A 3D wireframe model of a city layout, showing various rectangular blocks of different sizes and shapes arranged on a grid. The model is rendered in a light gray color with a visible wireframe structure, giving it a technical, architectural feel. It serves as the background for the title text.

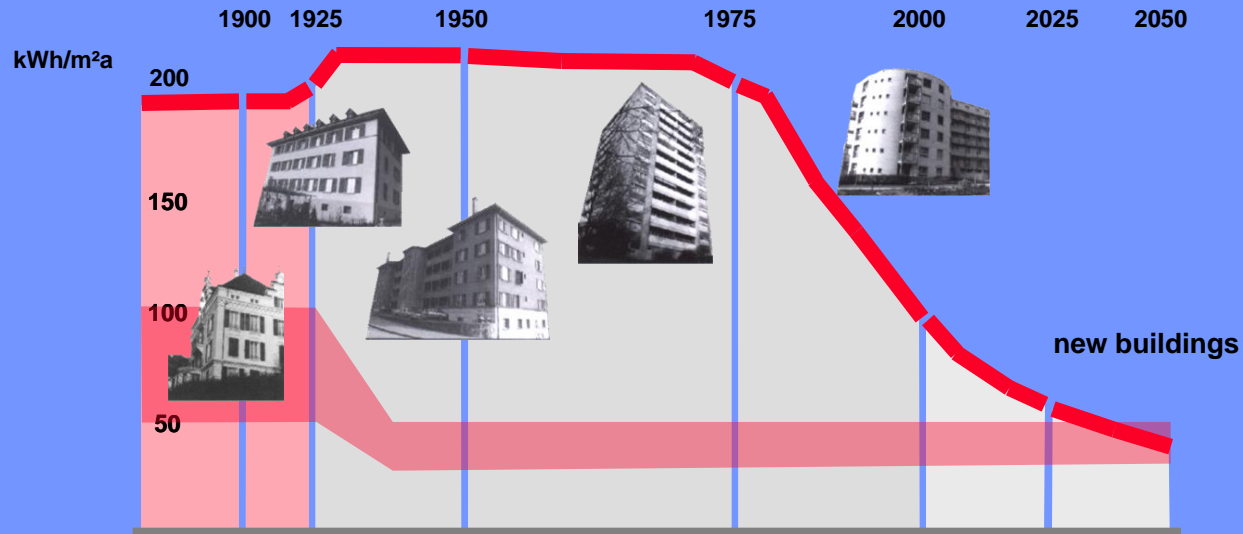
Sustainable cities

Adaption of communities towards SELF-REGULATING ENERGY SYSTEMS

Prof. dr. Jan Carmeliet

Chair of Building Physics, ETH Zurich
Laboratory of Building Science and Technology, Empa

Energy use by buildings



Heat Energy Demand of Dwellings in Zurich

Buildings are responsible for

- 48 % of energy consumption in Switzerland, 68% fossil fuel based
- by 2050 existing buildings will be responsible for 80% of the total building energy consumption (no interaction scenario)

Nowadays strategy

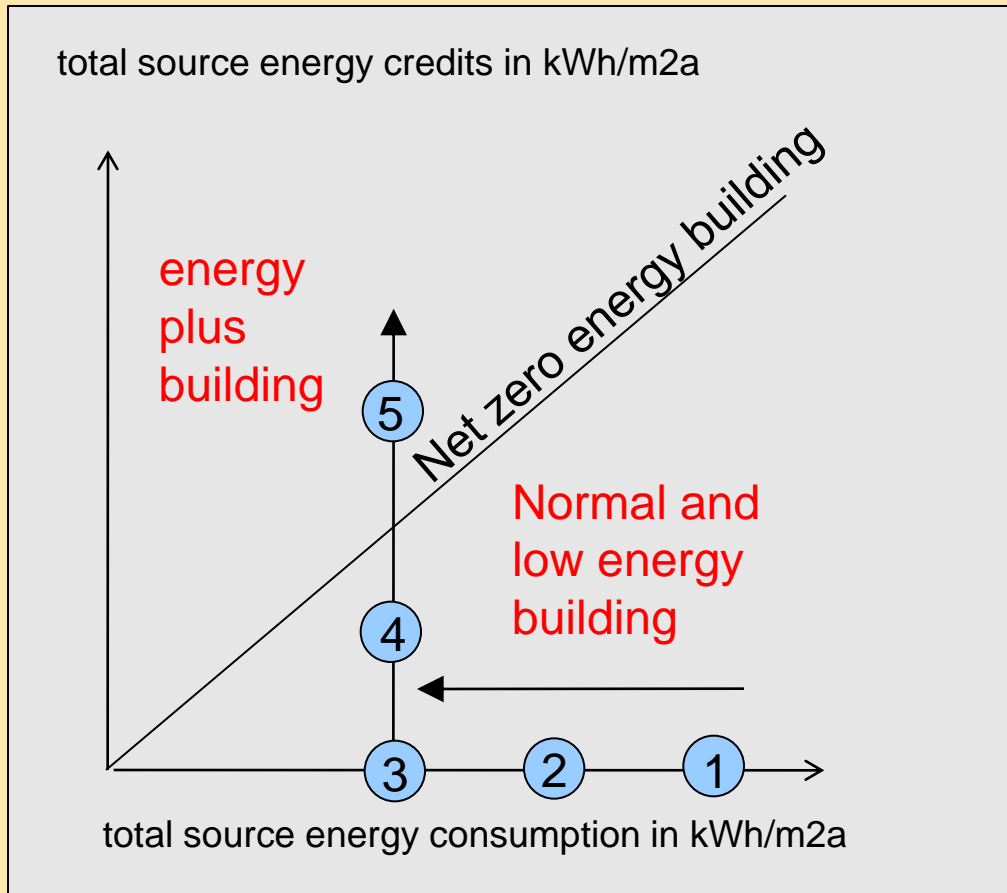
Future buildings will

- be Energy efficient
- produce Energy
- store Energy
- interact with (smart) Energy network

Trend to decentralisation: renewable integration

Adaption of communities towards SELF-REGULATING ENERGY systems

Energy Plus Buildings based on Annual Energy balance



Road to Energy+ buildings

1. National standard (SIA)
2. Low energy building technologies
energy efficiency
3. Renewable energy
4. On site generation
5. feed-in credits

Adaption of communities towards SELF-REGULATING ENERGY systems

Realistic solution ?

