.

Building Definition - Mechanical

- Occupied and unoccupied cooling and heating setpoints should match the design temperature setpoint for each SAA.
- The total modeled building ventilation air quantity must match the total design air. Ventilation air is defined at the SAA level and can be defined by either specifying outdoor air and exhaust air rates or specifying ACH and outdoor air fractions.
    - If defining ventilation air using the outdoor air and exhaust air rates, ensure that those entries are resulting in the correct total air quantity by calculating the resulting air quantity using the entered rates, the occupant density, and the SAA's area.

- If defining ventilation air using ACH and outdoor air fractions, ensure that the SAA's floor-to-floor height is defined in the Architectural section of the SAA definition.
- Because ventilation air is defined at the SAA level, it is possible that multiple SAAs are served by a larger mechanical system (or are served by the building's DOAS) and do not have easily identifiable individual ventilation quantities. In these cases, divide the ventilation air from the HVAC system among the SAAs it serves using their proportional area.

Building Definition - Architectural

- For all SAAs, space geometry must be defined to match the building's design. This includes shape, orientation, shared walls, and floor to floor height.
- To edit the SAA's geometry, the Shape, Wall Characteristics, and Orientation option must be set to Override. If this option is not overridden, the space will be modeled as a square with full exterior walls on all sides.
- To adjust the length of the sides of the SAA, click and drag an edge to move it in or out. To add an edge to the shape, click on the Segment Wall button on click on an edge. Because edge lengths cannot be numerically defined in the EST, the modeler should attempt to match the relative edge lengths of the SAA to those found in the building design.
  - More complex geometries such as diagonals and rounded walls are not available for modeling in the EST. For SAAs that have complex shapes, teams should make a good faith effort to approximate that general shape and orientation of the area.
- Shared walls are considered any wall that is not exposed to the exterior, including below-grade walls and interior walls that are shared with other SAAs. To mark walls as shared, select the Summary button in the geometry editor. Walls can be defined as being completely shared by checking the Whole Wall Shared button or partially shared by defining a height and width that are shared in the Shared Wall Width. If a wall is not shared, leave the Whole Wall Shared box unchecked and the Shared Wall Width and Height entries blank.
- For SAAs that have varying floor-to-floor height, the average height of all the SAA's floors should be entered.

Building Definition - SHW & Other Loads

- All SAAs will have default values for equipment power density, process load density, and service water heating flow set by the selected SAT. If these values are adjusted from the default, the modeling team should provide documentation in their submission indicating how these values were calculated.

Measure Entries – General

- As stated in Section 3.2, all measures included in the as-designed model must be supported by documentation included in the project team's submission, such as construction documents or a project manual. Measures which are not clearly indicated in design documentation must not be included in the as-designed model.
- More information about each measure can be found by clicking the icon with three grey buttons to the right of the measure name and selecting Show Strategy Info. The information in this section should be used to determine if measures are appropriate for the SAA in question based on the building design.

Measure Entries - Mechanical

- The measure entry for heating and cooling efficiency will vary depending on the HVAC system type selected. For systems that require entries of heating/cooling improvement percentage, the improvement percentage should be calculated using the values shown in the Show Strategy Info section based on the size of the unit in question.
    - For systems that contain multiple units with different efficiencies, the EST entry should be a weighted average based on heating/cooling capacity.
- All HVAC systems defined in the EST must have a fan power measure in the Ratings tab with a measure entry that accurately reflects the design fan power ratio for each system (either in BHP/kCFM or W/CFM, as required by the EST). These fan power calculations must include all supply, return, and exhaust fans included in the system.
- If a water-source heating or cooling plant is included in the model, pump power must be defined for these systems in W/GPM.
- Energy recovery measures must have effectiveness values that match those shown on the construction documents. There are separate measures for sensible-only heat recovery and total (sensible and latent) heat recovery; modeling teams should ensure that the correct measure is chosen for systems with energy recovery.
- Ventilation and temperature control measures are applied to SAAs rather than whole HVAC systems; modeling teams should ensure that these measures are applied to the correct SAAs and correspond with the sequences of operation shown in the submitted design documentation.

Measure Entries - Architectural

- Window-to-wall ratios (WWRs) should be adjusted so that the simulated window area closely matches the actual design window area of the building. The preferred method for this is to first enter the calculated WWR values from the

design documents in the EST measure entries, download the as-designed building simulation file to get the simulated building window area and window-to-wall ratio, and adjust the WWR EST entries up or down accordingly.
    - Simulation files can be accessed by mousing over the EUI graph in the upper left of the Rating tab, clicking on the three grey buttons that appear, and selecting Save & Get Design Sim Files. Once the resulting zip file is downloaded, the building simulation results will be in the "Design" folder as "DOE2InputFile.sim."
    - The total project window area can be found in the final LV-D report of the simulation file, most easily accessed by searching for "LV-G" and scrolling up to the LV-D report immediately above the LV-G report) in the "Window Area" column of the "All Walls" row. This value should be compared to the actual design window area to determine a ratio between the two, which should be applied to all WWR EST entries. Once the changes have been made to the EST entries, the modeler should redownload the simulation files to ensure the window area closely matches the design area.
    - Note that changing the building geometry will change the modeled wall and window areas; any major adjustments to the architectural building definition will require the window area to be rechecked.
- Wall and roof insulation measures are defined in total assembly R-value. This value should be determined by using ASHRAE 90.1, Appendix A to calculate the assembly's U-value, then calculating the assembly R-value by taking the inverse of the U-value.
- Window performance is defined in the EST by the full glazing assembly U-factor, center of glass U-factor, solar heat gain coefficient, and visible transmittance values. These EST entries must match the glazing specifications for the window type installed in the respective SAA.

