Appendix 6
Energy And Water Conservation: Building Energy Modeling

Building energy modeling, (BEM) also known as building performance simulation, refers to systematic procedures for estimating the results of operating and maintaining a building for its intended use in the environment at its location. Fundamentally, the object of BEM is to measure inputs necessary to maintain a desired interior environment in a building given the use and location of the building and the siting, design, equipment and construction methods employed in its construction. The U.S. Department of Energy (DOE) and the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) are primary sources of modeling standards and methods.

Any BEM software acceptable for use in modeling building performance in a mortgage application must be industry recognized and must comply with industry standards, notably ASHRAE 90.1 Appendix G, for any building where ASHRAE 90.1 is applicable, or for single family, townhouse or small structures with no common space, the RESNET Home Energy Rating System (HERS). For modeling purposes, the guidance for modeling in these referenced standards must be from the most recent available version. For example, the current most recent version of ASHRAE 90.1 Appendix G is part of the ASHRAE 90.1 2016 version and it is this version that must be used for modeling even though the HUD minimum code is ASHRAE 90.1 2007.

Building energy modeling is used for two main purposes:

1. Comparing a building to an alternative version of itself.

This is the purpose of BEM when perfecting a proposed building design or comparing the costs and benefits of alternative designs, equipment and construction methods. The object is to answer the question: how much more (or less) efficient is a building built per design “A” versus design “B”. BEM is essential to the use of performance-based codes and standards as opposed to prescriptive codes. Prescriptive codes set minimum performance, quality or construction methods for each component or assembly in a building and each requirement must be met. Performance based codes allow the design to exceed minimum prescriptions for some components or assemblies to compensate for less than the prescribed performance of other components, a much more flexible approach to design and construction. Many green building certifications have both performance-based and prescriptive options. Choosing a performance option requires the use of building energy modeling.

2. Estimating expected results for a building in operation or after it is placed in service.

This is the purpose of BEM when estimating the energy usage and costs for a building when it is occupied and operating normally.

While closely related, these two purposes embody a key distinction relevant to multifamily practice. Estimating actual results for a property requires modeling no matter whether the design conforms to a performance or a prescriptive code. When comparing a building to an alternative version of itself, the comparison is valid as long as all the loads, environmental conditions, and anticipated uses, are held constant (e.g. assumed interior hi/lo temperatures are fixed) with only alternatives for design, construction and equipment changing from one modeled result to another. When estimating expected results for an existing or designed building, all inputs are fixed and must be consistent with actual conditions for the property in operation. Examples illustrate this distinction. Set temperatures for heating and cooling seasons are inputs to a modeled result. When comparing a building to an alternative of itself, these temperatures are set in accordance with modeling standards or guidance, e.g. ASHRAE 90.1 Appendix G. When estimating results for a building in operation or to be placed in operation, these set temperatures may be different from Appendix G, reflecting actual tenant behavior. When estimating energy use in an existing property or a designed building the heating season set temperature should not be lower than 70° F versus the Appendix G minimum of 68°F. Similarly, the cooling season set temperature should not be higher than 75°F, not the Appendix G maximum of 78°F. In this example, Appendix G merely describes an acceptable range for comparative modeling purposes, not a range most likely in an occupied multifamily unit. Another, similar example is the different loads applicable to a family with children versus those likely for an elderly couple. Modeling to estimate actual results in a multifamily property must reflect the expected tenant profile and tenant behavior for the subject property.

BEM software is divided into two basic categories: simulation engines; and data entry and consolidation forms. The Department of Energy has developed and provided free and foundational simulation engines used by others to develop or elaborate copyrighted add-ons or overlays including user friendly data entry user interface and reports generating features. DOE's simulation engines are known as EnergyPlus and Spawn-of-EnergyPlus. DOE has also published OpenStudio, an open source software development kit for energy modeling with EnergyPlus. Information on these software products, resources for modelers and stakeholders and many other aspects of building energy modeling is available at DOE's website for emerging technologies-building energy modeling website:

https://www.energy.gov/eere/buildings/building-energy-modeling

A complete and searchable inventory of energy modeling software is available at the Building Energy Software Tools website:

https://www.buildingenergysoftwaretools.com/

Modelers working with green MIP applications should use a software product listed on this website selecting one of these products specifically identified as appropriate for "multifamily" properties. If the proposed green MIP project is composed of single family, duplex, four family or other small buildings with no common spaces a software listed as appropriate for "residential" may be appropriate.

Some listed software are narrow in scope, for example, limited to Manual J air conditioning load and sizing calculations or to water consumption metrics. These may be useful for their limited purposes, in particular water analytics, apart from water heating energy, may be severable from energy efficiency.