Low rate of replacement of buildings in communities

- economical reasons
- historical and architectural values

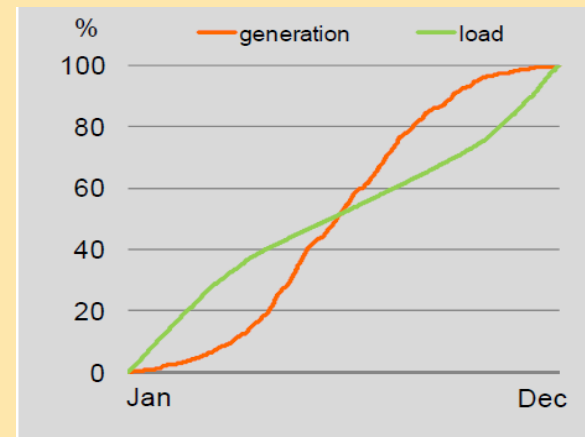


Integration of Renewables



Large PV installation on the Nervi Audience Hall of Vatican City

Load matching problem



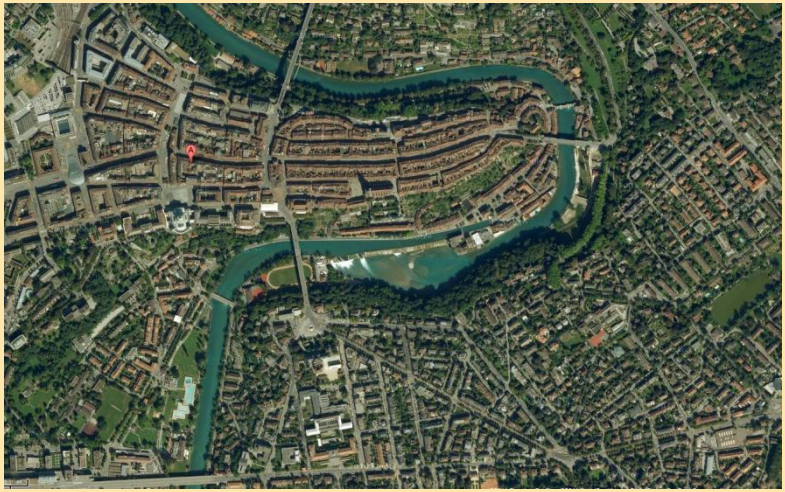
New scenario's needed

Upscaling to Community scale

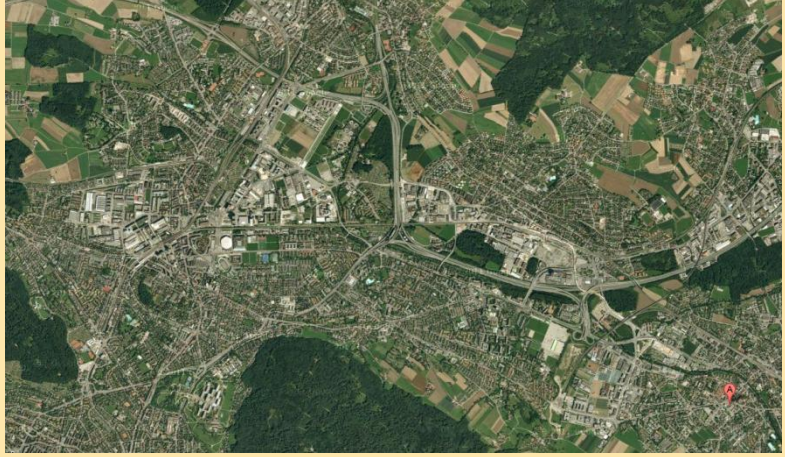
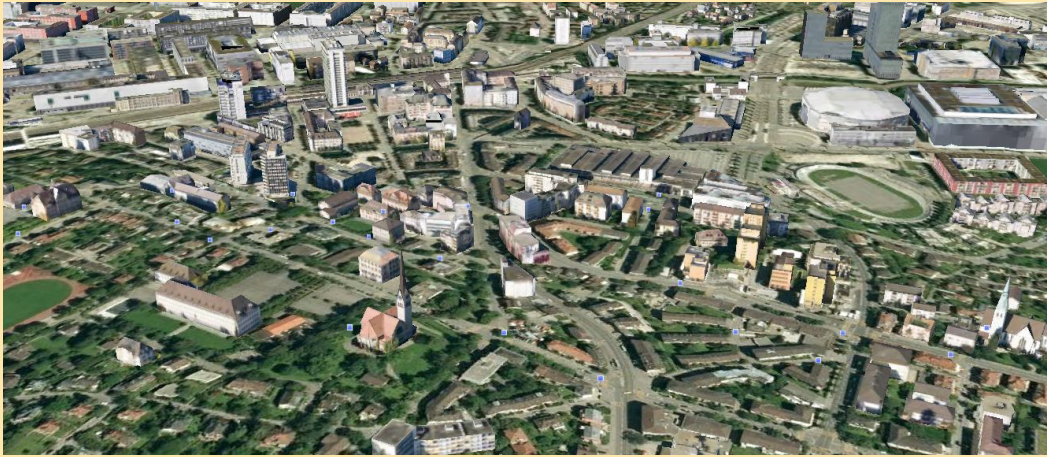
- Integration with other buildings
- Integration with local energy sources
- Economy of scales