Measure Entries - Lighting

- Lighting power density (LPD) must be defined for each SAA individually. The use of a single LPD value to represent the total building LPD EST entry for all SAAs w is inadequate and will be considered non-compliant.
- The exterior lighting power entry is the total kW used to light the exterior lighting features that were defined in the Building tab (such as parking lots, driveways, plaza areas, and building entrances).
- Lighting control measures in the EST are defined by the area controlled in each SAA.
    - Occupancy sensor and vacancy sensor measures cannot be added to the same SAA; for SAAs that contain multiple sensor types, an effective control value that represents both types of sensors can be used as the EST entry.

- The total daylighting area available in a SAA is determined by that SAA's geometry definition. If the total design area controlled by daylight controls is higher than the maximum area allowed in a SAA, the maximum value should be entered for that measure.

Measure Entries - Other Measures

- Traction elevator horsepower and Energy Star appliance performance details are commonly not available at the CD stage. If a project does not have this information, the modeler will be allowed to use the EST default values for these measures provided that the design intent is clearly shown in the specifications.
- Some refrigeration measures may require specific product cut sheets to verify compliance with SB 2030 guidelines; if a project team is planning on selecting refrigeration measures, please contact CSBR for guidance.
- Photovoltaic (PV) generation should not be included in the EST. **PV system generation should be entered directly into the chart in SB 2030 Guideline Tracking Tool section E1.**

4.3 Alternative Software for As-Designed Energy Simulation Guidelines

While the EST is required for setting an EUI target, it is not required for representing as-designed conditions. Software currently allowed as an alternative to the EST for as-designed simulation include:

- eQUEST
- TRACE 700
- TRACE 3D Plus
- Hourly Analysis Program
- IES-VE
- WUFI Passive
- Any DOE2.1E or DOE2.2 based simulation software that meets the requirements of Section G2.2 in ASHRAE Standard 90.1 2016 or later may be considered.
    - Contact SB 2030 program staff ahead of time, at SB2030@b3mn.org, to confirm that a particular software is allowed.

Ensuring Consistency Between EST and Alternative Simulation Software

Key building features must match across the alternative software (as-designed) and EST (reference) simulations. This ensures that SB 2030 target reflects a 90% reduction for as-designed conditions. Key building features include:

- Square Footage by Space Type
    - The gross square footage in both simulations must match exactly.
- Equipment Power Density:
    - Ensure that equipment power densities (watts per square foot for plug loads and other equipment) are consistent between the EST Reference

Building and the alternative simulation software. Differences in equipment loads can lead to significant variations in energy use.

- Outdoor Air Ventilation Level:
    - Make sure that ventilation rates (in CFM) match in both the EST Reference Building and the alternative model.
- Light Schedules:
    - The lighting schedules in EST simulations are typically limited. To the extent possible, lighting schedules should be comparable. Another simple way to make the lighting schedules comparable is to normalize overall lighting energy use. This can be done by comparing EFLH between the two simulations.

Differences in simulation software features may lead to scenarios in which it is challenging to match all key building features. Differences in key building features that significantly impact performance must be clearly noted with supporting documentation and an explanation of how the difference is resolved.

5. Renewable Energy

Energy efficiency by itself is not typically sufficient for achieving SB 2030 targets. Renewable energy from on-site sources, off-site sources, and credits contributes to meeting SB 2030 performance targets. Off-site and credit options come with the added requirement of an on-site target.

5.1 On-Site Renewable Energy

On-site renewable energy systems, such as photovoltaic (PV) panels, are a highly effective method for improving as-designed performance. To claim on-site renewable energy toward SB 2030 performance targets, the following rules must be followed.

1. RECs associated with the generated renewable energy may not be sold or otherwise transferred. [2]
2. Third-party ownership of an on-site renewable energy system is permitted when both:
    a. The associated RECs are retired by the SB 2030 project, and
    b. A power purchase agreement is entered into with a period of at least 10 years for the full portion of the system capacity contributing to meeting the SB 2030 Standard.
3. The renewable energy generating source meets the definition of renewable energy found in Minnesota Statute.[3]

Documentation Needed for On-Site Solar

Submittals must include the following documents to validate solar energy performance:

- Estimates of Annual Solar Energy Production:
  Annual energy production should be estimated in kilowatt-hours. This may be based on a photovoltaic modeling program, such as PVsyst Helioscope. Outputs from approved energy simulation programs listed in 4.3 Alternative Software for As-Designed Energy Simulation Guidelines may also be used.
- System Capacity:
  Provide the size, including both the AC and DC kW ratings, along with the total number of photovoltaic panels to be installed for the Solar Photovoltaic System.

