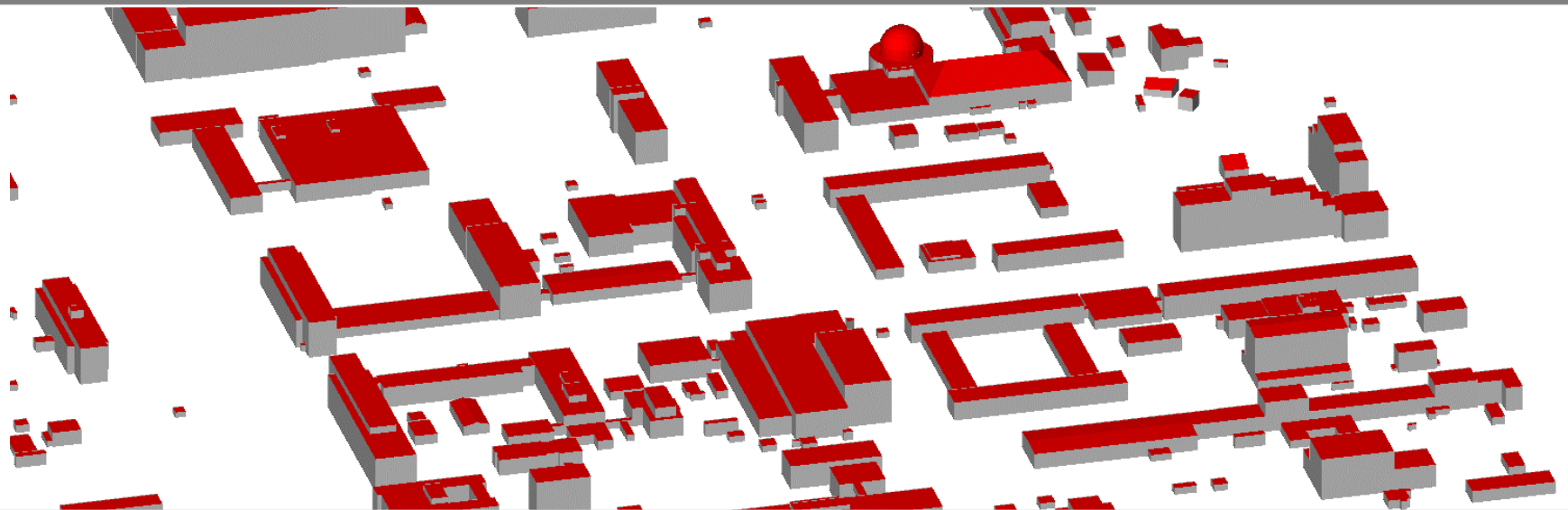


Scope and design principles of the Energy ADE

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Institut für angewandte Informatik

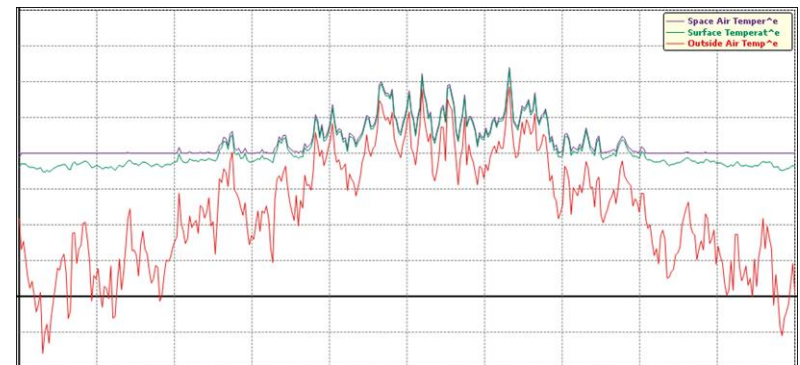


Goals for the ADE development

- Development of a data model supporting energy analysis on building and urban level
- Neutral, standardized interface between modelling and simulation systems
- Representation of all relevant input data and simulation results

Simulationsergebnisse

Name:	(1:Geb. 445)
Geschoßfläche:	3917.97 m²
Volumen:	11176.1 m³
Heizbedarf:	319512 kWh im Referenzjahr
Max. Heizlast:	172066 W im Referenzjahr ≙ 43.917 W/m² im Referenzjahr