New Energy scenario's on Community scale

Towards self-regulating energy systems



URBAN

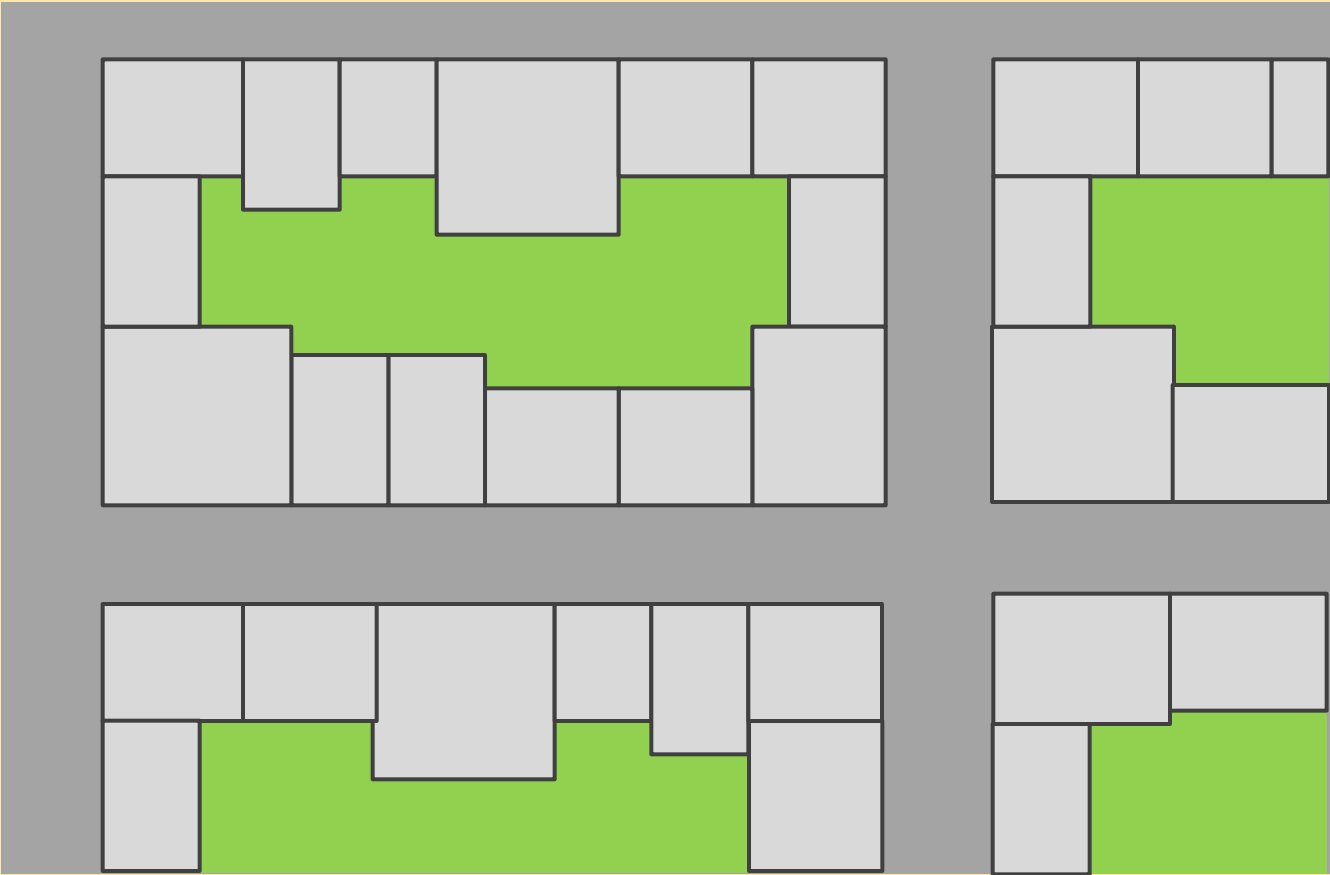


SUB-URBAN



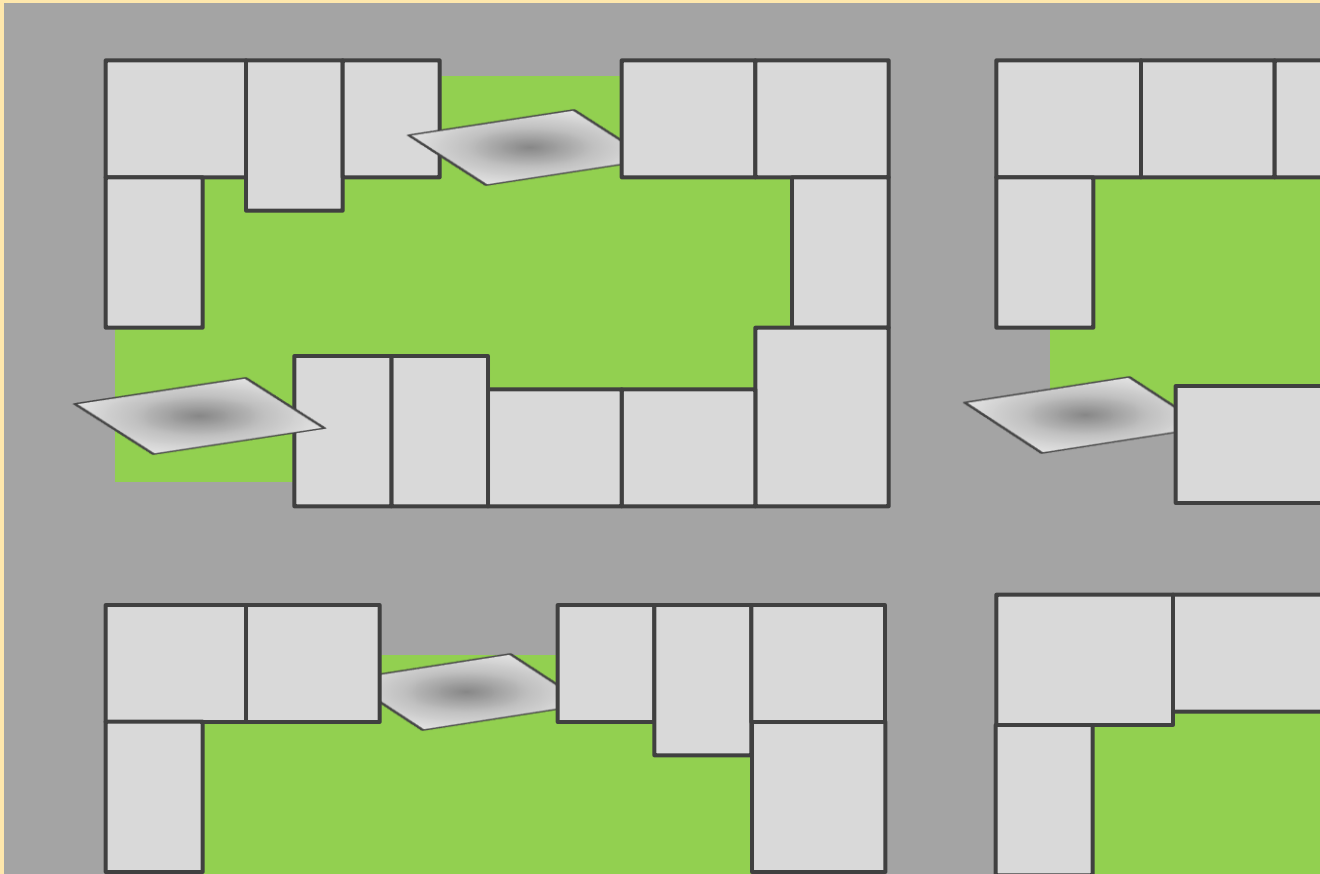