[2] If the installation of a renewable energy system has been used to obtain utility or other incentives by selling RECs, for example as part of a utility provided incentive program, the renewable energy system may also be permitted to contribute to meeting SB 2030, but only if the project procures the equivalent amount of RECs subject to the relevant procurement factor for the source of the replacement RECs. Consult the SB 2030 Project Team to verify requirements.

[3] Currently, this definition is found in Minnesota Statute 216b.1691 subdivision 1 and 1a, which is included at the end of this document as a reference.

In addition, submittals must show the placement of the solar panels and indicate whether they are roof-mounted or ground-mounted.

- Cost:
  Estimates from a solar contractor is required for any cost effectiveness analysis used in on-site target setting. For additional on-site target information, see 6. On-Site Target.
- Metering and Monitoring Plan:
  Indicate how metering of the Solar Energy System would be affected, including installation of meters recording the actual energy produced by the solar system. Describe in the metering narrative how the solar energy data will be integrated with the overall building energy tracking to confirm on-site solar energy generation data compared with energy consumption needs. For additional information on the metering and monitoring plan, see 7. Metering Requirements.

5.2 Off-Site Renewable Energy

The SB 2030 program allows off-site renewable energy to contribute to meeting energy and carbon reduction targets. Under Minnesota Statute 216B.1691 these off-site resources must come from eligible renewable sources such as solar, wind, small-scale hydro (under 100 MW), hydrogen from renewables, and biomass like landfill gas or anaerobic digestion. For off-site resources to be used to help meet the SB 2030 Standard allowances, an additional target for the building's on-site performance must be established and met. Similarly to the net performance SB 2030 target, the on-site target (OST) must be established through an EST model. Refer to 6. On-Site Target for guidelines and requirements.

For entities with the opportunity to leverage renewable energy development within a larger portfolio of projects that must be considered before moving to renewable energy development outside of the entities' portfolio. This is referenced as the "Rank in SB 2030 Hierarchy" in the table below and represents the order in which renewable energy options should be evaluated.

The following are qualifying off-site renewable energy procurement methods[4]:

1. Community renewables energy facilities
2. Renewable energy investment fund
3. Physical renewable energy power purchase agreement
4. Financial renewable energy power purchase agreement
5. Direct ownership
6. Green retail pricing

[4] Based on ICC 2024, CC103 with updates from the code development process, and using the definitions in IECC 2024 CC102.1.

7. Unbundled Renewable Energy Certificates (RECs) meeting the requirements of MN Statute 216B.1691

The following requirements apply to all *off-site renewable energy* procurement methods[5]:

1. The building owner must sign a legally binding contract or other approved agreement to procure qualifying off-site renewable energy.
2. The procurement contract must have a duration of not less than 10 years, or be of an amount that satisfies the full 10 years of required renewable energy/RECs, and must be structured to survive a partial or full transfer of ownership of the property.
3. REC and other environmental attributes associated with the procured off-site renewable energy must comply with the following requirements:
    a. The RECs must be retained or retired by or on behalf of the property owner of tenant for a period of not less than 10 years, or the equivalent of 10 years must be retained or retired within the amount of years they are purchased for (e.g. 10 years worth of RECs purchased for 1 year and retired after that year).
    b. The RECs must be purchased within 12-months of their creation (ie, production).
    c. The RECs must be from a generating asset constructed not more than 5 years before the issuance of the certificate of occupancy.[6]
4. The generating source must be a renewable energy system that meets the definition of renewable energy found in Minnesota Statute.[7]
5. Records on power sent to or purchased by the building must be retained by the building owner and made available for inspection by the SB 2030 program administrators upon request.

5.3 Procurement Factor for 90% Reduction Target

In effect for projects starting schematic design on or after January 1, 2025 renewable energy performance impacts will be adjusted based on procurement factors for off-site renewable energy used. Factors range from 1.0 (no adjustment) to 0.2 for unbundled RECs (i.e. requiring five times as much for an equivalent impact on the projects performance). The procurement factors are based on the provisions and default procurement factors in sections CC103.1, 103.2, and 103.3 of the 2024 International Energy Conservation Code Appendix CC Zero Energy Commercial Building Provisions.

[5] Based on ICC 2024, CC103 with updates from the code development process and minor modifications to align with the 10-year
timeline of SB 2030.

[6] If approved by the SB 2030 Review Team, existing systems developed with the intent to cover future SB 2030 project energy use may qualify if constructed outside the time period listed.

[7] Currently, this definition is found in Minnesota Statute 216b.1691 subdivision 1 and 1a, which is included at the end of this document as a reference.

Some changes have been made from the default values and updated. These changes are footnoted below.

