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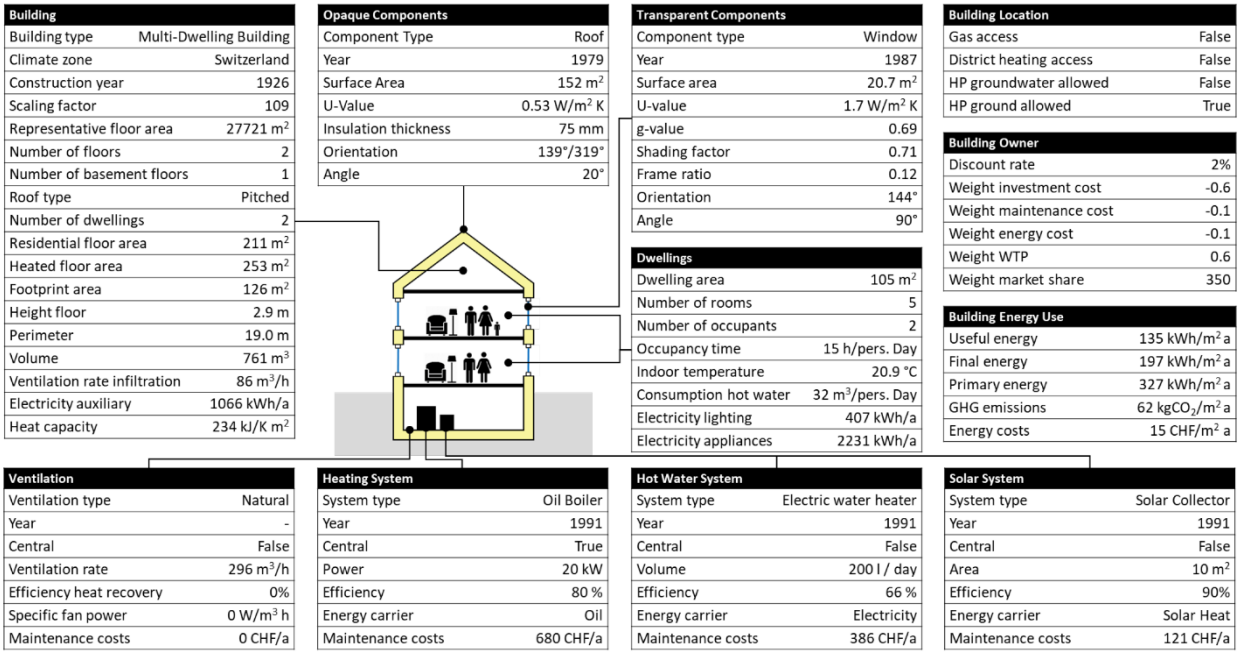
Agent-based Building Stock Modelling

From 2021, Germany levies a national CO2 price in the transport and buildings sectors with the purpose of promoting the switch to climate-friendly technologies and renewable energies. Buildings are responsible for a large share of the energy demand and greenhouse gas (GHG) emissions. The project aims to construct a bottom-up building stock model to assess the impact of CO2 taxation of operating energy on the building stock over time. In agent-based building stock modeling, the stock development in terms of new construction, envelope retrofit, and replacement of the heating system is determined by individual decisions at the building scale. Therefore, this model can better address the question of policy-makers, because the impact of policy measures such as a CO2 tax or subsidies on agent's decisions are modeled explicitly.

Source: Naegeli et al., 2020



Building	
Building type	Multi-Dwelling Building
Climate zone	Switzerland
Construction year	1926
Scaling factor	109
Representative floor area	27721 m²
Number of floors	2
Number of basement floors	1
Roof type	Pitched
Number of dwellings	2
Residential floor area	211 m²
Heated floor area	253 m²
Footprint area	126 m²
Height floor	2.9 m
Perimeter	19.0 m
Volume	761 m³
Ventilation rate infiltration	86 m³/h
Electricity auxiliary	1066 kWh/a
Heat capacity	234 kJ/K m²

Opaque Components	
Component Type	Roof
Year	1979
Surface Area	152 m²
U-Value	0.53 W/m² K
Insulation thickness	75 mm
Orientation	139°/319°
Angle	20°

Transparent Components	
Component type	Window
Year	1987
Surface area	20.7 m²
U-value	1.7 W/m² K
g-value	0.69
Shading factor	0.71
Frame ratio	0.12
Orientation	144°
Angle	90°

Dwellings	
Dwelling area	105 m²
Number of rooms	5
Number of occupants	2
Occupancy time	15 h/pers. Day
Indoor temperature	20.9 °C
Consumption hot water	32 m³/pers. Day
Electricity lighting	407 kWh/a
Electricity appliances	2231 kWh/a

Building Location	
Gas access	False
District heating access	False
HP groundwater allowed	False
HP ground allowed	True

Building Owner	
Discount rate	2%
Weight investment cost	-0.6
Weight maintenance cost	-0.1
Weight energy cost	-0.1
Weight WTP	0.6
Weight market share	350

Building Energy Use	
Useful energy	135 kWh/m² a
Final energy	197 kWh/m² a
Primary energy	327 kWh/m² a
GHG emissions	62 kgCO₂/m² a
Energy costs	15 CHF/m² a

Ventilation	
Ventilation type	Natural
Year	-
Central	False
Ventilation rate	296 m³/h
Efficiency heat recovery	0%
Specific fan power	0 W/m³ h
Maintenance costs	0 CHF/a

Heating System	
System type	Oil Boiler
Year	1991
Central	True
Power	20 kW
Efficiency	80 %
Energy carrier	Oil
Maintenance costs	680 CHF/a

Hot Water System	
System type	Electric water heater
Year	1991
Central	False
Volume	200 l / day
Efficiency	66 %
Energy carrier	Electricity
Maintenance costs	386 CHF/a

Solar System	
System type	Solar Collector
Year	1991
Central	False
Area	10 m²
Efficiency	90%
Energy carrier	Solar Heat
Maintenance costs	121 CHF/a

Task

In this project, you will create an agent-based building stock modeling.

- Study the model developed by Naegeli et al., 2020, by reading the ODD (Overview, design concepts, and details) protocol
- Create the system using Python, Java or R.
- Run and test the model using a building example

Requirements

- Good language skills in German or English
- Independent and thorough operation
- Programming experience in Python or Java

- Interest in building energy efficiency and sustainability

Reference Literature

Nägeli, C., Jakob, M., Catenazzi, G., & Ostermeyer, Y. (2020). Towards agent-based building stock modeling: Bottom-up modeling of long-term stock dynamics affecting the energy and climate impact of building stocks. *Energy and Buildings*, 211, 109763.