RURAL

Adaption of communities towards SELF-REGULATING ENERGY systems



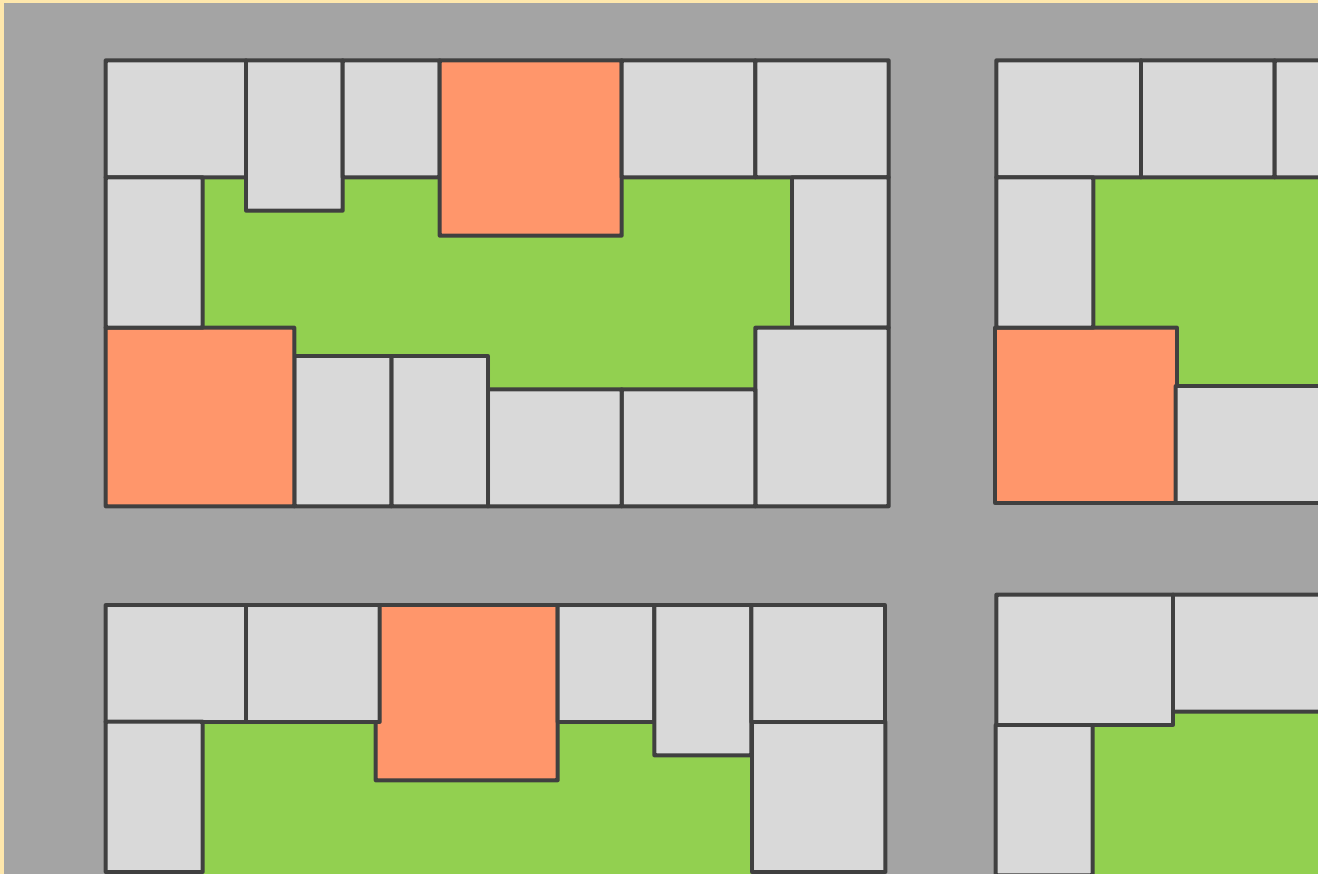
Adaption of communities towards SELF-REGULATING ENERGY systems

