



Materials Science & Technology

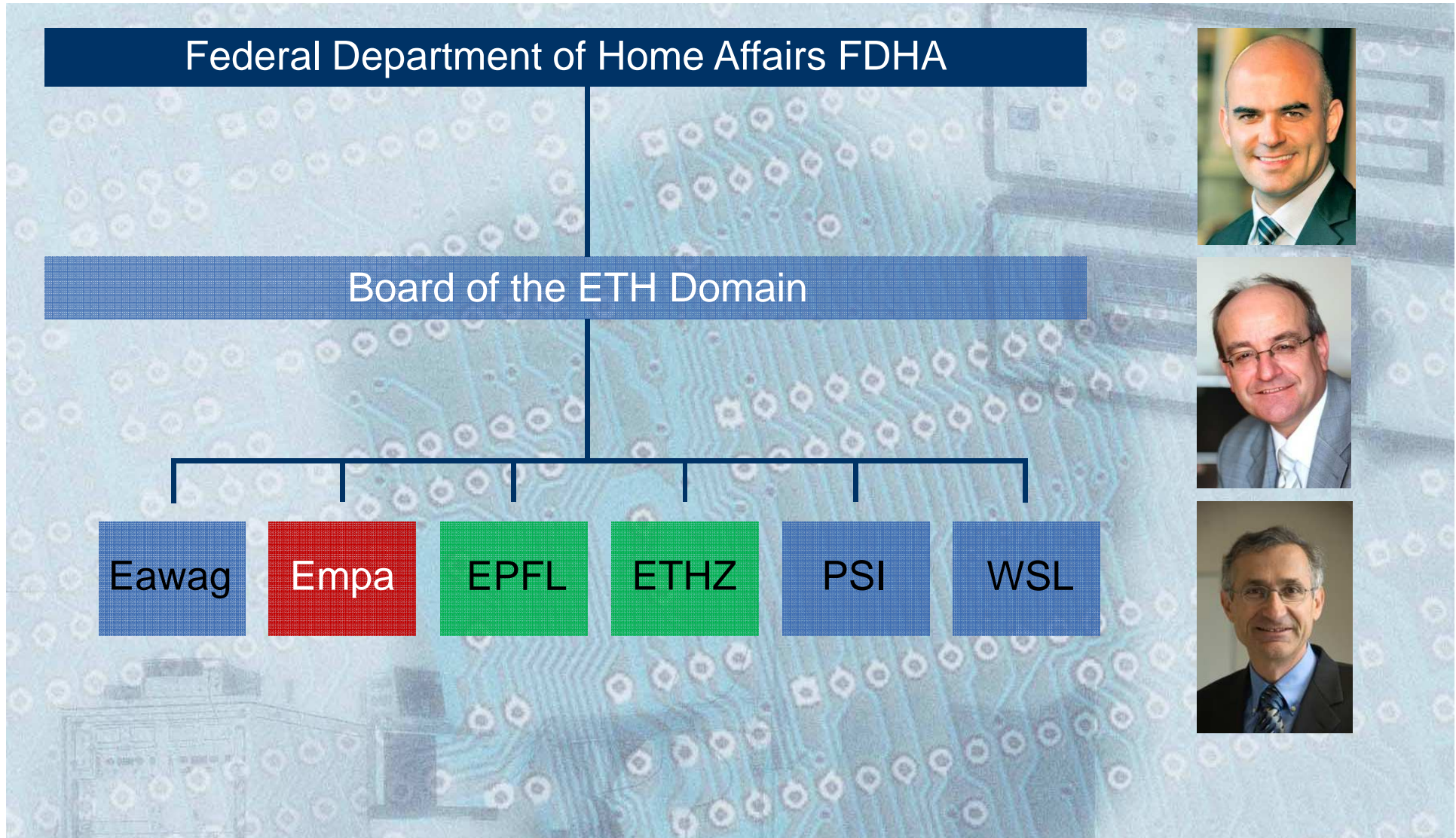
Research for a successful transformation of the built environment in Switzerland

Dr. Peter Richner; Empa

LNEC, Lisboa

June 19 2012

Empa within the ETH Domain



Our Vision



Materials and Technologies
for a Sustainable Future

Mission

Empa – Bridging Research and Applications

- Use-inspired Materials Science & Technology Development
- Interdisciplinary Know-how
- Efficient Technology Transfer
- For the Benefit of Industry
- For the Welfare of Society
- Committed to Excellence in all our Activities



Empa in Numbers (2011)

3 Sites

Dübendorf, St. Gallen, Thun

5 Departments

37 Laboratories
959 Employees (870 FTE; about 30% Women)
of which 24 Professors
140 PhD Students
40 Apprentices
plus 200 Master Students & Interns

Budget

97 Mio. CHF Public Funding
50 Mio. CHF Third Party Means

Scientific Output

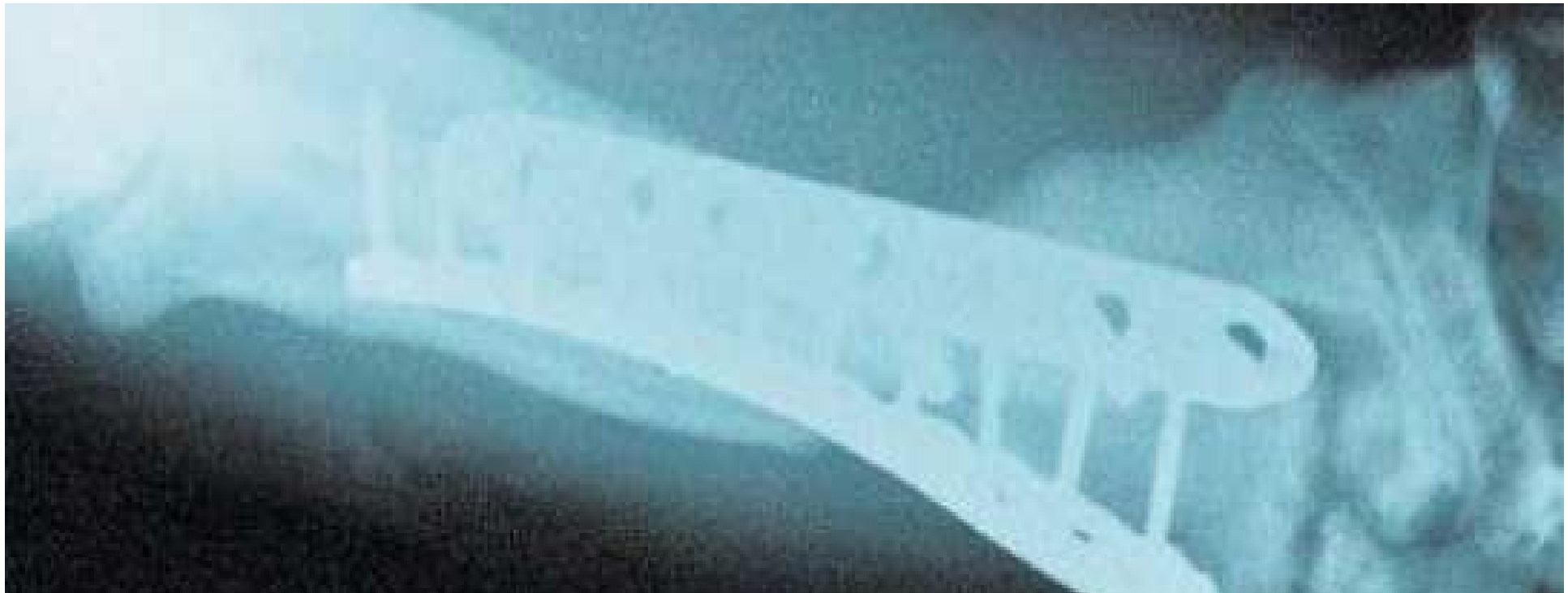
> 500 Peer-reviewed (SCI/E) Publications
85 Seminars & Conferences at Empa-Academy

Third Party Projects

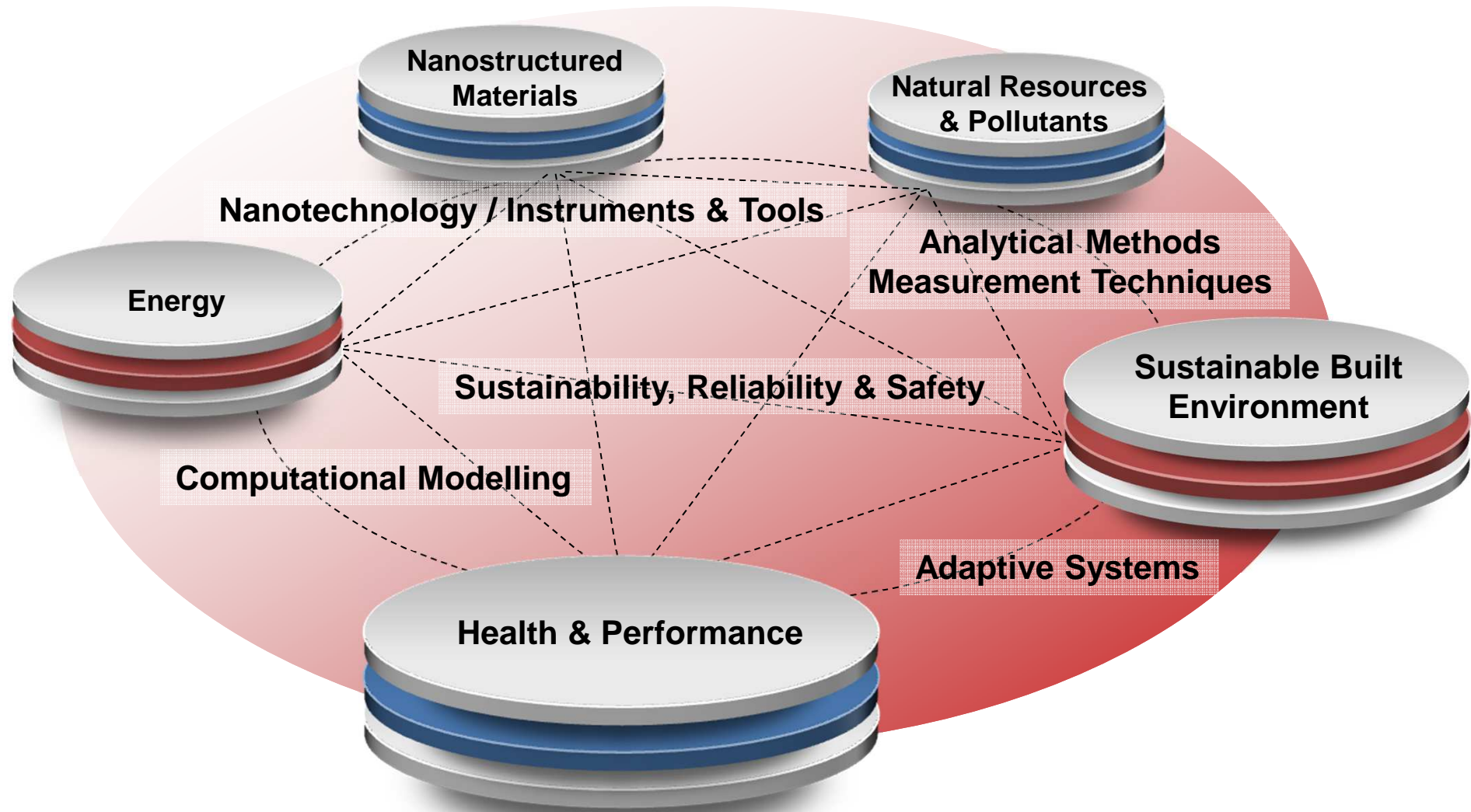
> 50 running Projects EU Framework Programmes
> 90 running SNSF Projects
80 running CTI Projects