Development process

- Project started in **May 2014**
- Project team: **~20 institutions** in **7 European countries**
- Up to now **8 workshops** in different countries
- Organizational information, minutes: <http://en.wiki.energy.sig3d.org/>
- Technical development platform: <https://github.com/cstb/citygml-energy/>



Purposes of urban energy demand simulation

- Energetic assessment of existing building stock
 - Evaluation of building performance
 - Derivation of refurbishment priorities

- Urban planning
 - Energy efficient planning of new buildings or quarters

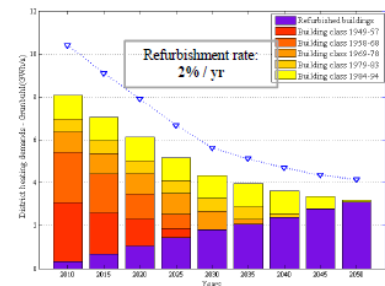
- Support of the energy transition process
 - Planning of low-carbon scenarios



Grünbühl - Ludwigsburg



Solar atlas, City Berlin



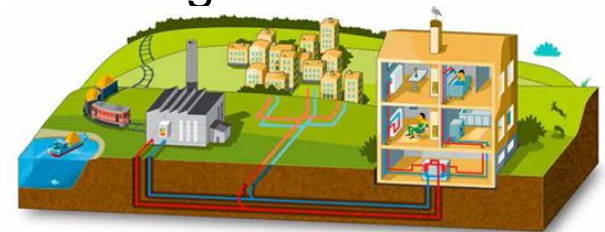
Needs energy estimations on a **yearly** time scale

Purposes of urban energy demand simulation

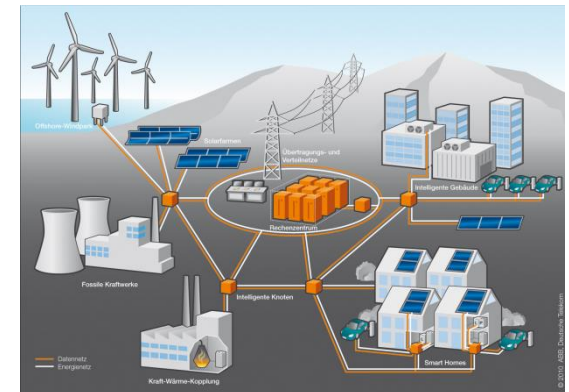
- Detection of deficiencies in energy consumption or wasting of energy
 - Needs energy assessment on **season** or **monthly** time scale

- Planning of energetic infrastructure, e.g. district heating
 - Needs energy simulation on **daily** time scale

- Technologies for active control of fluctuating energy demand and energy supply (e.g. smart grids)
 - Needs energy simulation on **hourly** time scale



Source: DESMI

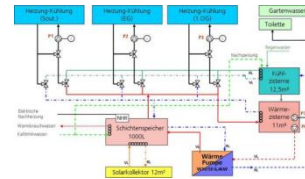
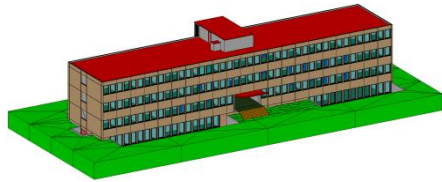


Building energy demand simulation - Methods

- Rough **estimation** based of selected parameters (e.g. volume, exterior shell area, height, year of construction, function) and statistical data
- Nationally standardized **assessment** methods (e.g. DIN 4108) based on real (generalized) geometry and constructions
- Numerical **simulations** of the thermodynamic equations, taking into account spatial- and time-dependent occupant behavior and dynamic weather / climate data (e.g. DIN 18599)