Demolition of some houses



Adaption of communities towards SELF-REGULATING ENERGY systems

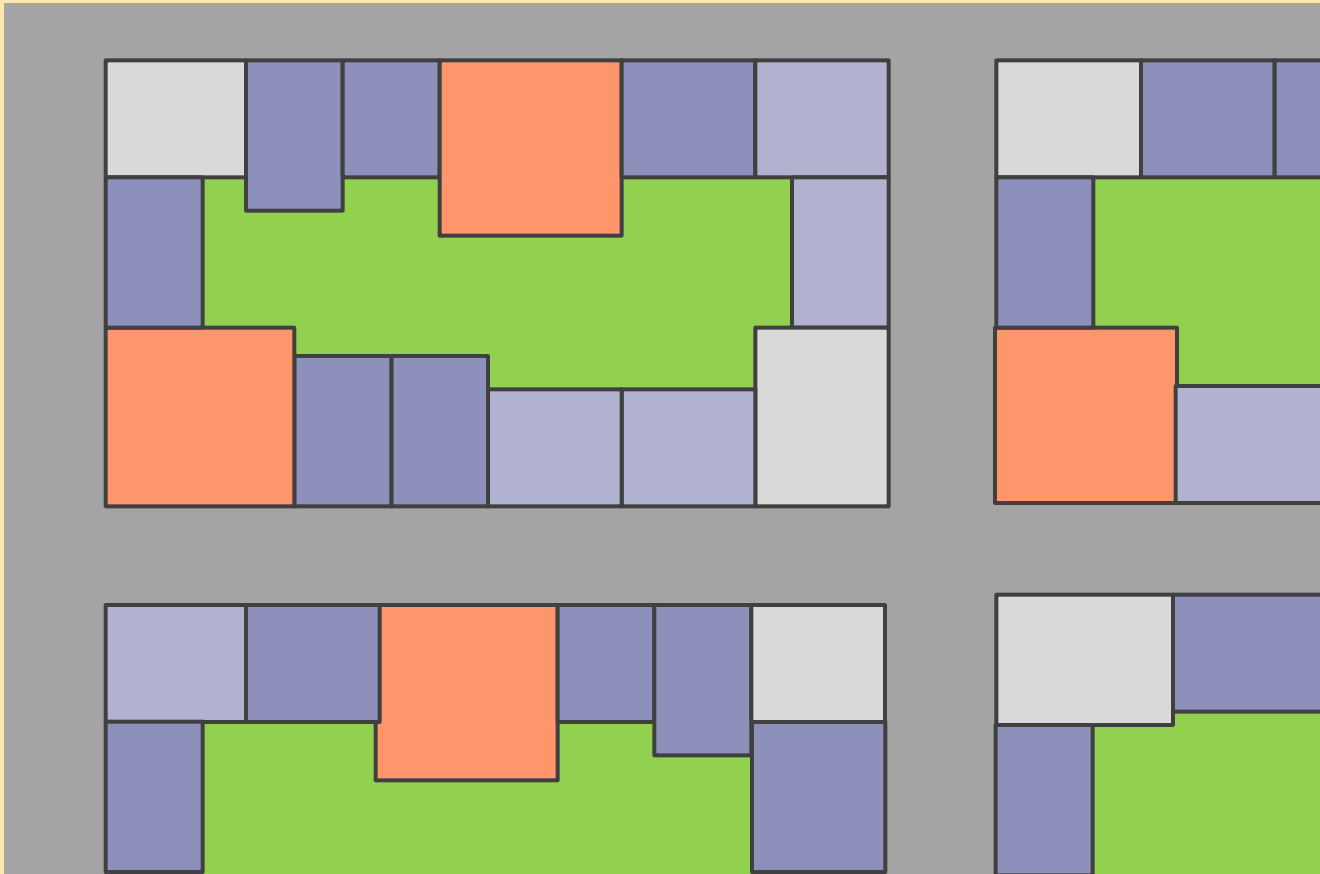
Replacement by energy positive houses (Low potential)



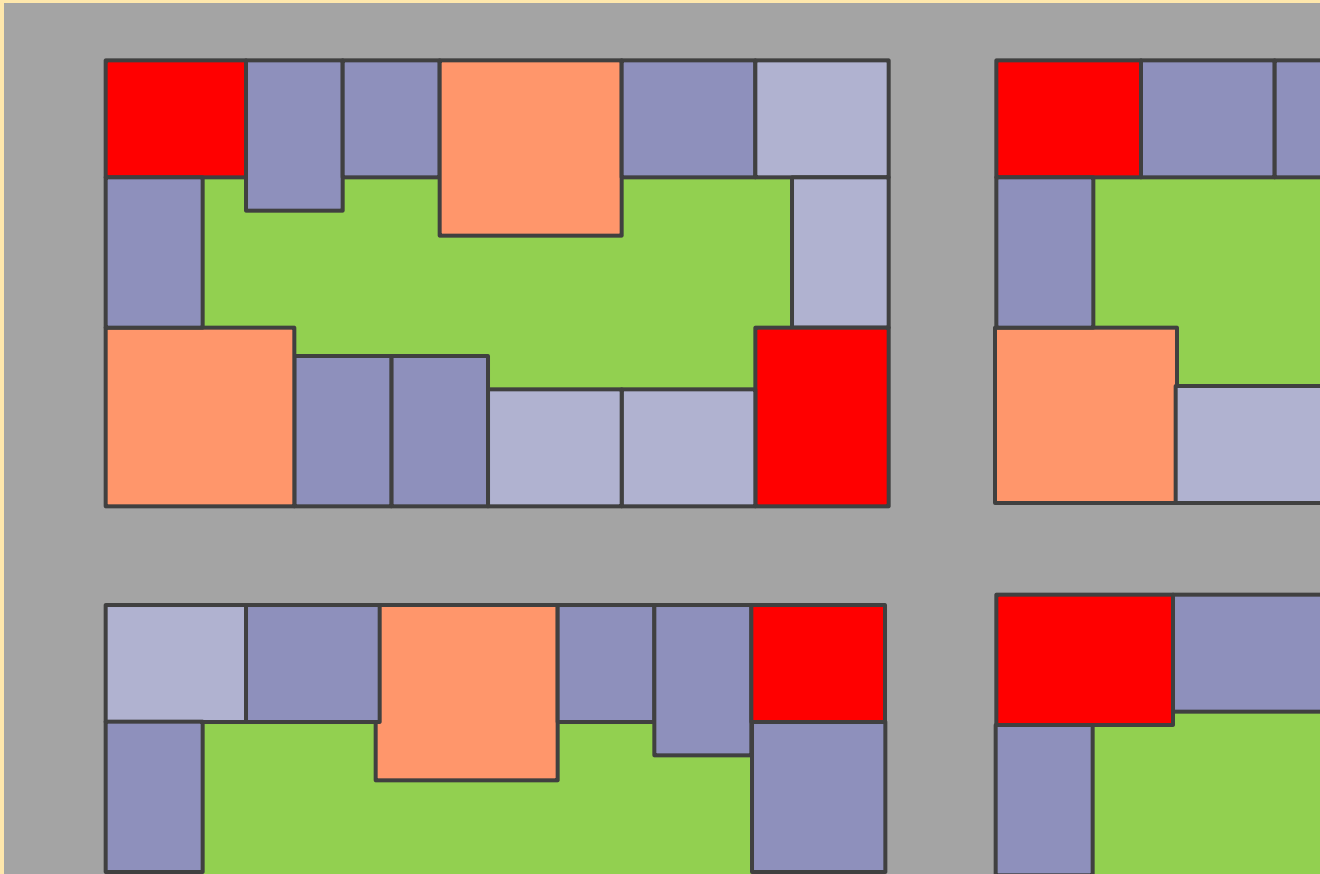
Bâtiment à énergie positive réalisé dans le quartier à haute densité d'habitation de Matthäus à Bâle (Feldbergstrasse 4-6, bâtiment de 1896, inscrit au patrimoine, combinaison d'une sur isolation thermique, d'implantation de capteurs solaires thermiques et photovoltaïques et de mise en place de réservoirs saisonniers de chaleur dans l'immeuble) (Prix Solaire Suisse 2009).

