Building Simulation User Manual

This short user guide explains the physical and numerical foundations of the BATEM building model, documents the relevant portions of the `batem.core.building` API, and walks through a sample script step by step so you can adapt it to your own projects.

Minimum fields to run a simulation: see **Building_Data_Required.md** (`ContextData` + `BuildingData` , compositions, roof/attic, checklist).

CAUTION: at first run, the running time is important because the historical weather data related to the building location defined by its latitude and longitude is downloaded from open-weather.com from 1980 till present. Don't interrupt the loading process.

You can get freely "batem": an open-source energy management toolbox in Python dedicated to building for teaching purpose: (the full sources) https://www.gricad-gitlab.univ-grenoble-alpes.fr/batem/batem_all or (the tutorials) https://www.gricad-

1. Underlying Model Architecture

The BATEM stack couples several modelling layers to simulate a multi-zone building with HVAC controls:

- **Context & Weather** – `ContextData` describes geographic location, simulation horizon, horizon masks, side masks and environment (albedo, pollution, ground temperature). This drives weather data retrieval, sun-path calculations, and solar mask generation.
- **Envelope & Topology** – `BuildingData` defines floor geometry, envelope compositions, glazing properties, HVAC capacities, set points, and possibly, a user strategy done during cooling period: if `super_air_renewal_rate_vol_per_hour` is not None, when the outdoor temperature is lower that the indoor one, the air flow is renewed at ``super_air_renewal_rate_vol_per_hour `(but the simulation time is significantly increased because the model becomes nonlinear, it is recommended to` super_air_renewal_rate_vol_per_hour`` to None at first

2. `batem.core.building` API Cheat Sheet

2.1 Data Containers

- `SideMaskData`
  - Describes distant shading obstacles in **site plan coordinates** (`x_center` , `y_center` , metres) with size, `elevation` (metres), `exposure_deg` , `slope_deg` , and optional `normal_angle_with_south_deg` .
  - Used in `ContextData.side_masks` : each entry becomes a global mask on `SolarModel` (same geometry as `SideMask` in `batem.core.solar`). These masks are **independent** of building façade indices: they do **not** inherit `BuildingData.sides_exposure_deg[i]` . Set `exposure_deg` (and position) to match a nearby block relative to the site, not to “pick” a window side index.
  - Optional finite `tangent_x` / `tangent_y` / `facade_normal_x` / `facade_normal_y` tie the rectangle to a footprint-aligned basis for 3D drawing

3. Walkthrough of `building_test.py`

3.1 Configure Context

```
context_data = ContextData(
    latitude_north_deg=45.1916,
    longitude_east_deg=5.7174,
    starting_stringdate="01/01/2022",
    ending_stringdate="01/01/2023",
    location="Grenoble",
    albedo=0.1,
    pollution=0.1,
    number_of_levels=4,
    ground_temperature=13,
    side_masks=[
        SideMaskData(...),
        SideMaskData(...),
    ],
)
```

- The one-year time frame drives the hourly simulation

4. Getting Started Checklist

1. Duplicate `tests/building_test.py` and rename it to your scenario.
2. Update `ContextData` with your site coordinates and simulate the relevant date range.
3. Populate `BuildingData` with actual geometry, envelope compositions, ventilation rates, and HVAC capacities.
4. Toggle `window_cooling` and comfort settings (`Preference`) to match the desired control strategy.
5. Run the script, inspect `PHVAC`, `TZ`, `Q:<zone>-outdoor`, and comfort metrics.
6. Iterate on envelope or control parameters, re-simulate, and compare energy/comfort trade-offs.

With the foundations described here, you can gradually layer more advanced control rules, calibration data, or integration with optimisation workflows.

Document version: aligned with polygon `BuildingData`*, roof/attic fields,* `max_unshaded_protections`*, per-side* `GAIN_SOLAR`*, and* `baterm` *building variation.*

Side masks

SideMask Parameters Schema

Overview

The SideMask class represents a rectangular flat surface, named a side, that can obstruct solar radiation. This document provides a comprehensive explanation of all parameters and their geometric relationships.

Fist of all, the side is referred by the position of the lower central point of the side: