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Spatial distribution of hourly load profiles for solar electricity generation and building related electricity demand – Case Study

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Utilities have an interest in knowing the potential solar electricity generation within their local grid area, matching to the effective electricity demand from buildings. This information is relevant for grid expansion planning and maintenance. However, the hourly information on electricity demand and solar electricity generation is hardly available, as smart meters with hourly resolution are not commonly installed. Within a techno-economic assessment financed by the Swiss government and the Swiss Gas Association, we provide such hourly generation and demand data using a GIS-based building stock model (BSM).
In this model, we merge GIS information on buildings (location, building type, etc.) together with the 3D-building shapes to estimate overall energy reference area of each building in the investigated spatial area. Based on the total floor area and on parameters such as building types and use, we estimate the annual electricity demand per building. Based on economic parameters such as costs and cost developments for energy saving measures and appliances, amongst others, we model potential future energy demand (scenario analysis).
In the load module of the BSM model, the annual demand is then broken down into hourly load profiles for selected building-related applications using a partial decomposition approach. Depending on the demand structure (e.g. different appliances develop different demand patterns), the future load profile deviates from the nowadays known standard load profile.
On the generation side, the potential for installed photovoltaic power per building is merged into the BSM based on data from the Swiss solar cadastre. Using the hourly radiation profile for the spatial area under investigation, the annual solar electricity generation is broken down into hourly values.
By comparing hourly electricity demand and solar generation, we derive estimates for the share of self-consumption of solar generation, indicating the need for potential grid expansion on selected grid nodes.