Adaption of communities towards SELF-REGULATING ENERGY systems

Advanced renovation and renewables Minergy A, Minergy-P

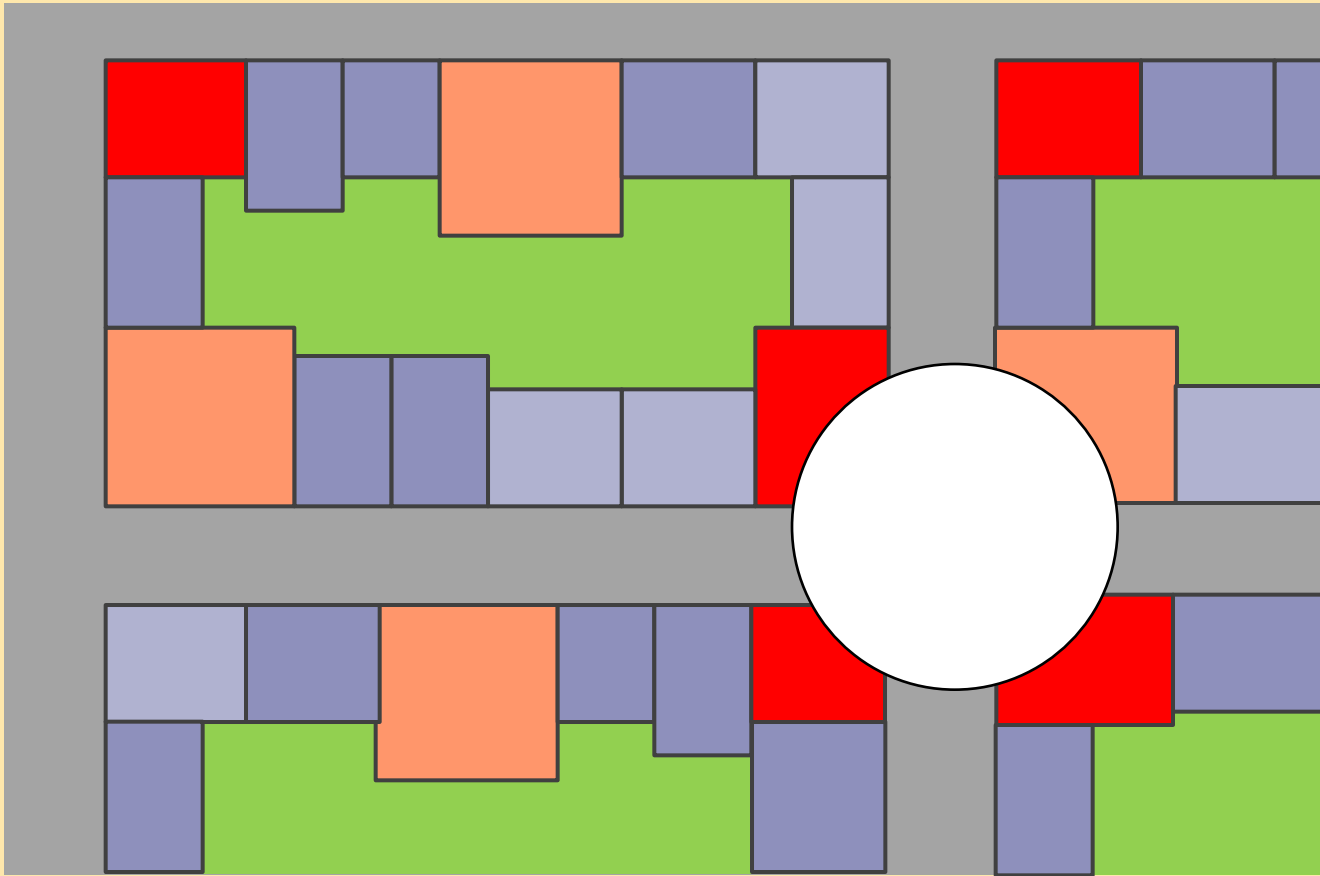


Protected Buildings : (seasonal) storage



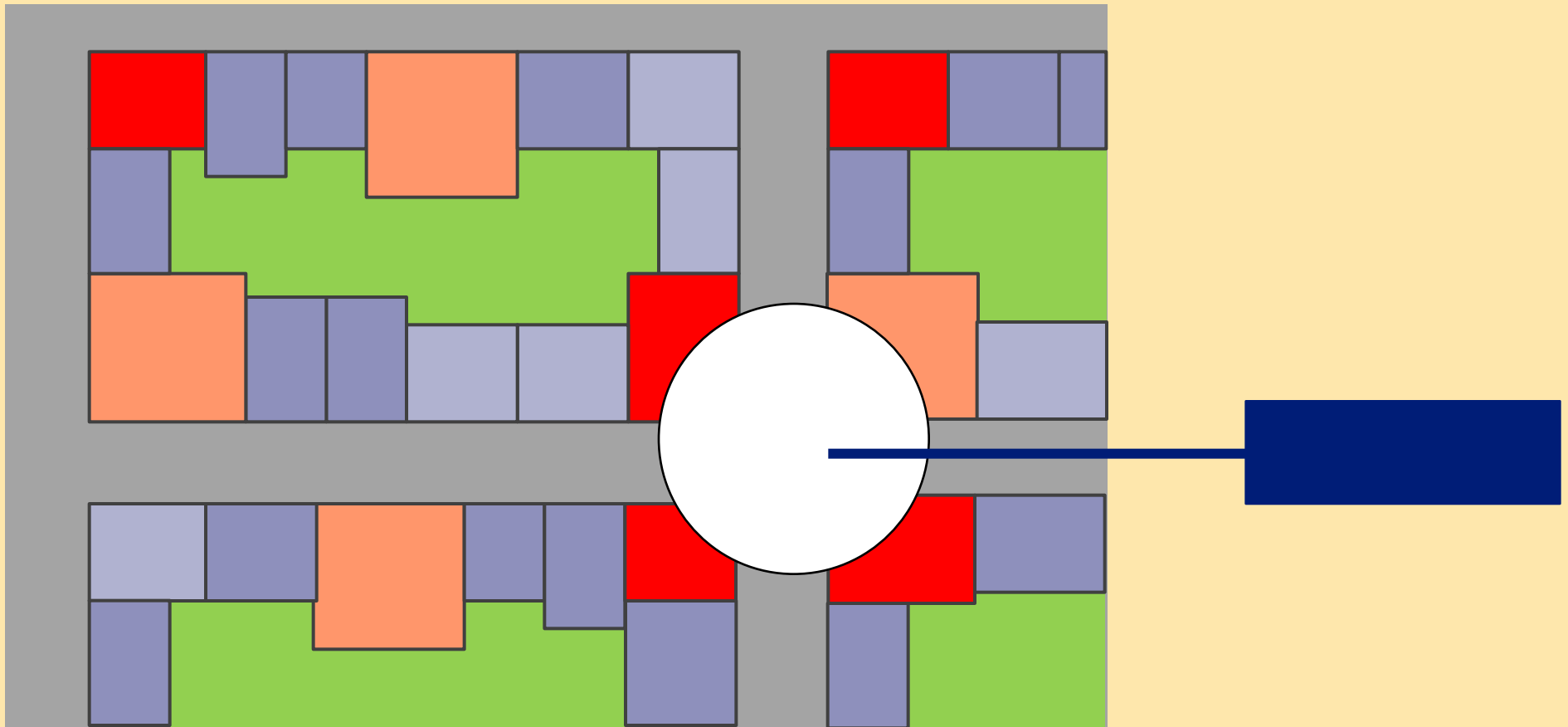