The data model needs to support all types of estimations / simulations

Energy simulation

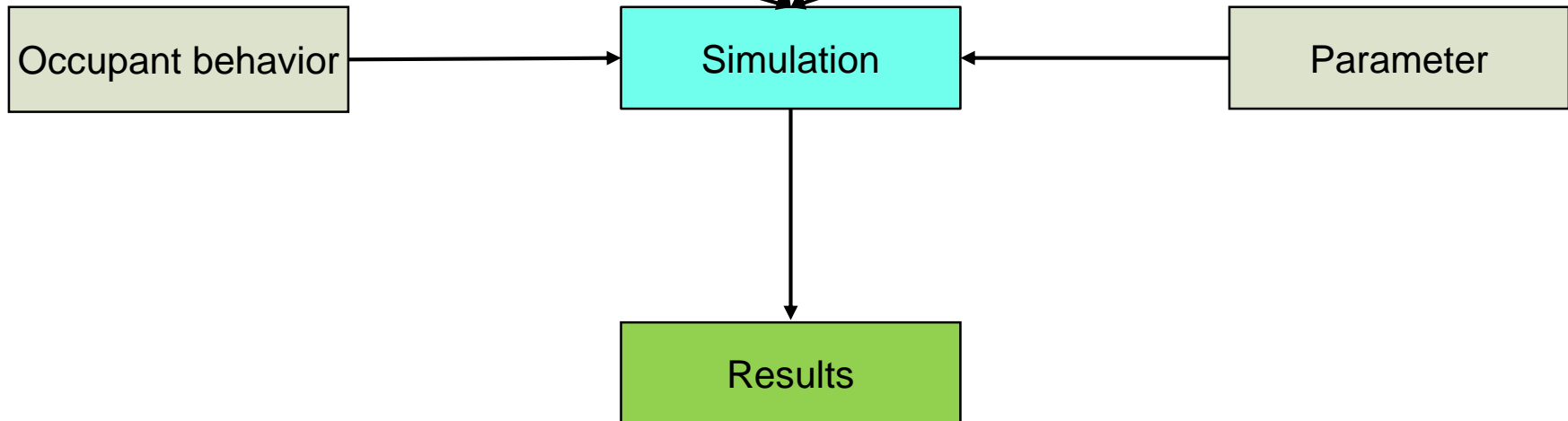


Building and component information

Weather data

Energy systems

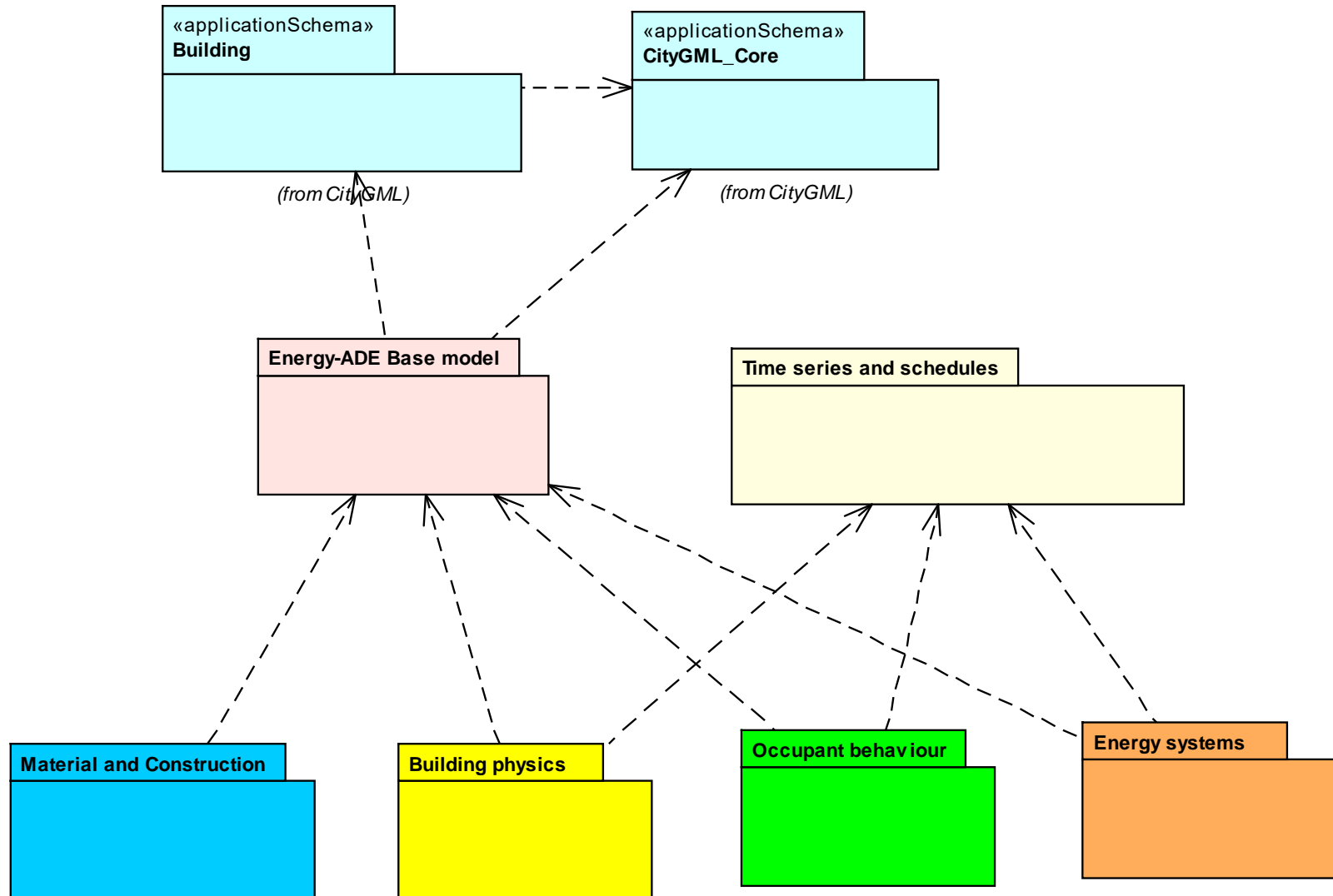
Heat dissipation



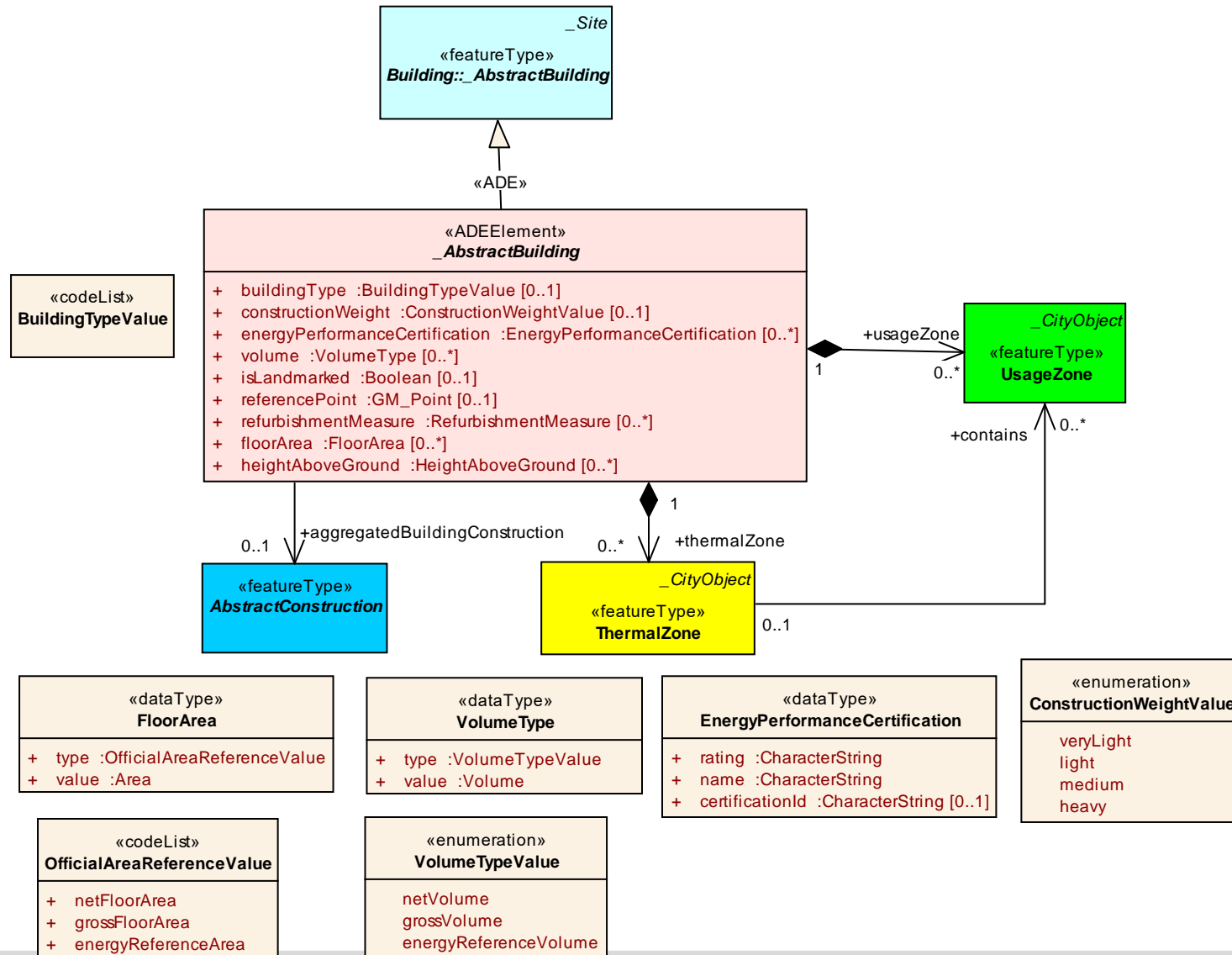
Attributive information on buildings

- Principally available in CityGML are
 - Year of construction (frequently missing)
 - Actual building function
 - Building height
 - Number of storeys above/below ground (sometimes missing)
- Not represented in CityGML are
 - Concepts for physical building models (e.g. Thermal Zones, Thermal Boundaries)
 - Materials, constructions
 - Energy systems (Generation, Conversion, Distribution, Storage)
 - Information on building occupants and their behavior
 - Time series of weather / climate data
 - Simulation results