The big Challenges of the Future

Health Climate/Environment Scarcity of Resources Energy **Renewal of Infrastructure**



Empa Research Focus Areas



Content

- Buildings

 - Materials

 - Systems

 - Cities

- Boosting Technology Transfer

Content

- Buildings

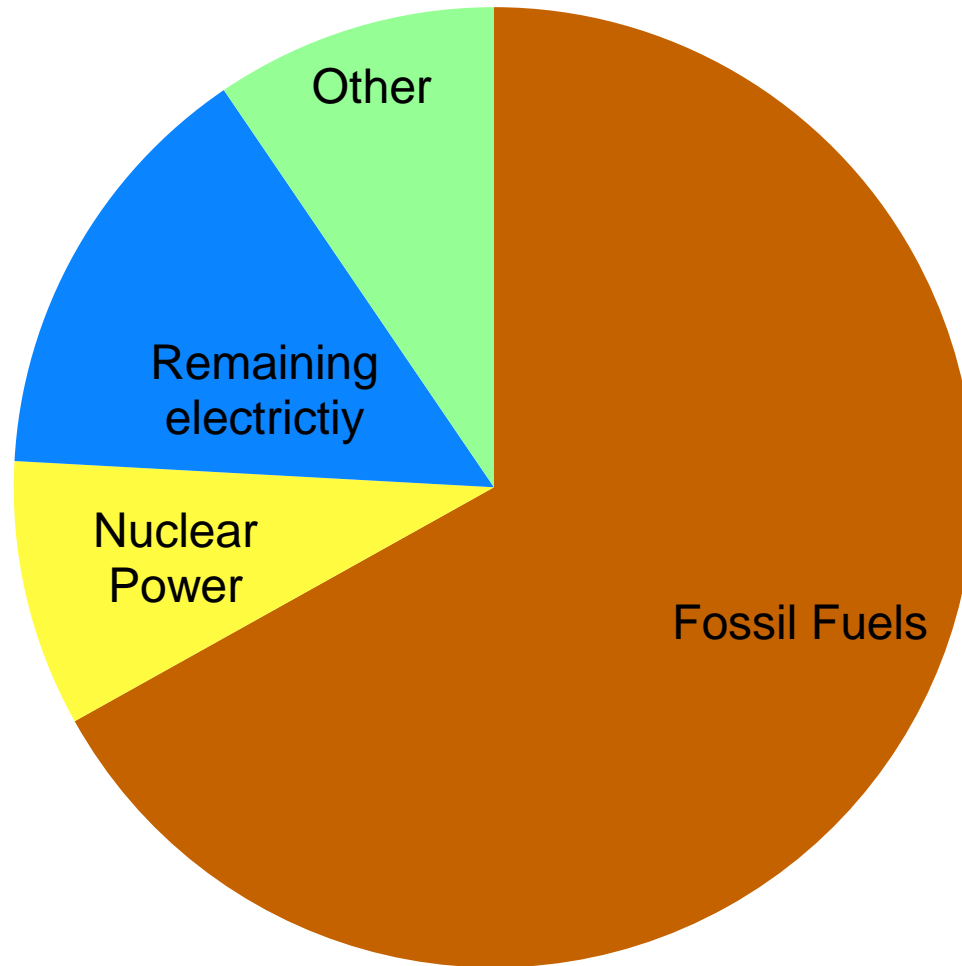
 - Materials

 - Systems

 - Cities

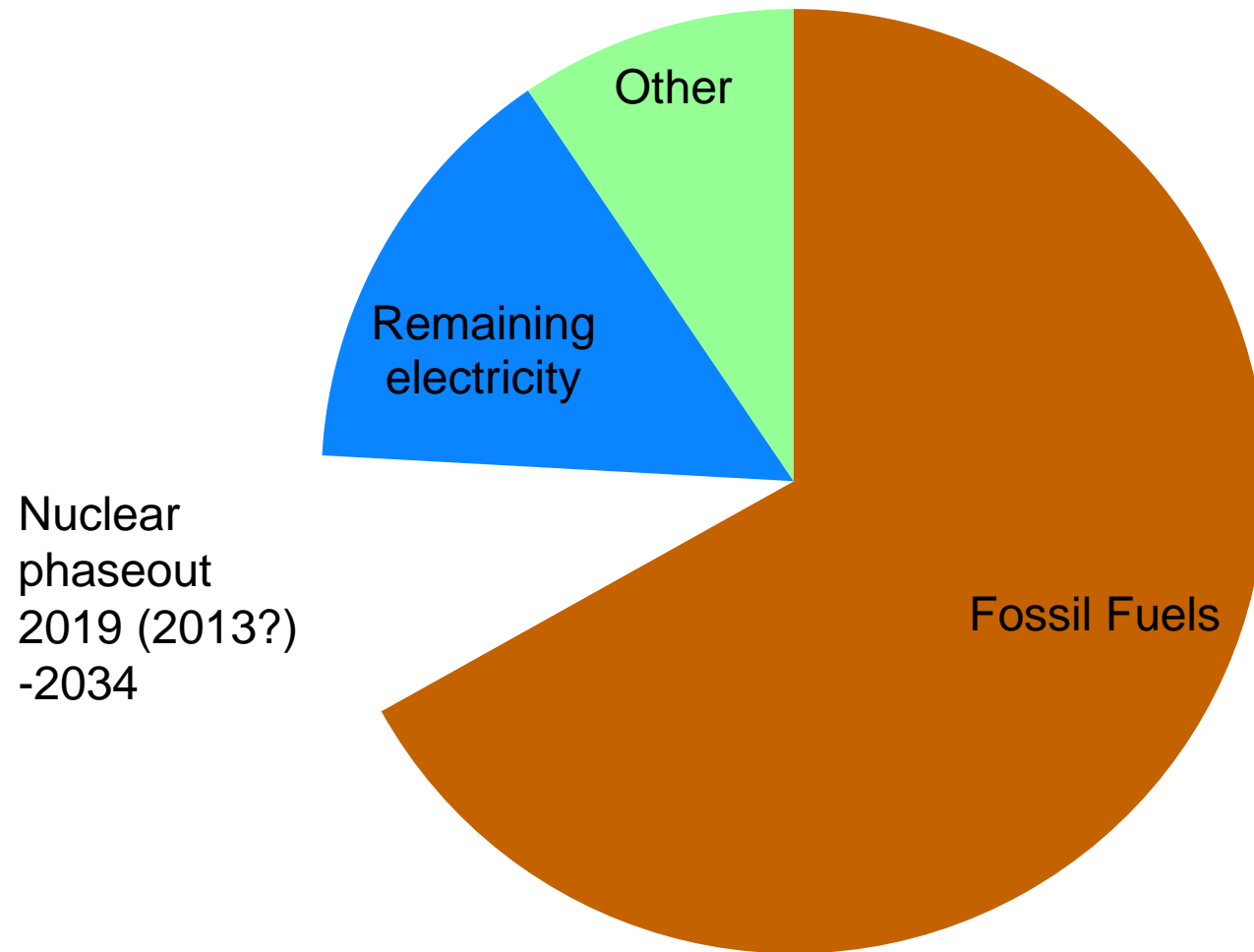
- Boosting Technology Transfer

Final Energy Use CH 2010



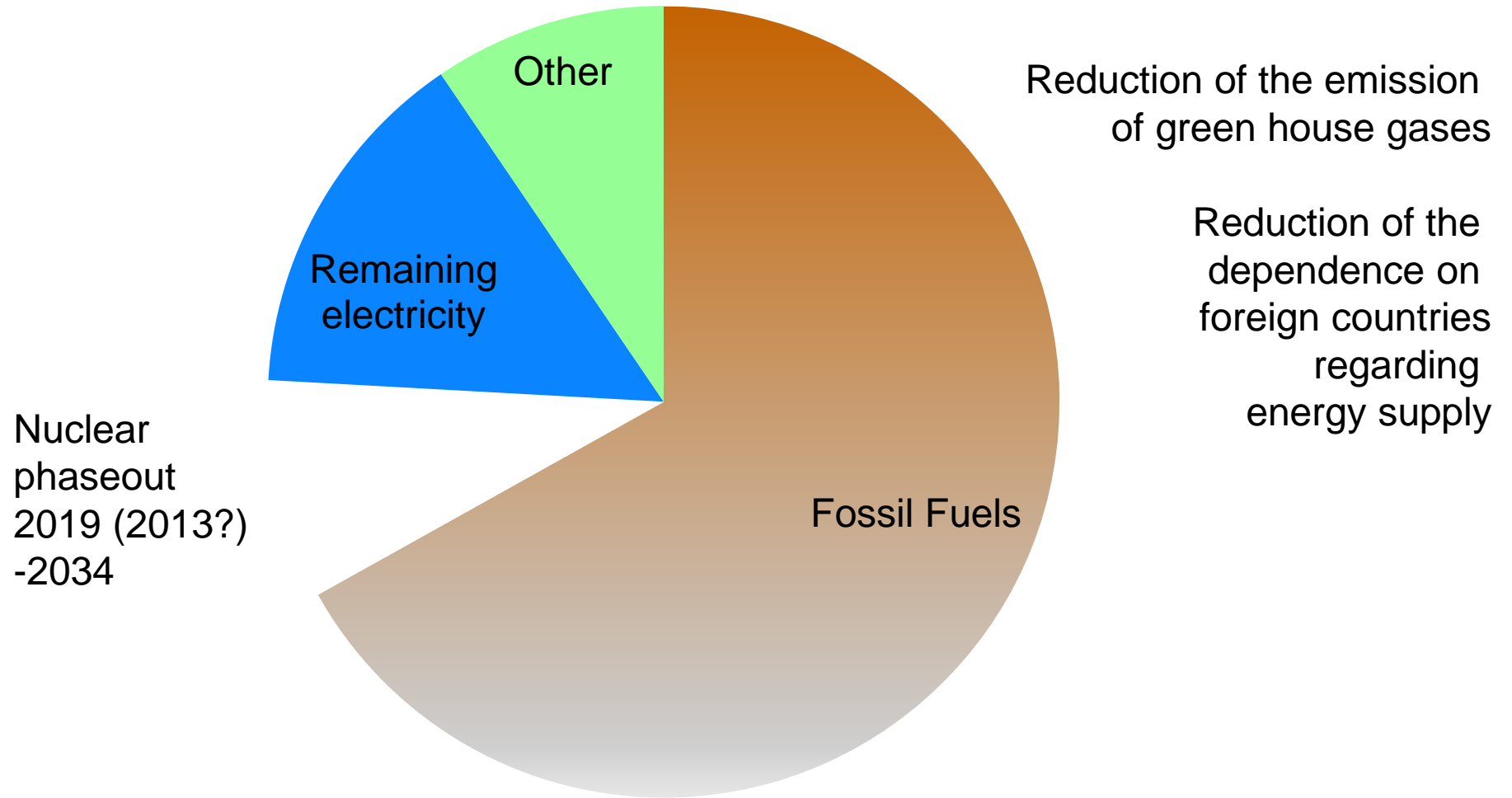
**End User Costs:
CHF 30.5 Billions**

Challenges of the Future I



Nuclear
phaseout
2019 (2013?)
-2034

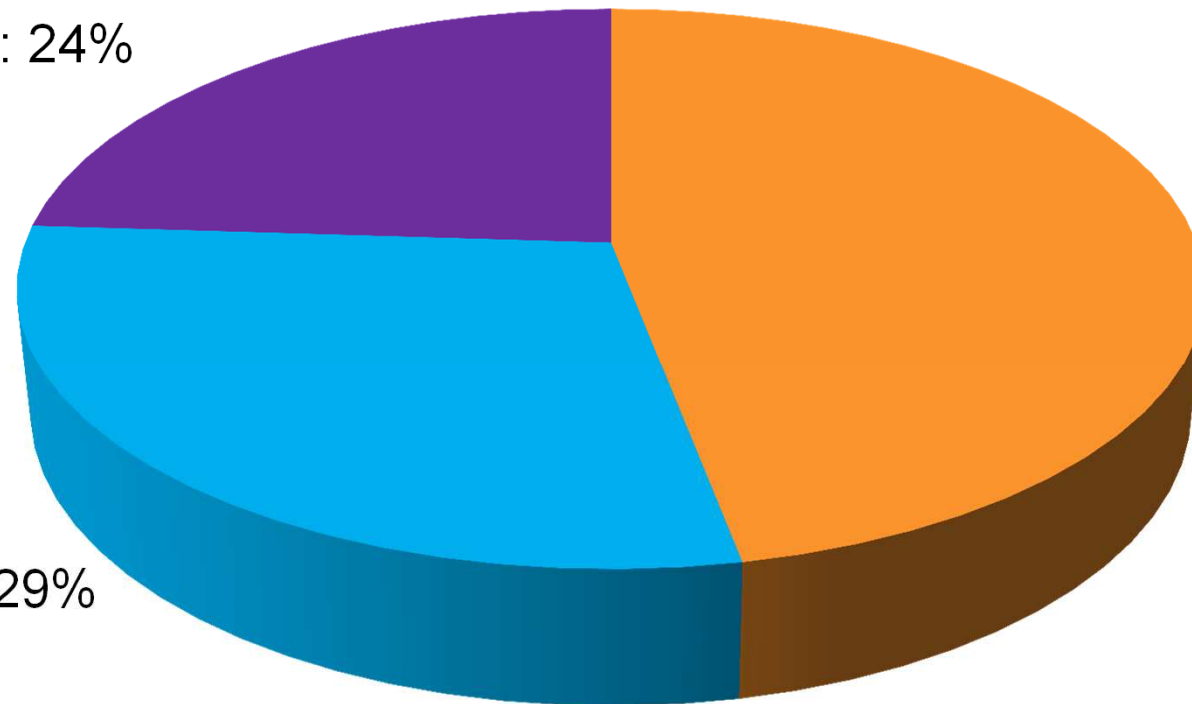
Challenges of the Future II



Final Energy Use CH 2009

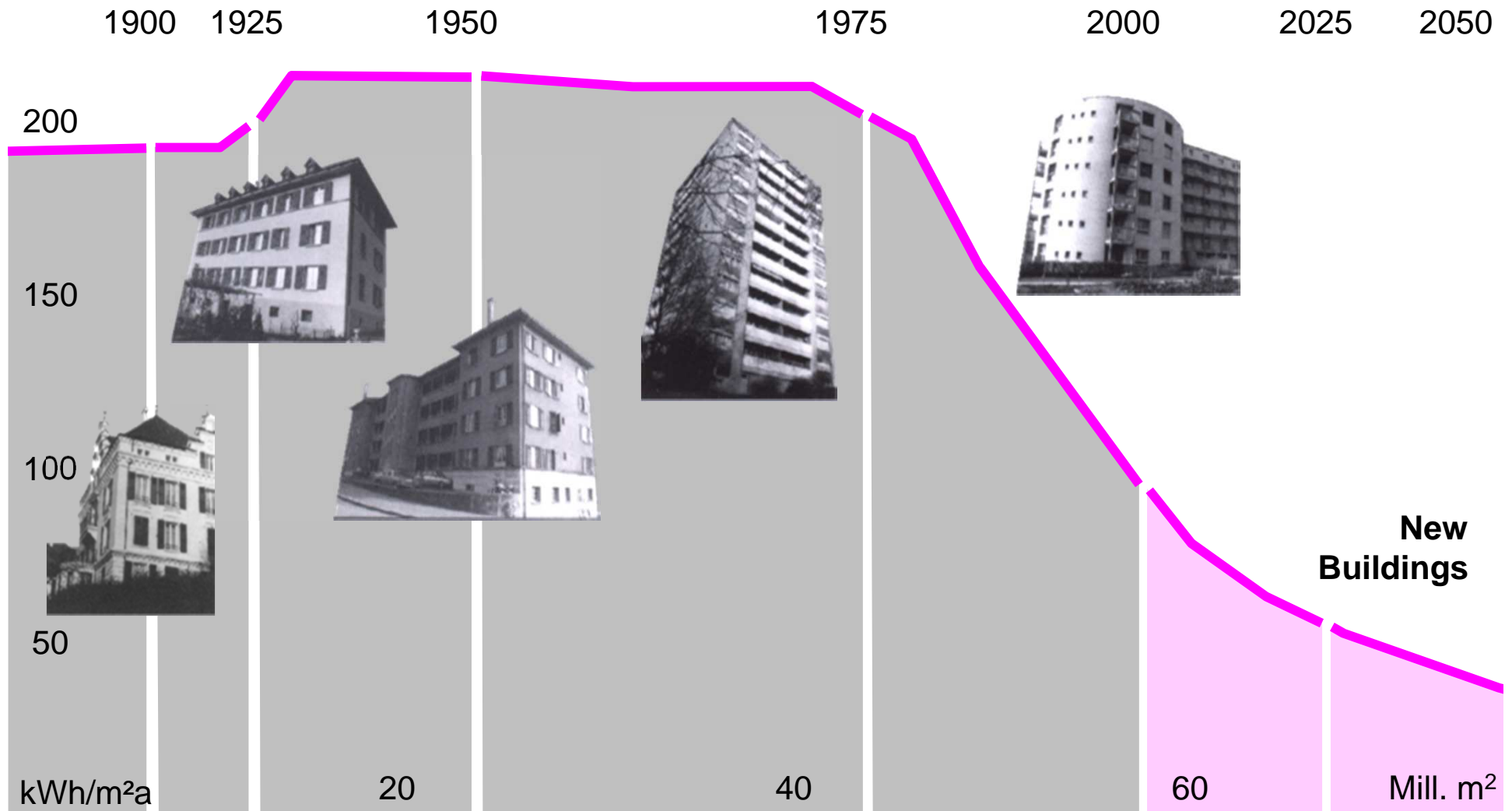
Industry,
Services,
Agriculture: 24%

Mobility: 29%

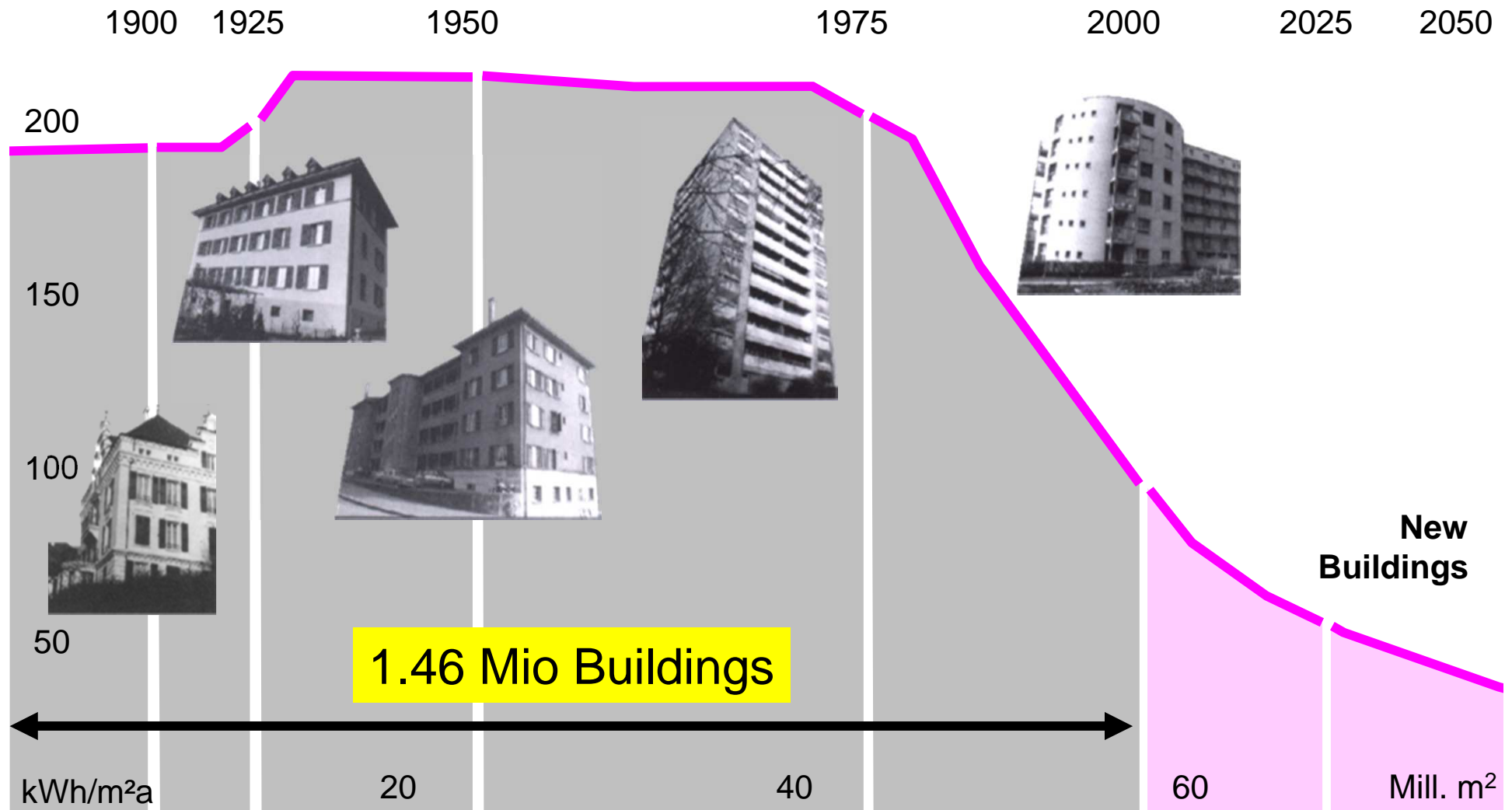


Buildings: 47%

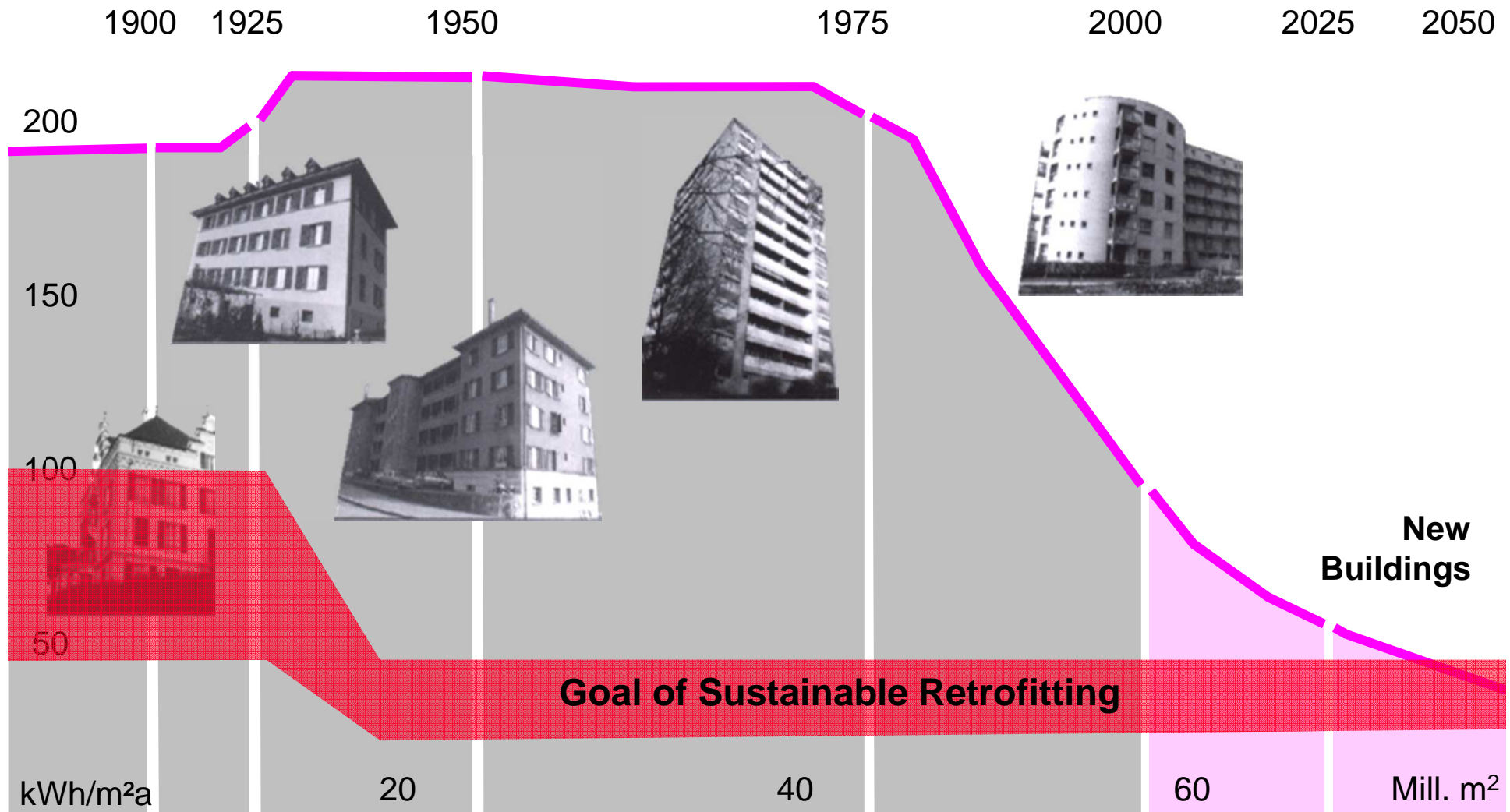
Energy Demand of Residential Buildings in Switzerland as Function of the Year of Construction



Energy Demand of Residential Buildings in Switzerland as Function of the Year of Construction



Energy Demand of Residential Buildings in Switzerland as Function of the Year of Construction



From Materials

Aerogel Plaster

- Lower thermal conductivity than conventional insulation materials: 25 mW/m*K
- Application by standard methods
- Purely mineralic material
- Open for water vapour diffusion

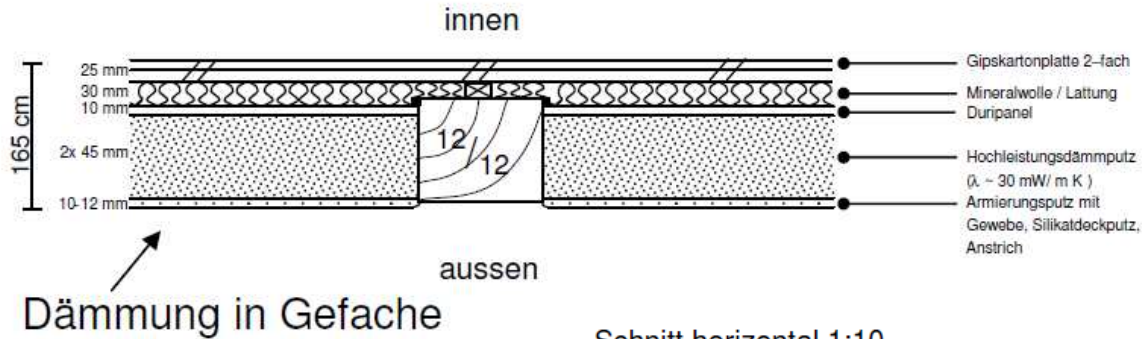


About 85% nanoporous aerogel granulate is used as additive for the light weight plaster