The process for calculating the adjusted off-site renewable energy is shown in the Equation below.[8]

$$RE_{off-site} = RE_{NonRecs} + 0.2 * RE_{Recs}$$

where:

- RE_{off-si} = Adjusted renewable energy
- $RE_{NonRecs}$= Annual energy production for the renewable energy procurement method other than RECs
- RE_{Recs}= Annual energy production associated with unbundled RECs

Renewable energy procurement factors[9]:

RANK IN SB 2030 HIERARCHY	PROCUREMENT OPTIONS	PROCUREMENT FACTOR
1	On-site or on-campus system	1
2	In-portfolio system	
3	Community renewables energy facility	
	Renewable energy investment fund (REIF)	
	Physical renewable energy power purchase agreement	
	Financial renewable energy power purchase agreement	
	Green retail pricing	
	Unbundled RECs	0.2
	Other: Consult the SB 2030 Program Administrators for procurement options not listed here.	TBD

[8] Based on ICC 2024 CC103.3.3.

[9] Based on ICC 2024, table CC103.3.3 and using the definitions in IECC CC102.1. Note that while the IECC applies a procurement factor of 0.75 to off-site renewable resources if the project does not first implement on-site solar (or show adequate constraints to the implementation of on-site solar), the SB 2030 program requires projects to implement cost-effective on-site measures (including renewable energy) before bringing in off-site measures.

6. On-Site Target

An on-site target (OST) represents the achievable energy use intensity (EUI) through the implementation of energy efficiency measures and on-site renewable energy systems, with payback periods that are considered cost-effective under the SB 2030 program requirements. The OST establishes an energy performance goal within the building site boundary. Cost-effectiveness is a key qualifying factor in the OST, with simple payback calculated for each energy conservation measure (ECM). If a project is unable to meet the SB 2030 target with energy efficiency measures and on-site renewable energy alone, then off-site renewable energy options, such as renewable energy credits (RECs), may be used to make up the difference between the OST and the SB 2030 target. This ensures compliance with SB 2030 while prioritizing on-site solutions first.

Steps for On-Site Target Setting and Cost-Effectiveness

OST discussions should begin in the early design phase, allowing ECM strategies to be incorporated from the outset. Early consideration of RECs and ECMs provides flexibility for design and budget adjustments, facilitating alignment with SB 2030's energy and cost-effectiveness requirements. Revisiting on-site target discussions during the CD phase supports alignment with the final project design, ensuring ECMs are both feasible and financially viable. The following steps should be taken.

1. **Initial ECM Identification and Energy Assessment**:
    a. Early in the design phase, the project team conducts an initial assessment to identify ECMs and system type selections for improving building energy performance.
    b. If this initial assessment indicates that the building's on-site EUI will be more than 5% above the SB 2030 target, the on-site target setting process is likely required and the review team should be notified at SB2030@b3mn.org.
2. **As-Designed Simulation Development and Cost-Effectiveness Analysis**:
    a. The project team develops an as-designed model incorporating items identified during the on-site target discussion in step 1. Ideally, this is initially submitted during the design phase. Modeling requirements are described in 4. Simulation Requirements.
        i. If the as-designed simulation confirms that the building's on-site EUI is more than 5% above the SB 2030 target, the on-site target setting process is required.
    b. Where OST setting is required, the project team creates an On-Site Target model.
        i. This model must be nearly identical to the as-designed model except where different energy efficiency strategies are applied. If the EST is used for the as-designed simulation it can be cloned to quickly generate the OST model.

ii. The OST model must include all ECMs that meet a predefined cost-effectiveness threshold based on their payback period. Projects with an 80% reduction target have a 12-year payback threshold. Projects with a 90% reduction target have measure-specific thresholds:

Measure Categories	80% Reduction	90% Reduction
Lighting (Fixtures & Controls) Water Heaters Low Flow Showerheads Thermostats	12 years	9 years
HVAC Equipment (except boilers and chillers) HVAC Controls (except thermostats) Appliances	12 years	14 years
Boilers and Chillers	12 years	17 years
Renewable Energy (Solar Photovoltaic and Wind)	12 years	20 years
Building Envelope	12 years	24 years

iii. The OST model EUI defines the maximum allowable on-site EUI for the project, also known as the on-site target. The as-designed simulation EUI must be equal to or less than the on-site target. RECs can then be applied to make the net EUI meet the SB 2030 target.

iv. The OST model must be compliant with the Minnesota Energy Code applicable to the construction schedule.

3. **Refinement and Finalization in the CD Phase**: During the Construction Document (CD) phase, the project team refines ECM strategies based on updated design details, ensuring that chosen measures remain feasible, cost-effective, and in compliance with SB 2030 goals. This step provides an opportunity to make final adjustments to the ECM selection in line with the project's evolving needs and budget.
4. **Comprehensive Evaluation and Documentation**: The team prepares a final report documenting ECMs, on-site renewables, off-site renewables, REC purchases, and the projected cost savings associated with each measure. This documentation confirms compliance with SB 2030 on-site target and cost-effectiveness standards, serving as a key element in demonstrating the project's commitment to sustainable energy practices.