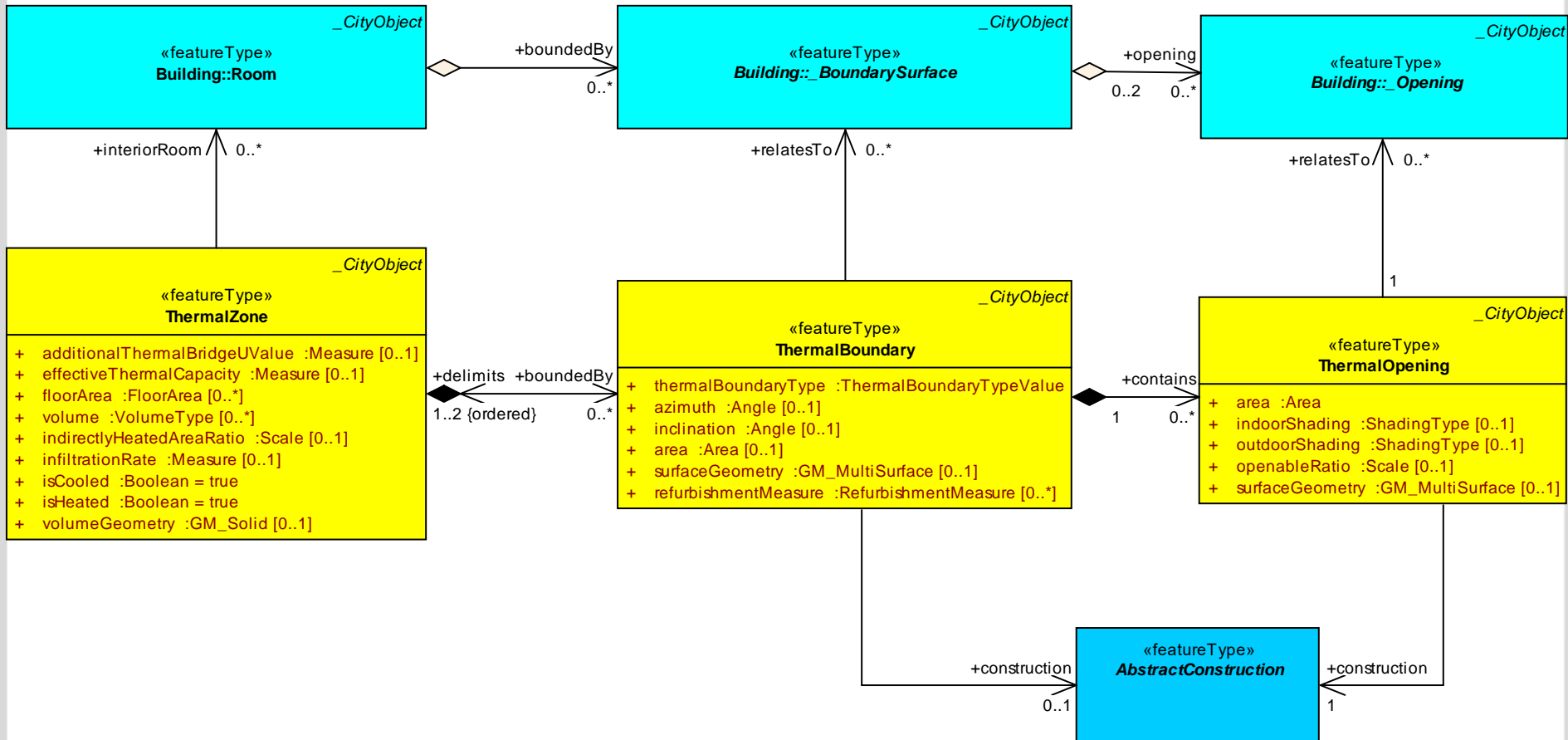
Energy ADE structure



Energy ADE base model

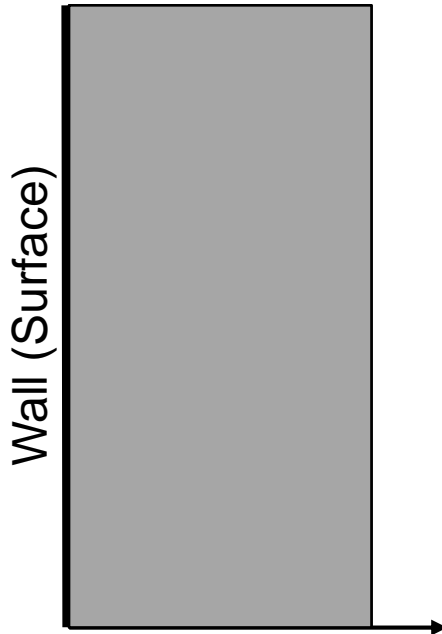


Building physics model



Material and Construction – 1

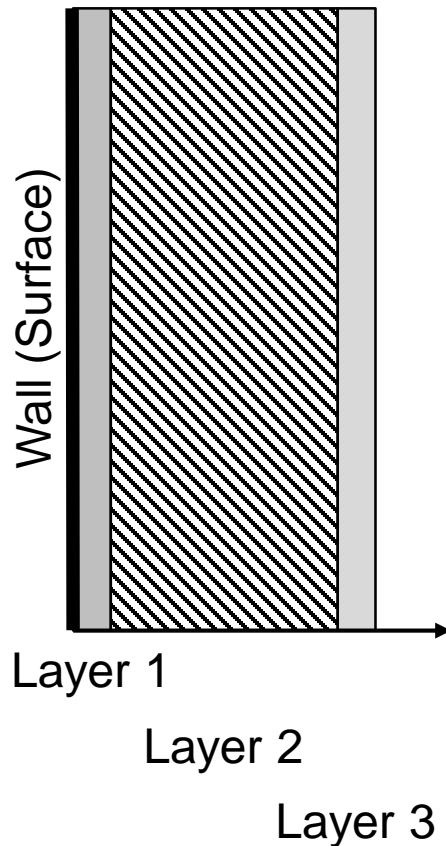
Single Layer Construction



- Thermal transmittance (U-value)
- Optical properties (emissivity, reflectance and transmittance for different wavelengths)
- Glazing ratio

