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Multi-criteria clustering analysis to discover optimal community solar PV systems for existing urban neighborhoods

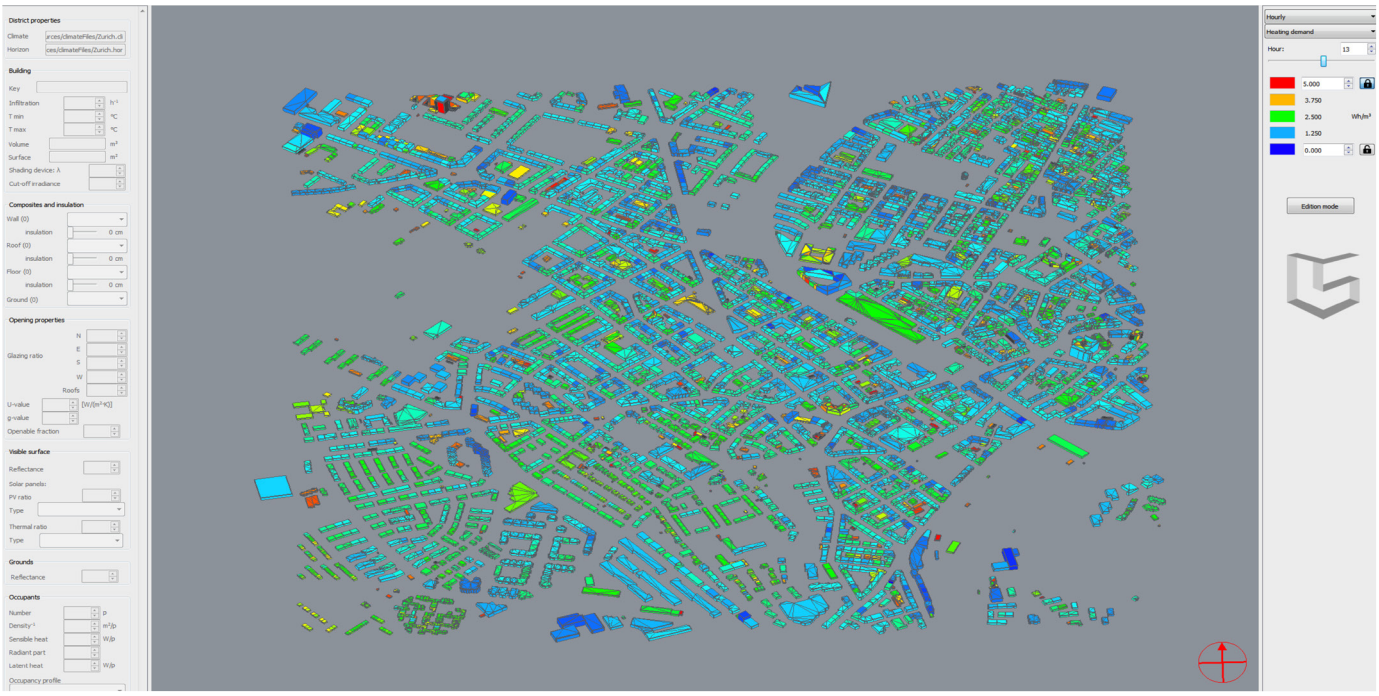
Shared solar PV resources are projected to be an important avenue to increase the adaption of **distributed energy systems** in urban areas. In particular, community solar systems show great potential in neighborhoods with mixed building typologies and in areas with multi-tenant buildings. However, limited research goes beyond the initial feasibility assessment for energy production potential and energy demand at a building level, on a city-scale. Furthermore, the current gap in literature exists in how **community solar** systems are characterized and subsequently implemented in analytical models. Specifically, community solar systems fall under the provision of **common pool resources (CPR)** and have shown great potential to achieve sustained cooperation between multiple users, if designed correctly.

CPR are characterized as being used by relatively small groups of people (50-15000), who live in close proximity, that depend on the rates of return produced from the CPR and when the resource is both scarce and **renewable**. Additional requirements for long-term cooperation between users of a specified CPR are clear boundaries, transparent monitoring, and graduated sanctions among others. While all design principles are necessary to achieve **sustained cooperation** for CPR, the research outlined in this proposal will focus on **defining feasible boundaries**, while considering optimal community size and proximity for shared PV resources.

Therefore, this aim of this PhD research project is to **identify optimal building clusters** within select urban areas for community-scale solar PV systems using a validated deterministic energy demand model as well as a statistical model to predict the solar fractions for thousands of buildings.

More specifically, the work packages include:
1) a **calibrated urban energy model** of 100 buildings using CitySimPro (http://www.kaemco.ch) as the simulation engine;
2) a predictive model to determine the energy consumption for the greater neighborhood area of ~4000 buildings;
3) **solar energy production potential** and respective **solar fractions calculations** on an hourly, daily and weekly basis
4) and most importantly, a **multi-criteria clustering assessment** for optimal building clusters for community-scale solar PV systems.

The analysis defined under work packages 1 and 2 will also be used as the basis for the energy analysis for the SNF research project titled "**ESUM**-Analyzing the trade offs between the energy and social performance of urban morphology". The results of this research will also include energy supply/demand statistics to identify potential **net zero energy clusters.**



Annual energy demand visualization for a select building district