General Approach: Multiple Building Modeling

Sometimes projects may include several buildings that are individually metered for some or all fuels, or have a common set of utility bills. Each building may have a single whole-building set of bills for each fuel or may include multiple sets of bills (i.e. electricity consumption in apartments is metered separately from the common space). This document provides guidelines for aggregating model results and utility bills for the purpose of model calibration.

1. When a **single building** has multiple sets of bills for a given fuel — for example, if electricity consumption in apartments is directly metered, or if there is a separate set of electric bills for the common space — all individual sets must be combined so that there is one set of bills representing the total whole building consumption of each fuel.

   (Comparing the individual sets of bills to the modeled consumption of corresponding spaces — for example, comparing electricity usage of common spaces predicted by the model to the billing data for common spaces — may provide valuable additional insight into building operation, but it is not required.)

2. When a project includes **multiple buildings**, the model calibration approach depends on the metering configurations and whether the buildings have similar envelope and mechanical systems.

   Buildings are considered to have *similar envelopes* if ***all*** of the following conditions are met:
   - Building geometries are similar
   - Total conditioned building area differs by no more than 20%
   - Percentage of area taken by common spaces differs by no more than 20 percentage points.
   - Spaces in buildings are of a similar occupancy type
   - Areas of surfaces of each type (exterior and below grade walls, windows, roof, slab) differ by no more than 20%
   - Thermal properties of envelope components are similar
   - Infiltration rates are similar.

   Example: There are two 60,000 SF, 6-story buildings in the project. One building has 12,000 SF of corridors and common spaces (20% of total building area). The other building has the same corridor area, plus a community room, rental office and laundry on

the first floor, with the total area of common spaces equal to 20,000 SF (33% of total building area). The percentage of common spaces in each of these buildings differ by 13 percentage points (33%-20%), and the buildings have spaces of different occupancy types; therefore, they may not be considered as having similar geometry.

Buildings are considered to have *similar mechanical systems* if ***all*** of the following conditions are met:

- HVAC or domestic hot water equipment in buildings is of similar type
- Overall plant efficiency varies by no more than 5 percentage points.
- Mechanical ventilation rates are similar.

Buildings are considered to have similar usage if the annual fuel usage per square foot of conditioned floor area differs by no more than 10%.

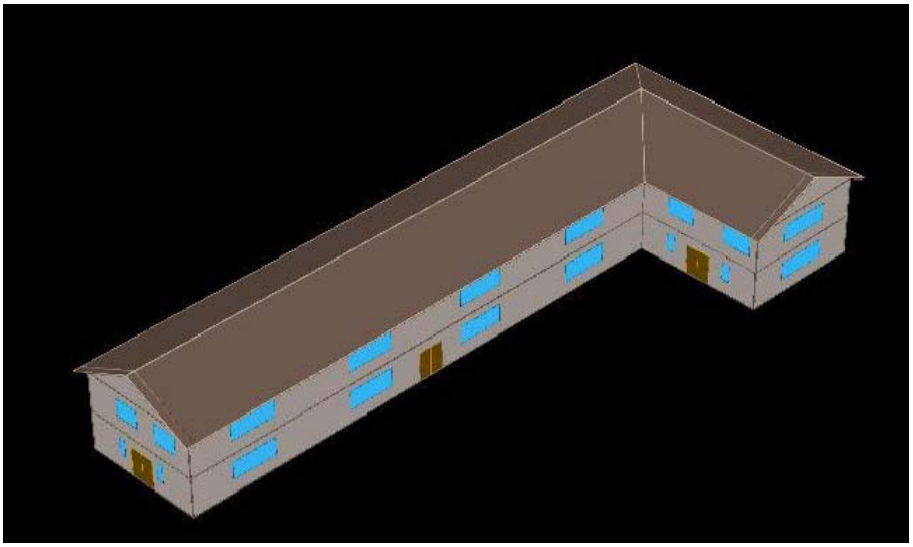
The summary table below shows modeling approaches for multiple building projects depending on the similarity of envelope and mechanical systems:

	Similarity of Buildings and Systems	Type and Similarity of Heating Bills	Modeling Approach
Case A	Non-similar envelope or mechanical	Billing for heating fuel is either per apartment or per building.	Buildings must be explicitly modeled and individually calibrated to the corresponding set of utility bills.
Case B	Similar envelope and mechanical	Billing for heating fuel is either per apartment or per building; usage is similar between buildings.	Create single model representing *one* building; calibrate to area-weighted average annual usage.
Case C	Similar envelope and mechanical	The meter or billing data for heating fuel applies to multiple buildings.	Create single model representing *all* buildings that are served by a single heating-fuel meter; calibrate to the total annual usage shown for all fuels used at those buildings.
Case D	Non-similar mechanical systems	The meter or billing data for heating fuel applies to multiple buildings.	If simulation tool supports explicit modeling of non-identical HVAC systems in a single model file, the same approach as for Case C may be used. For tools that do not have this capability (such as TREAT), separate models must be created representing each building, and the total heating usage of these models must be calibrated to utility bills.

Example: Country Apartments complex consists of 25 two story buildings with 327 apartments, including 190 one bedroom, 72 two bedroom deluxe, 56 two bedroom junior, and 8 three bedroom apartments. The gross floor area of the apartment complex is approximately 200,000 SF.

Using the guidelines previously described, it was determined that the buildings within the complex have both similar envelope *and* mechanical systems. Additionally, each building has its own boiler plant. Therefore, as Case B requires, a typical building was modeled and a multiplier

added to represent the total square footage of the complex. A screenshot of the typical buildings is shown below.



The total utility consumption of the complex was then calibrated against this model. ECMs were then be modeled like any other project. Because a multiplier was used within eQUEST, the savings results were extrapolated to the entire complex.

NOTE: It is important to remember that all buildings in a project must be 'similar' as defined in the preceding section. For example, if one building is served by a new boiler while the other is service by an original boiler to be replaced in the retrofit, the buildings are not similar and each must be explicitly modeled. Similarly, some but not all buildings may need insulation added in attics. So both the existing condition and scope of work (ECMs) for different buildings should be similar. In other words, buildings should be scaled up or down versions of each other. Another important consideration is utility bills. For example, if one building has significantly different heating kBtu/SF than another building, it means that even though the two may appear 'similar', they are actually not. Reason for discrepancy should be investigated – for example, is it due to the fact that some apartments were vacant in one building? In this case we could still consider them similar and assume some average occupancy rates in the model. Or it could be something like high distribution losses from buried pipes in one building and not the other, in which case the scope of measures will likely be different between the two, which would make them not similar.