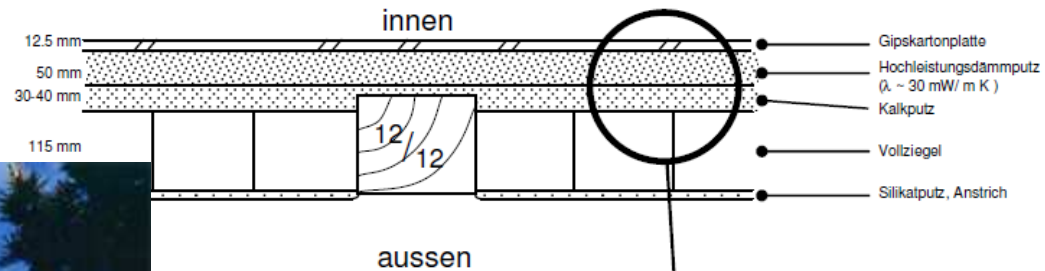


Applications: Half-timbered Houses

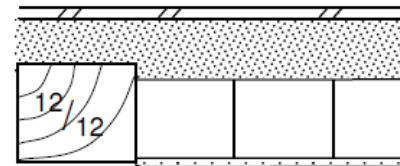
Schnitt horizontal 1:10



Schnitt horizontal 1:10



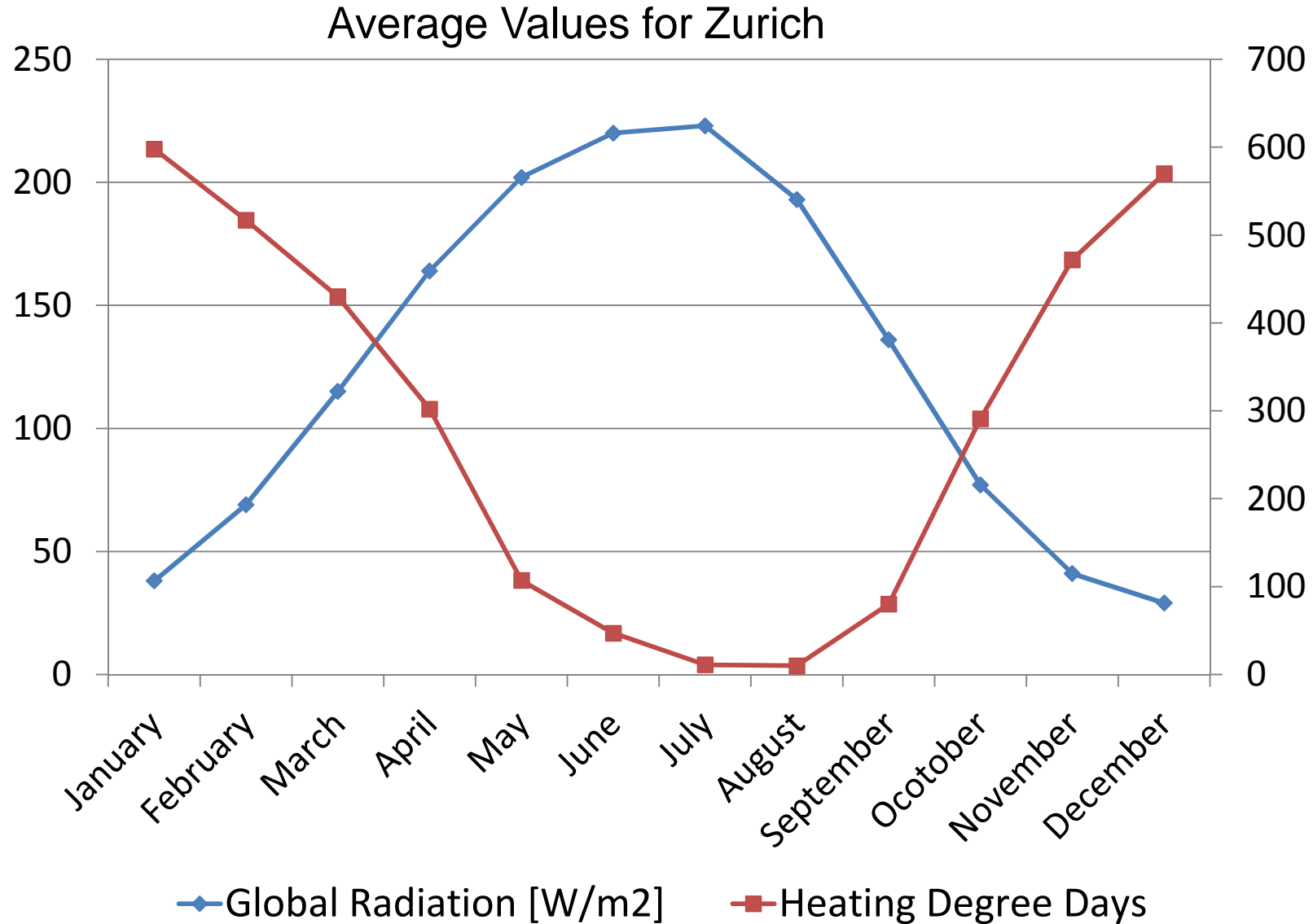
und / oder



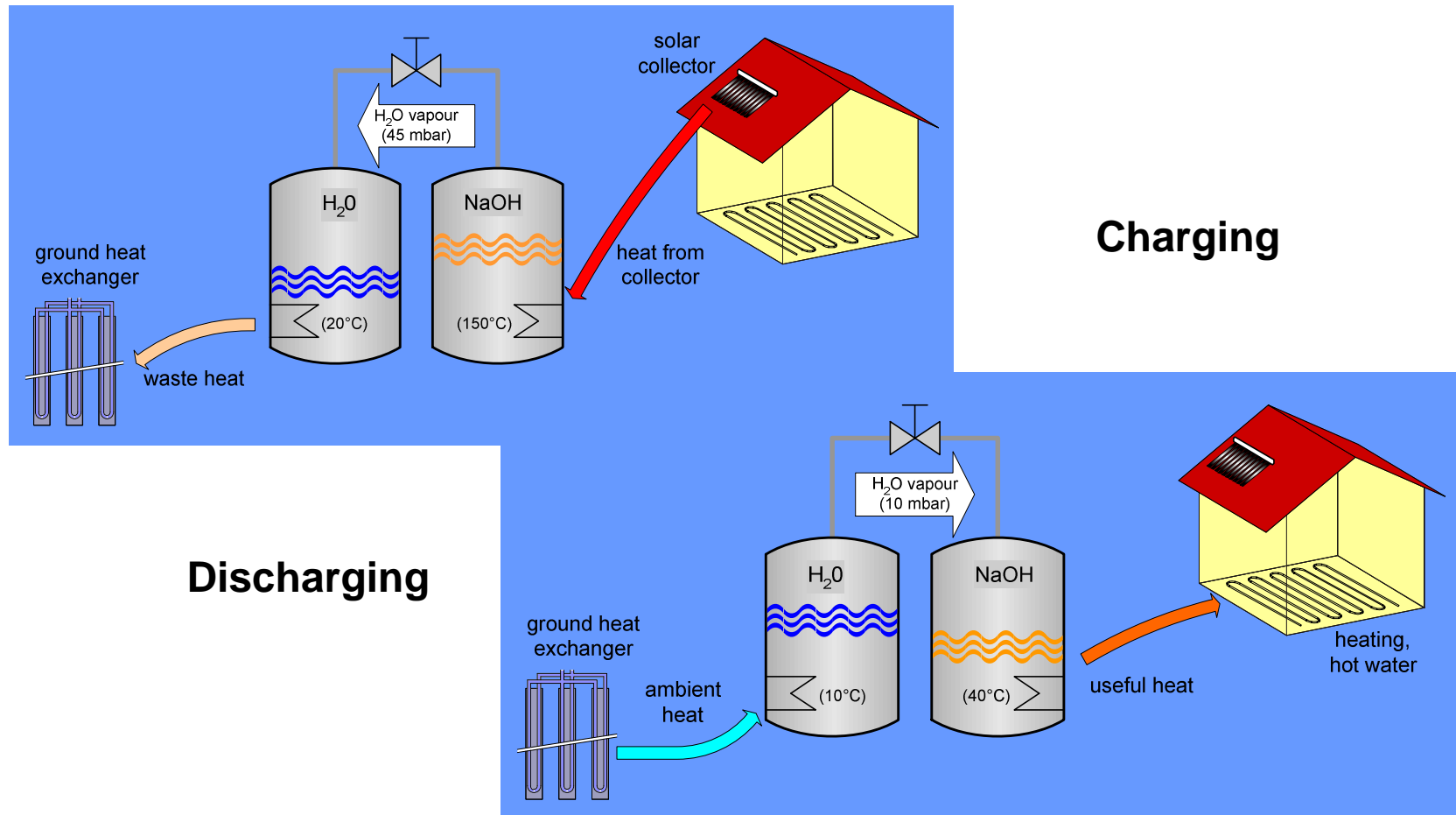
Innendämmung (Dämmputz direkt auf Ziegel)



From Materials to Systems: Seasonal Heat Storage



Chemical Heat Storage with NaOH



Storage density: 7 times higher than for water at 30°C

Chemical Heat Storage with Ettringite

Calcium sulfoaluminate (CSA) clinker (commercially available)

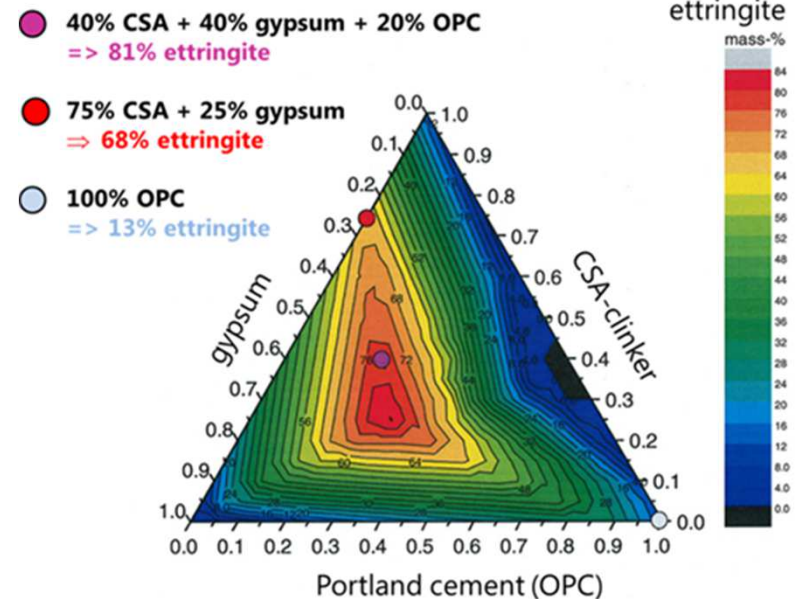
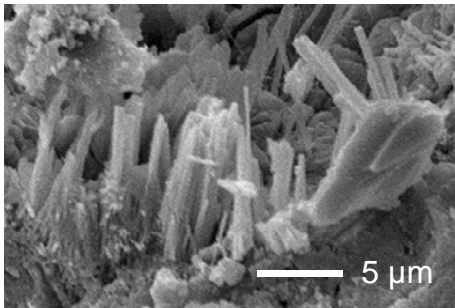
limestone, bauxite and anhydrite + rotary kiln $\approx 1250^{\circ}\text{C}$

main phase: ye'elimite ($4\text{CaO}\cdot 3\text{Al}_2\text{O}_3\cdot \text{SO}_3$)

blended with

15-25% calcium sulfate (gypsum, anhydrite) and/or Portland cement (OPC)

main hydration product: **ettringite**



600 kJ/kg ettringite



From Materials to Systems to Buildings

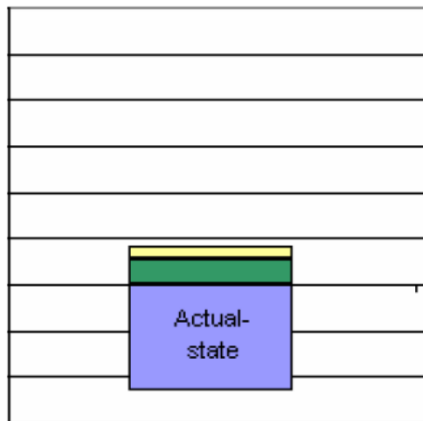
Retrofit Advisor

- Rapid analysis of to potential for **retrofitting of existing multi-family houses**
- Evaluation of **economic, energetic, environmental and social** aspects
- Supporting the selection of the appropriate option: **Repair, renewal or demolition and new construction**
- Focus on renewal with an energy performance of **30-50 kWh/(m²·a) (Minergie to Passive House)**