Material and Construction – 2

Multi Layer Construction



■ Layer

■ Thickness

■ One or more

Material

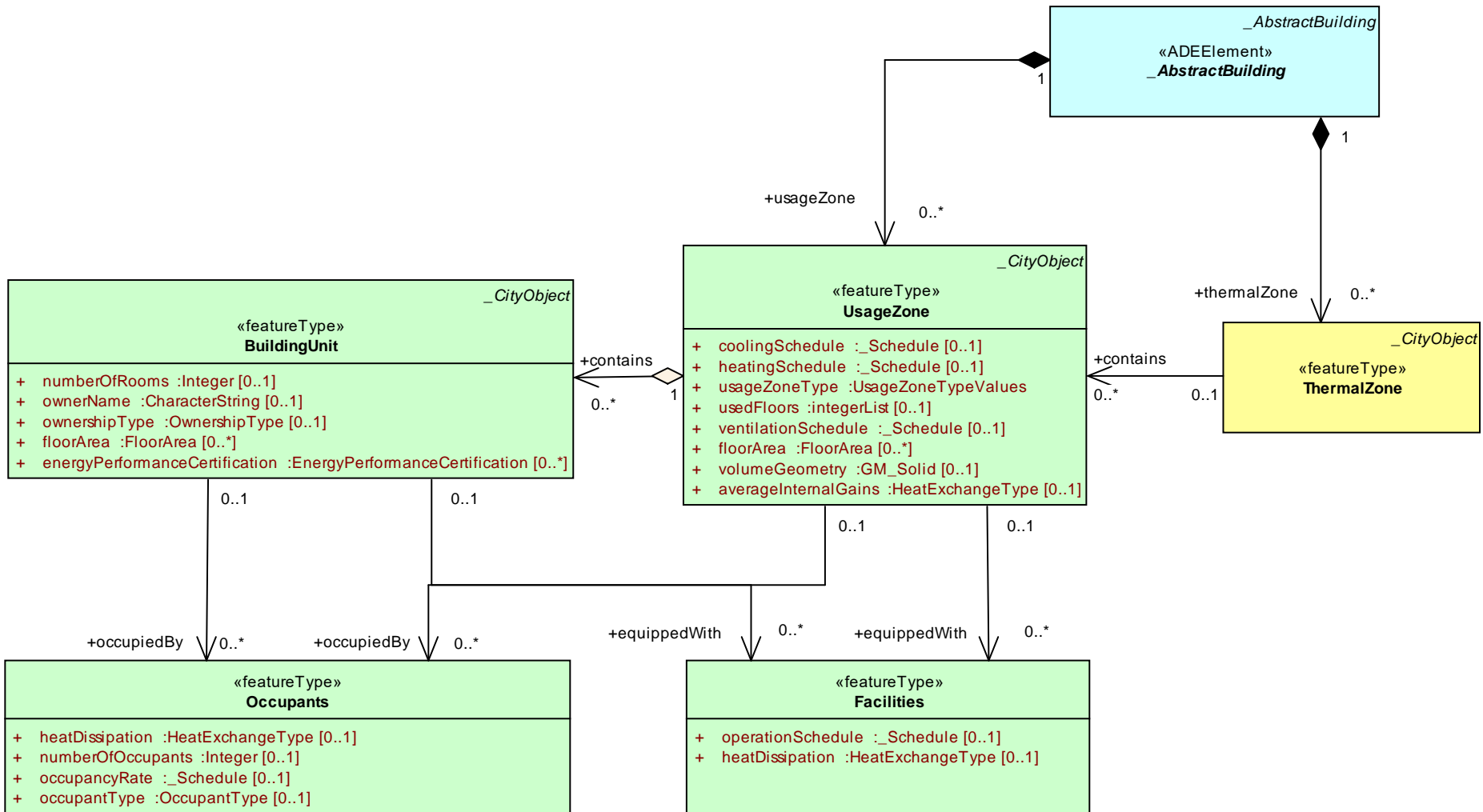
Gas

■ R-Value

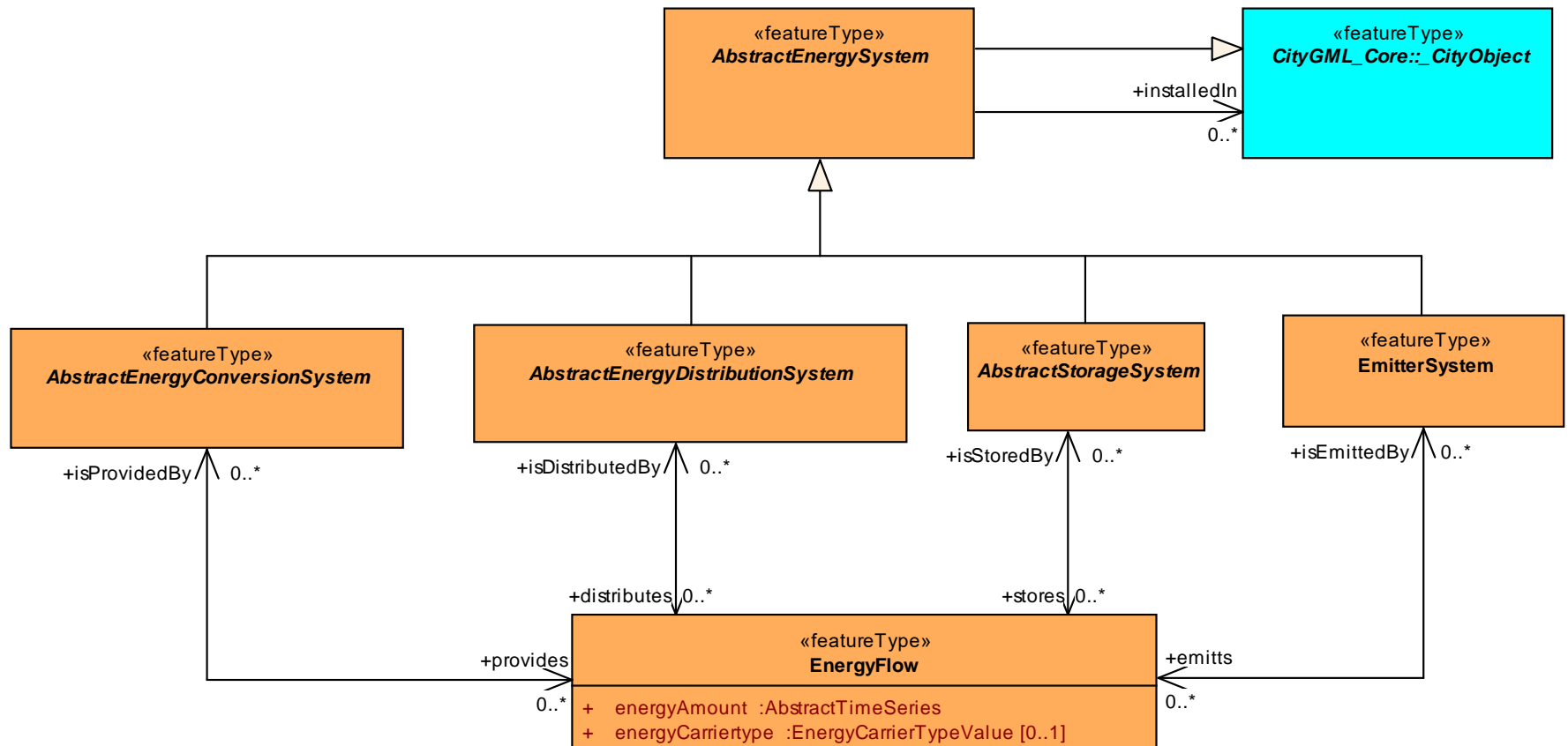
SolidMaterial

- Conductivity
- Density
- Permeance
- Porosity
- Specific Heat
- Embodied Carbon
- Embodied Energy

Occupant behavior



Energy systems



Supporting classes: Time series, schedules, weather data

- **Time series** – Ordered list of physical values corresponding to instances of time
 - Regular and irregular time series
 - Values stored inside or outside the XML document
- **Schedules** – Specification of time depending properties, e.g. set-point temperature for heating and cooling
 - One Constant value
 - Two values for operation and idle times
 - Daily schedules for specific days of the week
 - Schedule defined by an arbitrary time series
- **Weather data**
 - Time series for specific meteorological parameters
 - Aggregation of parameters referring to a specific location