Adaption of communities towards SELF-REGULATING ENERGY systems

Energy Hub: energy conversion unit
conditioning, storage, distribution



Adaption of communities towards SELF-REGULATING ENERGY systems

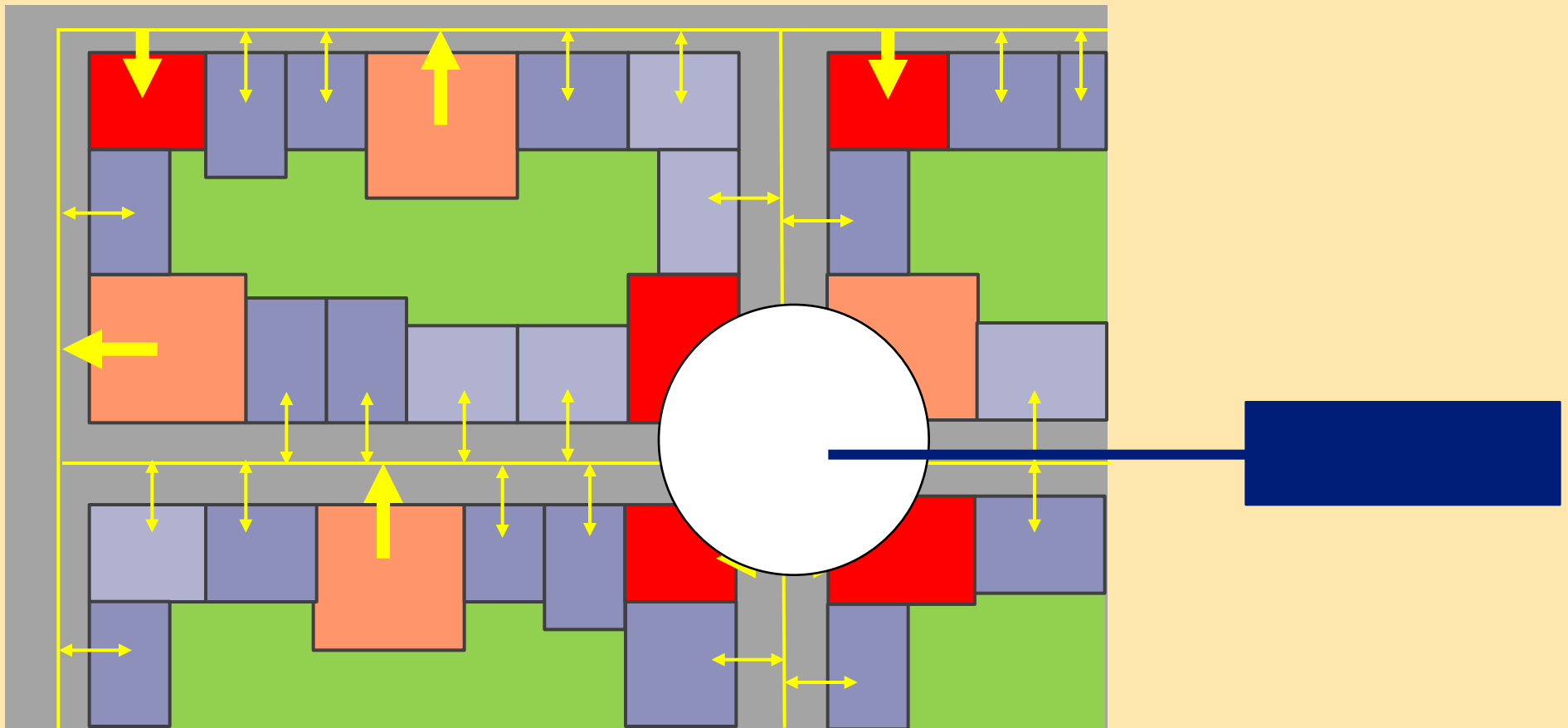
Local energy resources:
biomass, wind-energy