Retrofit Advisor



Ist-
Zustand



Retrofit Advisor





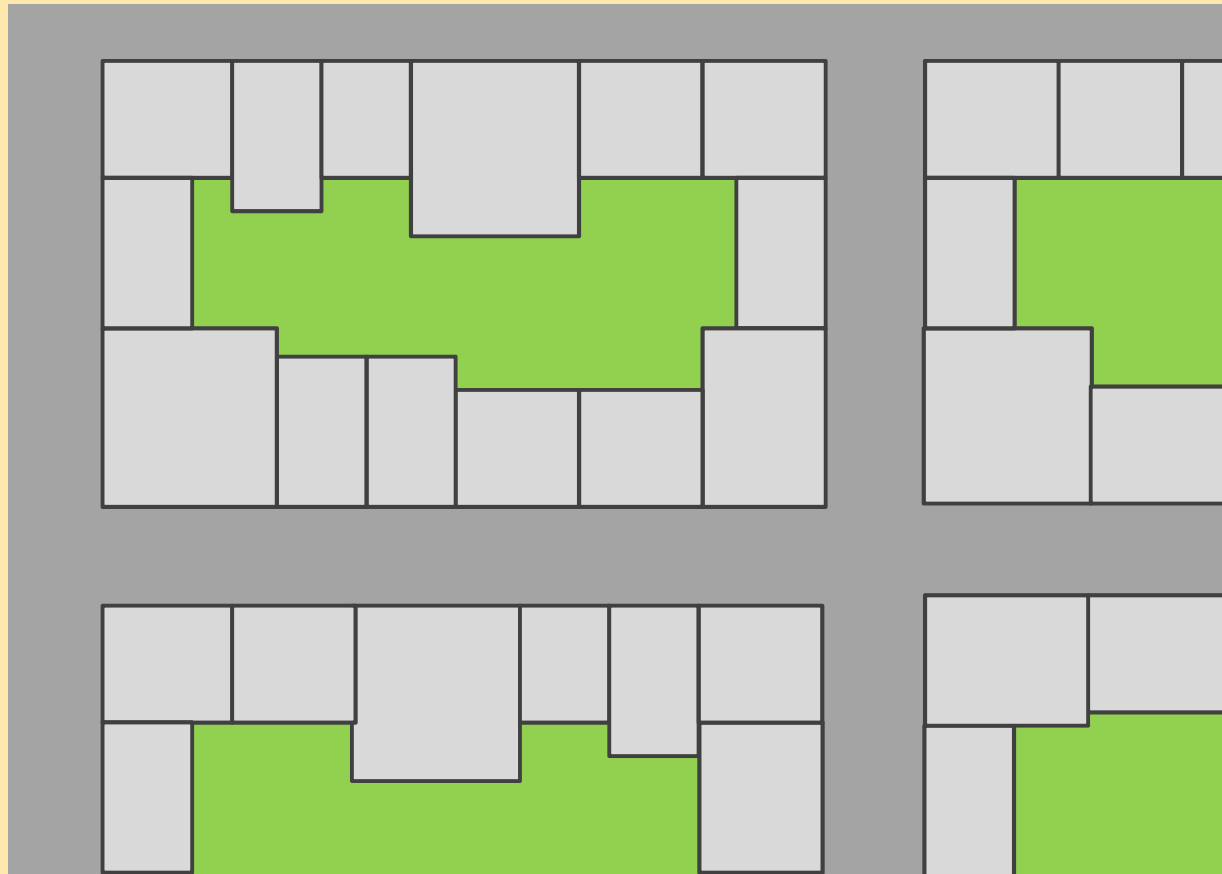
Multi-family residential building
Zug, Architect Reto Miloni



Multi-family residential building
Zürich,
Architect Beat Kämpfen

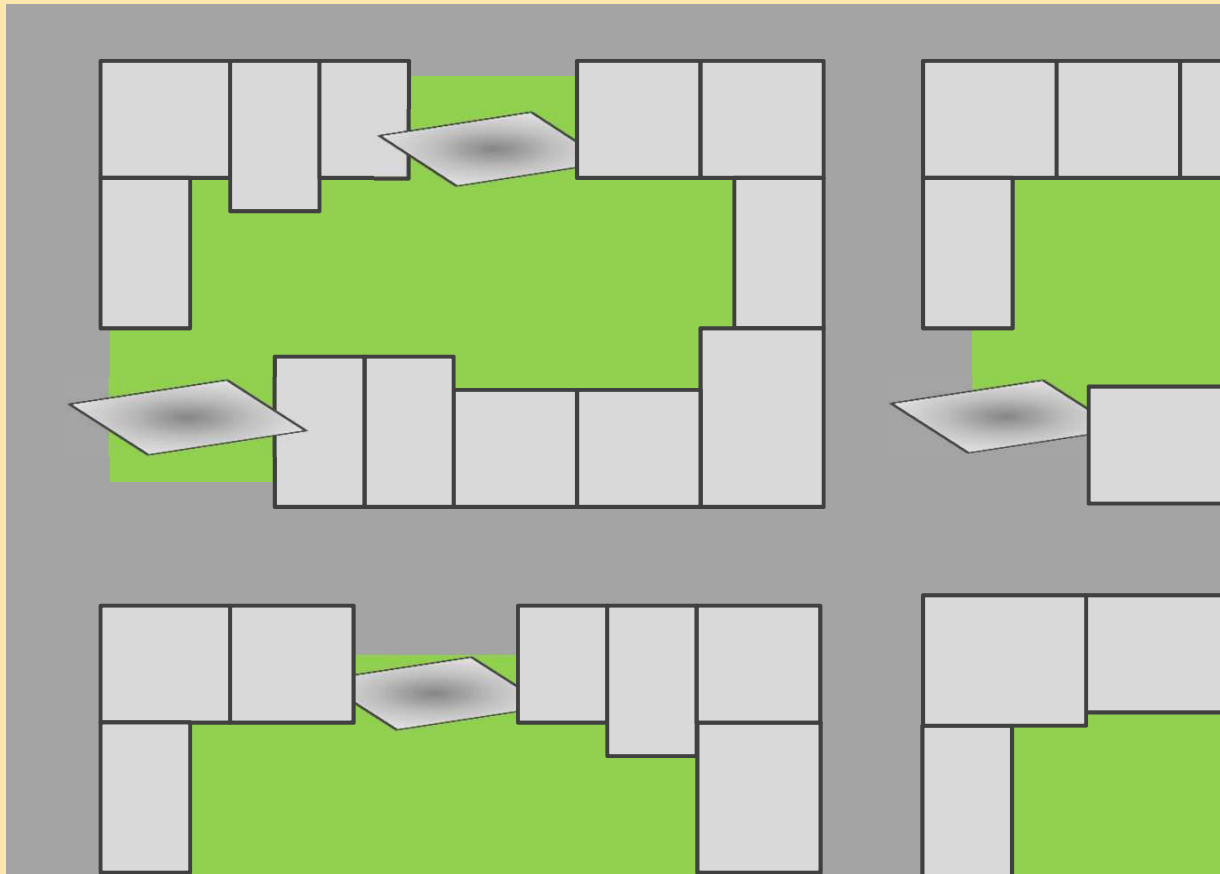


Adaption of communities towards SELF-REGULATING ENERGY systems



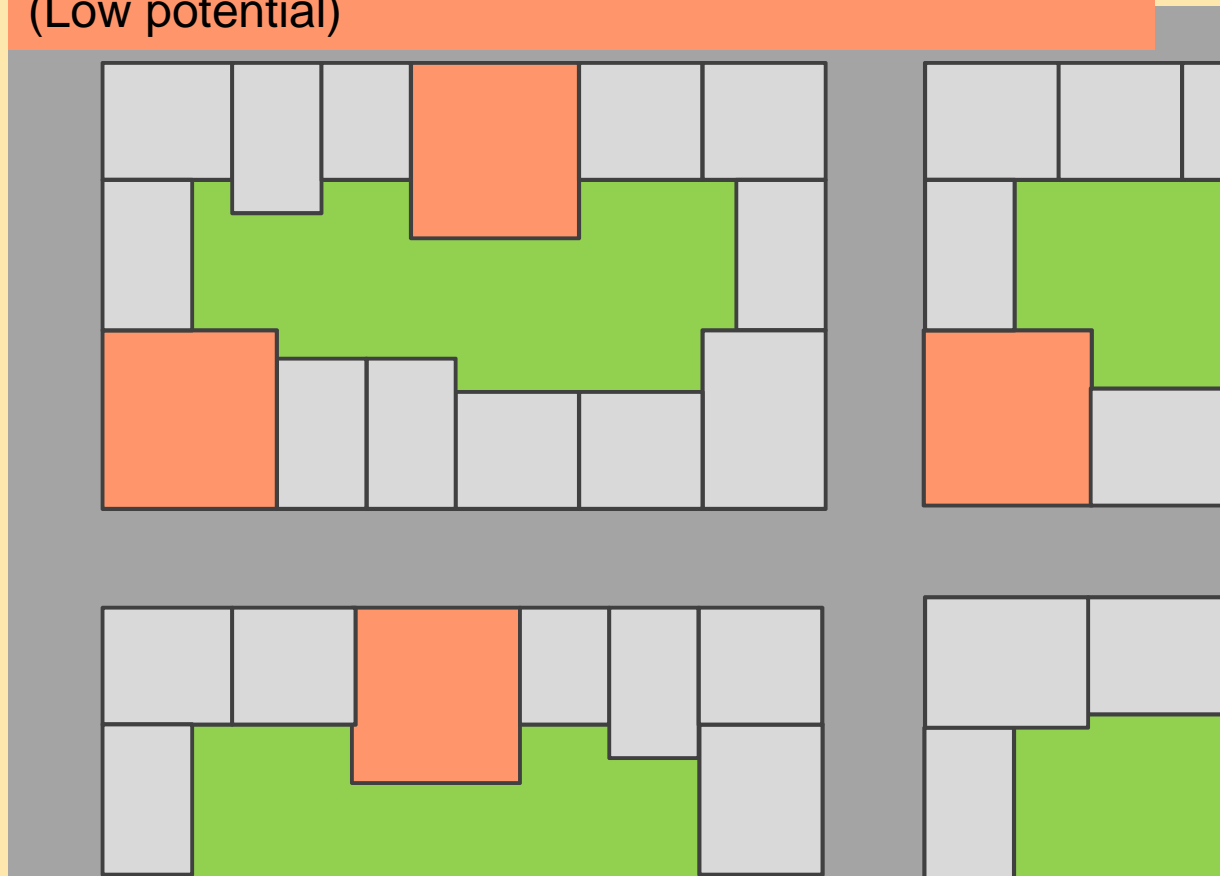
Adaption of communities towards SELF-REGULATING ENERGY systems