Cost-Effective Strategies and Energy Conservation Measures (ECMs)

Cost-effective ECMs are central to the on-site target setting process, supporting SB 2030 energy goals while maintaining project budget alignment. The following measures are commonly implemented to achieve these goals. Note that this is not a comprehensive list of potential cost-effective measures.

- **High-Performance Windows:** Windows with a U-value of 0.27 or lower significantly reduce thermal transfer, decreasing heating and cooling loads in dwelling units.
- **Optimized HVAC Systems:** Efficient HVAC systems, including demand-controlled ventilation, are essential for reducing unnecessary energy use and maintaining indoor air quality.
- **Energy Recovery Ventilation (ERV):** ERV systems capture heat from exhaust air to precondition incoming air, reducing HVAC loads and improving overall energy performance.
- **Reduced Variable Refrigerant Flow (VRF) Systems:** Right-sizing VRF systems minimizes energy consumption by only conditioning spaces as needed, optimizing localized heating and cooling.
- **Efficient Lighting Systems:** LED lighting combined with occupancy sensors ensures energy savings by illuminating spaces only as needed.
- **Demand-Controlled Ventilation:** Real-time ventilation adjustments based on occupancy help maintain air quality while reducing energy use.
- **Optimized Building Envelope:** Enhancing air-tightness, applying shading, and using high-performance materials improve thermal control, lowering heating and cooling demands.

90% Reduction Target

For projects starting schematic design on or after January 1, 2025, SB 2030 requirements for on-site target setting will be expanded due to changing cost-effectiveness requirements. Key changes and associated impacts are:

- New measure specific payback thresholds (specified in item 2.b.ii of this section)
    - Renewable energy has a 20-year threshold, a 66% increase from the previous 12-year threshold. Solar photovoltaic cells are more likely to be required.
        - Note: Where it is not possible to fully meet the SB 2030 Standard using on-site renewables, system size should be maximized within the renewable cost-effective payback threshold.

    - Building envelope measures have a 24-year threshold. High efficiency windows and enclosure measures are more likely to be required.
- Full utility bill impact included in cost effectiveness calculations
    - High efficiency centralized equipment is more likely to be required in buildings that traditionally contain a large number of gas meters, each with their own fixed monthly service charges. This is common in multifamily buildings where each residential unit can have its own gas meter.
- First cost estimates include available incentives
    - Federal incentives must be factored into payback calculations. Solar and geothermal system are more likely to be required as a result.
    - Utility specific incentives that are part of a 3-year utility program do not need to be considered.

7. Metering Requirements

FD phase submissions must include a metering narrative that defines how the building's actual energy performance will be calculated. This requirement goes beyond what is included in a typical metering plan. The narrative must include:

- A list of all meters that will be used as a basis for verifying monthly energy performance.
- A clear definition of any calculations that are needed to translate metered data into values that can be directly compared to the building's SB 2030 Energy Standard.
- Projects over 10,000 square feet must include sub-metering for plug loads.
- Projects pursuing compliance with the full B3 Guidelines should reference guideline E.1C for sub-metering requirements above what is required under SB 2030.
- Energy loads that are excluded from SB 2030 performance measurement (e.g., large process loads, EV charging) must be sub-metered.
- Sub-metering does not have to directly measure energy use (e.g., district chilled water energy can be calculated based off the vale position).
- Detailed metering guidelines can be found on the Tracking Tool page E1D or through this link, http://www.b3mn.org/2030energystandard/download/SB2030_MeteringRequirements_v3.pdf .

- Example metering narrative and plan:

Dear CSBR review team,

The entire [redacted] project is required to meet the SB2030 standard per the Saint Paul, MN sustainability requirements (overlay requirement 1). The project is a low-income housing project and will include individual tenant electric meters, a central house electric meter, a commercial tenant meter, individual tenant gas submeters and a central house gas meter.

A list of meters, their labels, and units of measure

	Meter	Type	Label	Units	Read by	Conversion
01.	Natural gas	Utility	Gas	Therm	Utility	Therm x 100 = kBtu
02.	Domestic water	Utility	Water	Gallons	Utility	
03.	Electricity main – House Service	Utility	House Service	kWh	Utility	kWh x 3.412 = kBtu
04.	Electricity tenant meters – (128) Apartments	Sub-meter	Apartment Service	kWh	LS Black	kWh x 3.412 = kBtu
05.	Electricity main – Commercial Tenant Service	Utility	Commercial Tenant	kWh	Utility	kWh x 3.412 = kBtu
06.	Natural gas – (128) Apartments	Utility	Apartment sub-meter	Therm	Utility	Therm x 100 = kBtu
07.	Electricity – (9) Building End Uses	Sub-meter	Building End Uses	kWh	LS Black	kWh x 3.412 = kBtu
08.	Natural gas – Commercial Tenant	Sub-meter	Commercial Tenant	Therm	LS Black	Therm x 100 = kBtu
09.	Natural gas – (4) Building End Uses	Sub-meter	Building End Uses	Therm	LS Black	Therm x 100 = kBtu

Formulas to determine total building energy use for comparison to the SB2030 target.