Adaption of communities towards SELF-REGULATING ENERGY systems

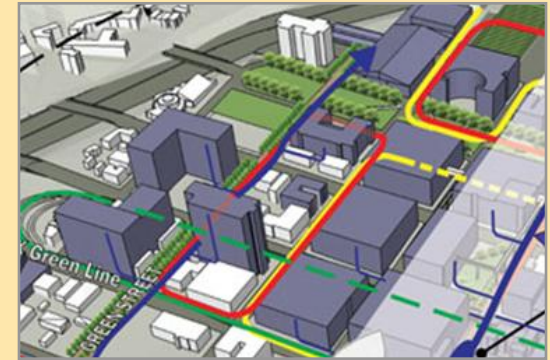
Community integration

heating/cooling, IT, electricity networks. Flexibility.



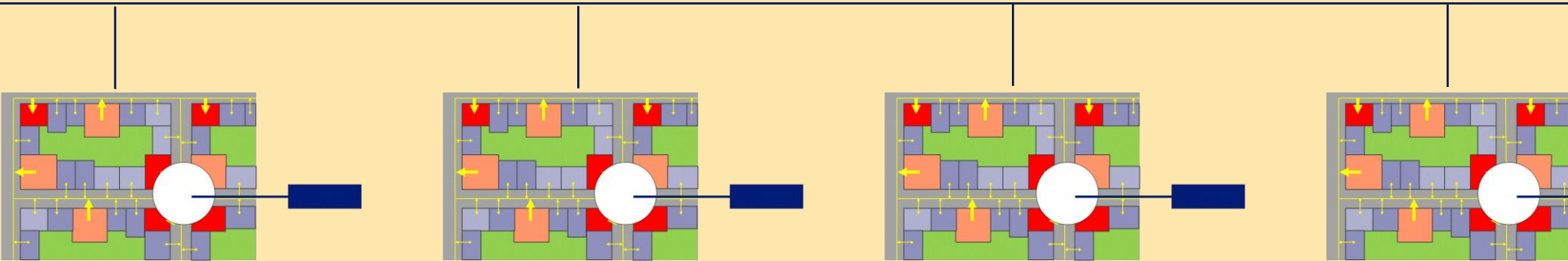
Optimized selection of set of advanced technologies

- Building Integrated PV
- Small scale district co- and trigeneration
- Solar cooling
- Central / local heat storage
- H₂ based systems
- Electricity storage
- Link to E-mobility
-



Adaption of communities towards SELF-REGULATING ENERGY systems

City scale



community

Adaption of communities towards SELF-REGULATING ENERGY systems



Research: Energy modelling in Built Environment

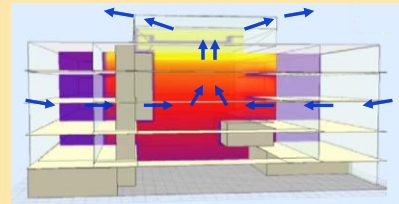
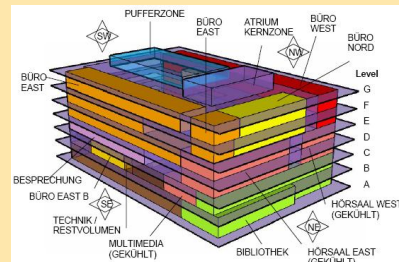
■ ABL Wind Tunnel

ETHZ/EMPA
Atmospheric Boundary
Layer Wind Tunnel



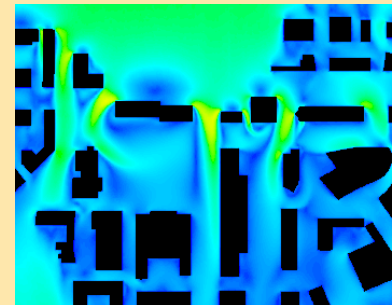
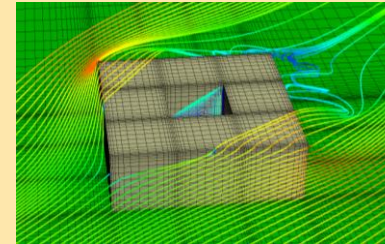
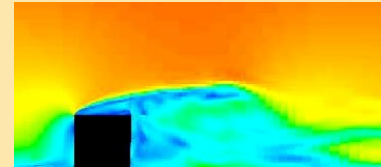
■ BES

Building Energy
Simulations



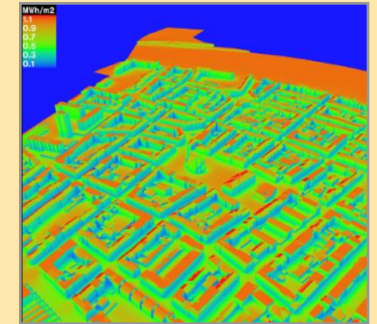
■ CFD

Computational Fluid
Dynamics



■ radiation

Solar and longwave
radiation



*Suntool simulation
Robinson, EPFL*



*Interreflective and
longwave radiation*

A 3D wireframe model of a city or urban environment, rendered in a light blue color. The model features various rectangular blocks of different heights and shapes, representing buildings and structures. The perspective is from an elevated angle, looking down at the city. The background is a grid of lines, suggesting a map or a digital landscape.

THANK YOU

Adaption of communities towards
SELF-REGULATING ENERGY SYSTEMS

Prof. dr. Jan Carmeliet