Demolition of some houses



Adaption of communities towards SELF-REGULATING ENERGY systems

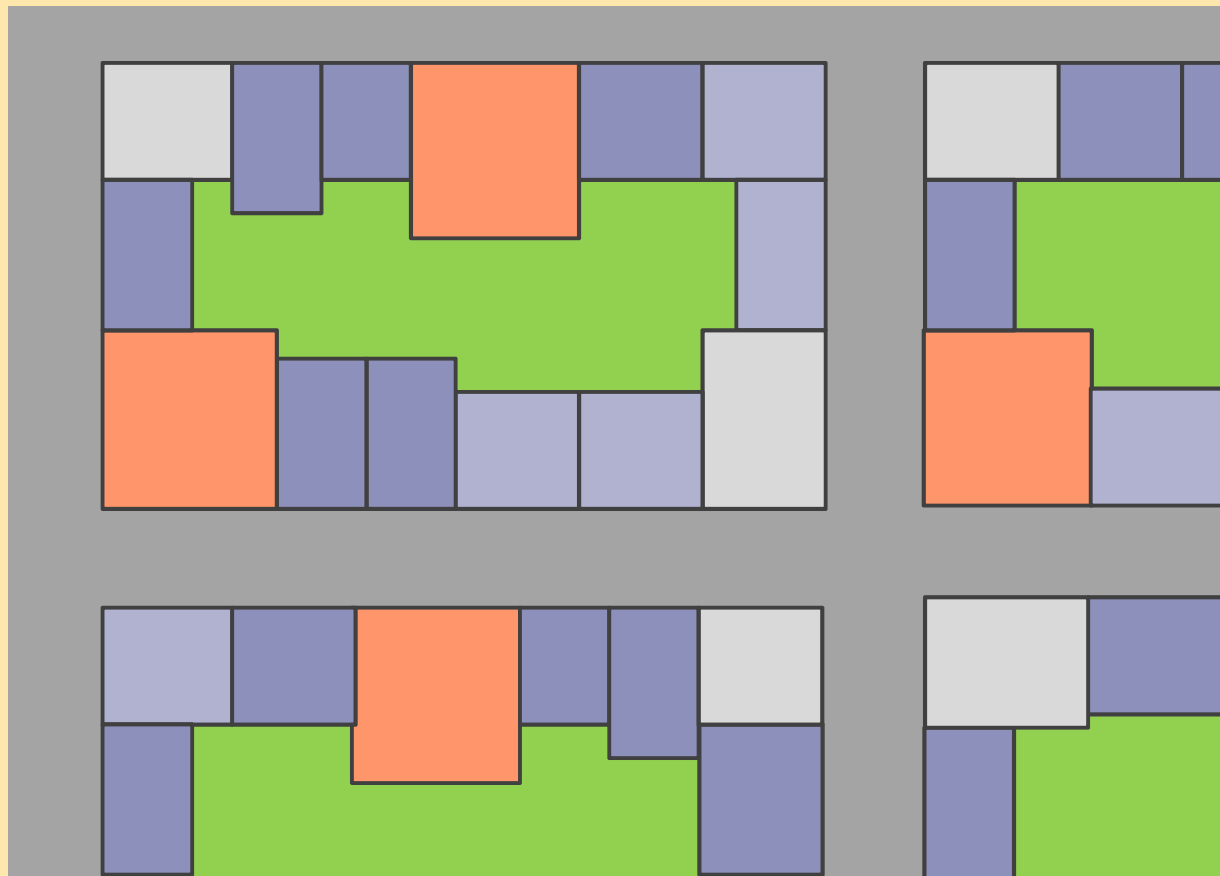
Replacement by energy positive houses (Low potential)



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).

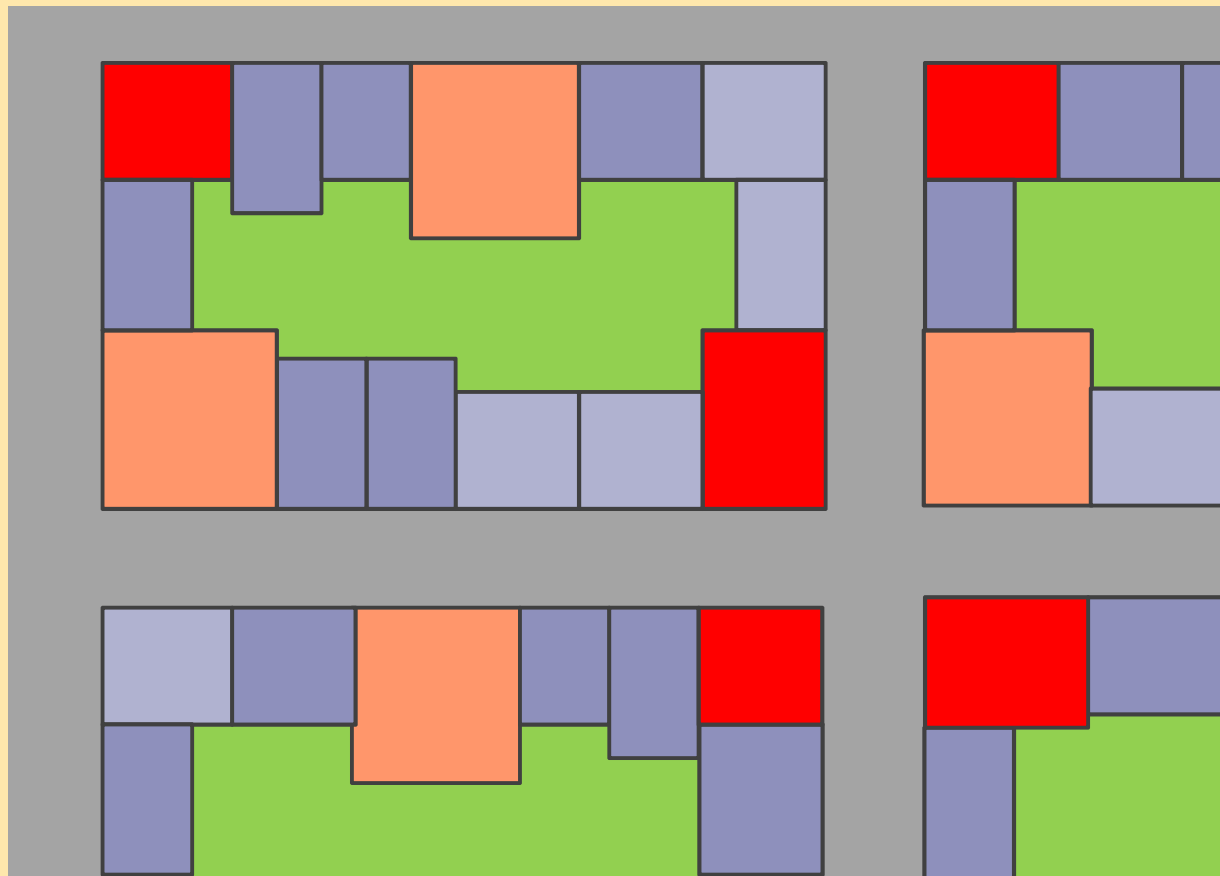
Adaption of communities towards SELF-REGULATING ENERGY systems

Advanced renovation and renewables (Minergie A, Minergie-P)



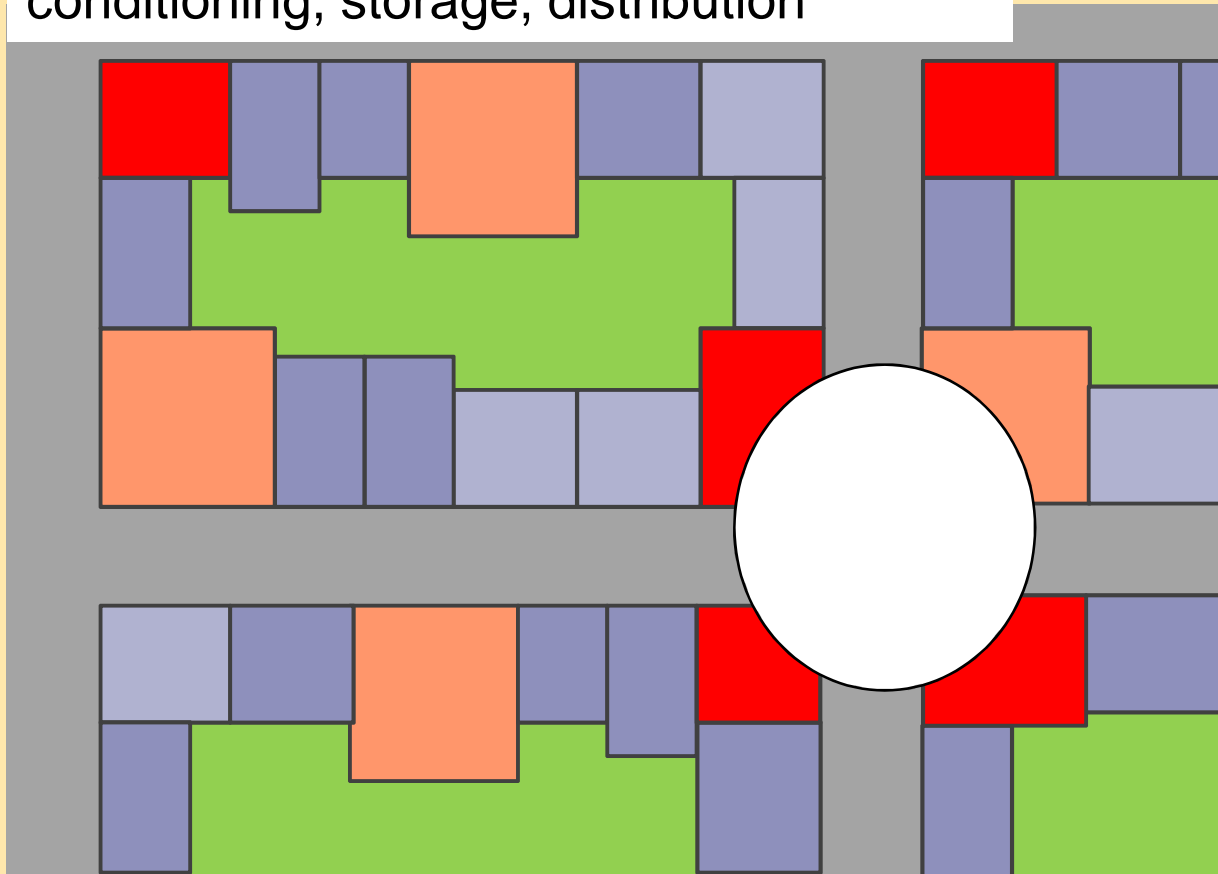
Adaption of communities towards SELF-REGULATING ENERGY systems