Natural Gas Usage:

$$SB\ 2030\ Gas\ Use_{kBtu} = Utility\ Gas\ Meter\ 01_{therm} * 100\ \frac{kBtu}{therm}$$

Electric Usage:

Electric energy usage for the building will be provided in an aggregate form the Xcel Energy Benchmarking Portal.

$$SB\ 2030\ Electric\ Use_{kBtu} = (Utility\ Electric\ Meter\ 03_{kWh} + Utility\ Electric\ Meter\ 05_{kWh} + Utility\ Electric\ Meter\ 06_{kWh}) * 3.412\frac{kBtu}{kWh}$$

8. Additional Resources

- B3 Sustainable Building 2030 Energy Standards homepage: https://www.b3mn.org/2030energystandard/
- SB 2030 in 2025 Program Update: https://www.b3mn.org/wp-content/uploads/SB-2030-2025-Program-Updates-20241022.pdf

Appendix A. Sample Simulation Input and/or Output File(s).

This appendix lists the minimum set of simulation input and output reports that are expected for a number of the building energy simulation software options that are allowed for SB 2030 program compliance. Submittal of electronic text, INP, SIM, or PDF version of key simulation input and/or output files and other documentation as listed below satisfy the requirements of Section G1.3(l) in ASHRAE Standard 90.1 (2016 or later) as needed to confirm the validity of as-designed performance and SB 2030 target reported in guideline E1 of the Minnesota Sustainable Building Guidelines' online tracking tool.

A1. *DOE2 Based Software (eQUEST, DOE2.1E, etc.).* Although submitting the simulation input files (.INP and .PD2 when available) and output file (.SIM) is the simplest option for providing adequate documentation, the output reports listed below are adequate documentation for DOE2 based software simulations (and these may simply be included as part of a larger output file that includes additional reports). Note that the full .INP file may be substituted for the output reports noted with an asterisks.* The Parm files are also desired as optional additional documentation when available.

A) Space type indicator for each zone in model per 2.5.1.3.B (not an output report)
B) BEPS—Building Energy Performance
C) BEPU—Building Utility Performance
D) ES-D—Energy Cost Summary
E) ES-E—Summary of Utility Rate (for all utility rates)
F) LS-C—Building Peak Load Components
G) LS-D—Building Monthly Load Summary
H) LV-A—General Project Parameters*
I) LV-B—Summary of Spaces
J) LV-C—Details of Spaces (for all spaces)*
K) LV-D—Details of Exterior Surfaces (for all surfaces)*
L) LV-G—Details of Schedules*
M) PS-A—Plant Energy Utilization
N) PS-B—Utility and Fuel Use Summary
O) PS-C—Equipment Loads and Energy Use
P) PS-E—Energy Use Summary (for all meters)
Q) PV-A—Plant Design Parameters
R) SS-A—Systems Loads Summary (for all systems)
S) SS-C—System Load Hours (for all systems)
T) SS-D—Building HVAC Load Summary
U) SS-E— Monthly Plant Load Hours
V) SV-A—System Design Parameters (for all systems)

A2. *TRACE 700 Software*. The reports listed below are adequate documentation for TRACE 700 based software simulations (and these may simply be included as part of larger files that include additional reports).

A) The following ENTERED VALUES and SYSTEM CHECKSUMS reports:
   a. Walls by Direction
   b. Room by Room
   c. Room Assignments
   d. System Entered Values

B) The following Library Members (except sections where no members used):
   a. Floor – Construction Types
   b. Roof – Construction Types
   c. Wall – Construction Types
   d. Glass Types
   e. Adjacent Building – Shading
   f. Overhead – Shading
   g. Schedules
   h. Lights
   i. Misc. Loads
   j. People
   k. Ventilation
   l. Heating Equipment
   m. Cooling Equipment
   n. Misc. Equipment
   o. Fans
   p. Heat Recovery

C) The following VIEW RESULTS reports:
   a. Energy Consumption Summary
   b. Energy Cost Budget / PRM Summary
   c. Monthly Energy Consumption
   d. Building Temperature Profiles
   e. Room Checksums
   f. System Checksums
   g. Engineering Checksums
   h. System Summary
   i. Building U-Factors
   j. Equipment Energy Consumption

A3. *Hourly Analysis Program (HAP) Software.* Submitting the simulation file is the simplest option for providing adequate documentation. Alternatively, the reports listed below are adequate documentation for Hourly Analysis Program based software simulations (and these may simply be included as part of larger files that include additional reports).

A) The following Input Reports:
    a. Spaces
    b. Systems
    c. Plants
    d. Buildings
    e. Project Libraries: Schedules, Walls, Roofs, Windows, Doors, Chillers (if any), Cooling Towers (if any), and Boilers (if any)
B) Air System Simulation Report including:
    a. Unmet Load Report
    b. Zone Temperature Report
C) Plant Simulation Report including:
    a. Unmet Load Report
D) Building Simulation Report including:
    a. Energy Budget by System Component
    b. Energy Budget by Energy Source
    c. Monthly Energy Use by Component
E) System Design Reports including:
    a. System Sizing Summary
    b. Ventilation Sizing Summary
F) Plant Design Reports including:
    a. Cooling Sizing Summary
    b. Heating Sizing Summary

A4. *IES-VE Software*. The reports listed below are generally considered adequate documentation for IES-VE based software simulations (and these may simply be included as part of larger files that include additional reports). However, providing the project's archive file will tend to speed up the review process and reduce the need for reviewer questions.

A) A model report from ModelIT application showing at least the following:
    a. Thermal Template Data
    b. Constructions
    c. Surface Areas
    d. Floor areas
    e. Orientation
    f. Profiles
    g. Internal Gains
B) The following reports generated through the PRM Navigator:
    a. Complete BRM Reports showing energy end usage by space types and total equipment energy use
    b. BEPS
    c. BUP
    d. Unmet Load Hours

e. All other detailed simulation reports generated through the PRM Navigator

C) Apache Database: showing profile (schedule) input data [open in NotePad and SaveAs .txt].

D) HVAC Load and Sizing Reports: Provides information on fan power, ventilation, and HVAC schedules.

E) The following exports (to Excel) from VistaPro:
   a. Hourly lighting gain, people gain, miscellaneous gain, and HVAC airflow
   b. Space Data: Internal gains and schedules used for
   c. Peak individual energy consumption for each fan, pump, chiller, boiler, etc.
   d. Hourly energy consumption for each fan, pump, chiller, boiler, etc.

F) Images of the 3D model using ModelViewer2 and Apache to graphically show:
   a. Zoning room data (areas, etc.)
   b. The assignment of constructions
   c. Shading devices and/or adjacent obstructions (e.g., buildings)

G) Screenshots:
   a. IES ApacheHVAC systems I/Ps – Fan, cooling coil, zoning, HVAC system diagram
   b. Assign Constructions I/Ps – Provides detailed information on thermal envelope
   c. Project Compact Profile – Provides types of schedules used in the simulation
   d. Heating and Cooling Plant Screenshots – Provides COP, SEER, power and capacity

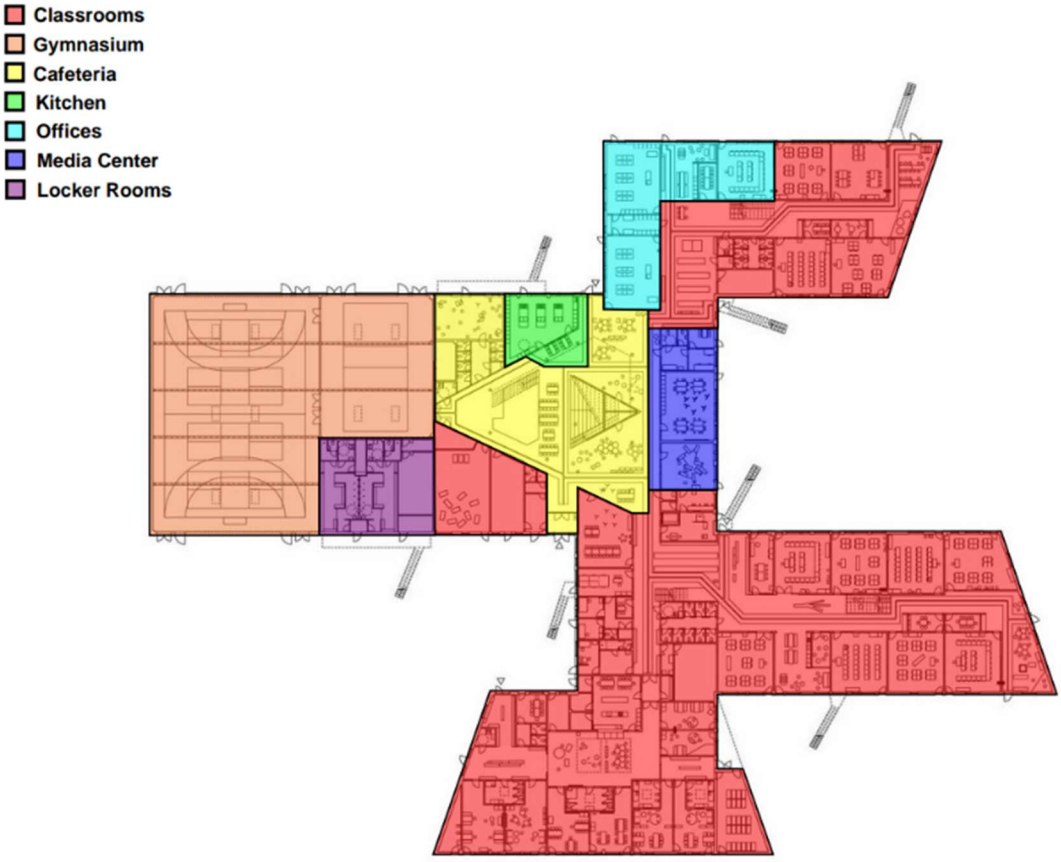
A5. *WUFI Passive Software.* For WUFI Passive based software simulations, the following reports are sufficient documentation (these may be included as part of larger files that include additional reports). Providing the project archive file will speed up the review process and reduce the number of questions from reviewers.

A) Report: data & results (All Reports)
   a. Total Square Footage
   b. Building/Space Type
   c. Energy Use by Fuel
   d. Maximum Occupancy
   e. Ventilation Capacity
   f. Envelope Thermal Performance (Walls, Roofs, Foundation, and Windows)
   g. Building Orientation
   h. Window to Wall Ratio

i. Fan Power
j. Central heating and cooling plant information
k. Pump Power

B) Screenshots:
a. Zoning
b. Lighting power density
c. Plug load density

Appendix B. Example Zoner Diagram



Appendix C. Situation Specific Simulation Guidance

Default assumptions in the EST can lead to situations in which it's challenging to reflect actual design. This appendix lists challenges that can arise, and strategies for addressing them.

Space

- Situation: Occupancy schedules define equipment operation for given defined space. This can lead to high operation hours of equipment that may operate intermittently (e.g., commercial kitchen equipment in a cafeteria).
    - Resolution: Break out spaces with high energy use density for others and apply schedules that reflect the intermittent use of equipment in those spaces.
    - Note: Areas with similar energy use densities and operation schedules can be merged in simulations. This reduces the complexity of the model and avoids redundant efforts.

Envelope

- Situation: The combination space geometry and window to wall ratio (WWR) simulation settings can lead to incorrect window and wall area results.
    - Resolution: After defining the geometry of a space, the WWR should be set to get correct window area results. Wall area is a secondary concern.
        - The total simulated wall and window areas can be found in the simulation files in the LV-D reports. In the EST, window-to-wall ratios can be adjusted by adding a measure to each space in the Architectural section of the Ratings tab.
    - Evaluation Standard: Simulated window area should be within 5% of CDs, simulated wall area should be within 20% of CDs, and WWR is not directly compared to CDs.

Lighting

- Situation: EST lighting schedules are limited to a lower level of detail than some alternative simulation software. Schedules typically cannot be directly compared due to the difference in detail.
    - Resolution: Comparing the calculated EFLH of both simulations validates alignment in the modeling. This can be done by dividing Lighting kWh (from End Use Breakout) by the LPD w/sq. ft.
    - Additional Complication: Lighting control strategies in the EST reduce lighting wattage outputs (as opposed to EFLH). Alternative simulation software that reduce EFLH for the same strategies are not directly comparable.
        - Solution: The as-design (alternative simulation) vs. target (EST) ratios for lighting kWh usage, LPD * EFLH should be consistent. As an equation, the requirement is:

- $\frac{kWh_{as-designe}}{kWh_{EST}} = \frac{LPD_{asdesigned}}{LPD_{EST}} * \frac{EFLH_{asdesigned}}{EFLH_{EST}}$
    - Evaluation Standard: The as-designed EFLH, or kWh vs. LPD*EFLH ratio, must be no more than 25% below target EFLH.
- Situation: EST High End Trim and Manual Dimming ECMs do not pair well with occupancy sensor ECMs.
    - Resolution: Represent dimming with reductions to LPD. For example, a reduction to the fixture count that features dimming would be acceptable.

<u>Ventilation</u>

- Situation: Ventilation and lighting operational hours are defined together by occupancy schedules for a given space. Differences in ventilation and lighting operation can't be represented (e.g., 24/7 lighting operation in a garage results in 24/7 fan operation).
    - Resolution: Use the Reduced Fan Power measure to get the fan power per cfm set to match the design.
        - Note: If modeled total supply cfm is higher than outdoor air ventilation cfm, then outside air ventilation bhp/cfm or Watts/cfm should be scaled down by the ratio of the outdoor air ventilation airflow to the simulated supply air flow. The simulated supply fan airflow can be found by looking at the .SIM file and adding the supply flow from the individual HVAC unit SV-A reports for all the HVAC systems serving the garage. Unit heater fan power can be ignored due to their relatively low power and runtime.
    - Alternate Simulation Resolution: In the baseline model, scale down overall ventilation rate to represent assumed average ventilation. If carbon monoxide sensors reduce run time to 6 hours/day, then apply a 25% (6/24) factor to ventilation cfm.
- Situation: Air sealing, as an ECM, is not easily specified in construction documents.
    - Resolution: Acceptable documentation for the assumed infiltration reduction include:
        - CD specified blower door test target
        - List of previous projects performed, and results achieved, by the same air-sealing contractor

<u>Exceptional Calculations Required</u>

- The EST is not able to model the following scenarios. Exceptional calculations are needed.
    - Free cooling (winter)
    - Winter humidity loads
    - Snow melt with electric heating

<u>Metering Plan</u>

- Situation: Multifamily and other buildings with a large number of energy meters have difficulty obtaining approval for tracking tenant utility data.
    - Resolution: Any available utility tools for aggregating anonymized data (e.g., Xcel Energy's Whole Building Tool) must be used. Any additional energy consumption not recorded in aggregated tenant meters must be recorded separately, so that the building's entire energy consumption is captured.