Protected Buildings : (seasonal) storage



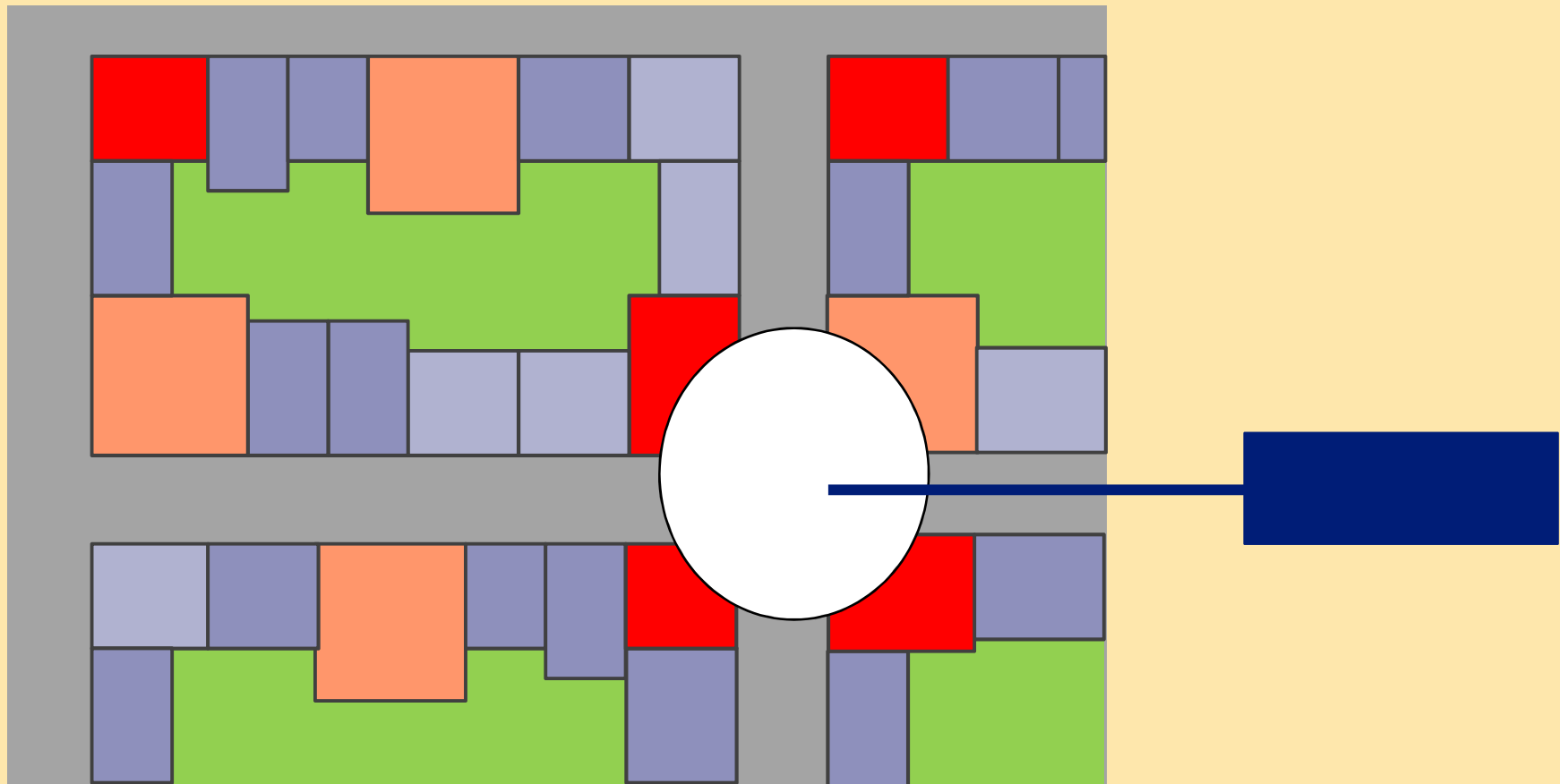
Adaption of communities towards SELF-REGULATING ENERGY systems

Energy Hub: energy conversion
unit
conditioning, storage, distribution



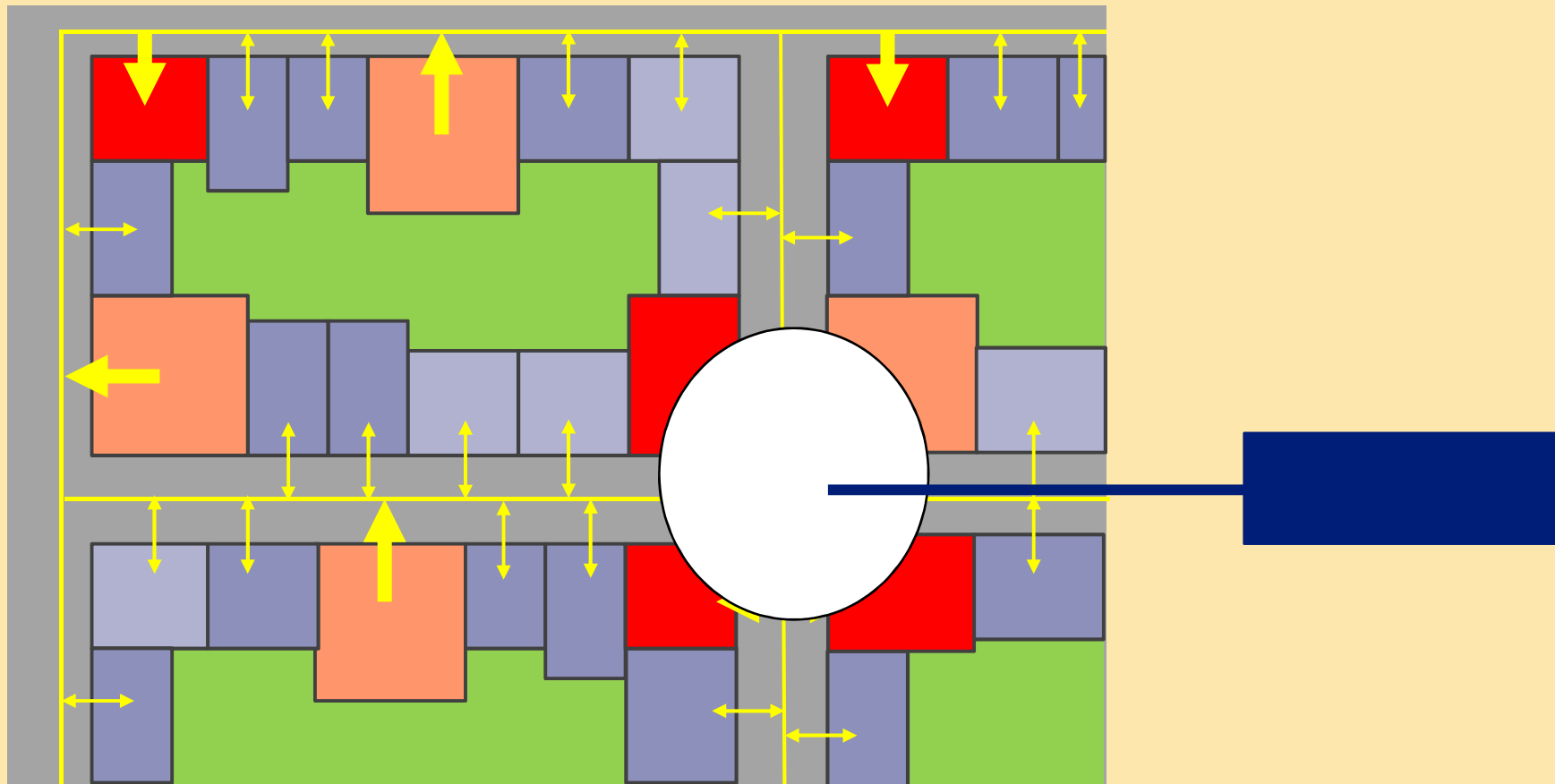
Adaption of communities towards SELF-REGULATING ENERGY systems

Local energy resources:
biomass, wind-energy



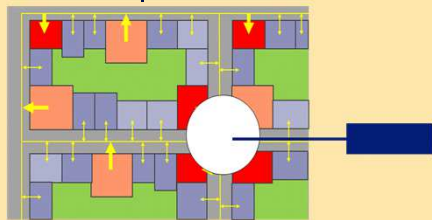
Adaption of communities towards SELF-REGULATING ENERGY systems

Community integration
heating/cooling, IT, electricity networks. Flexibility.

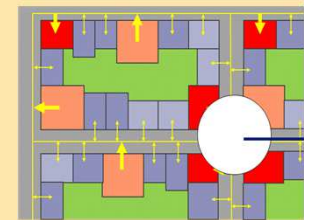
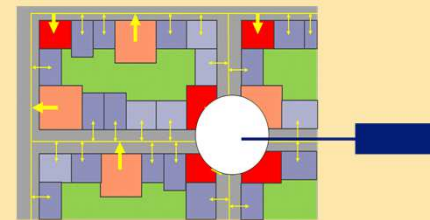
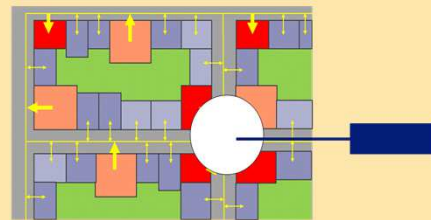


Adaption of communities towards SELF-REGULATING ENERGY systems

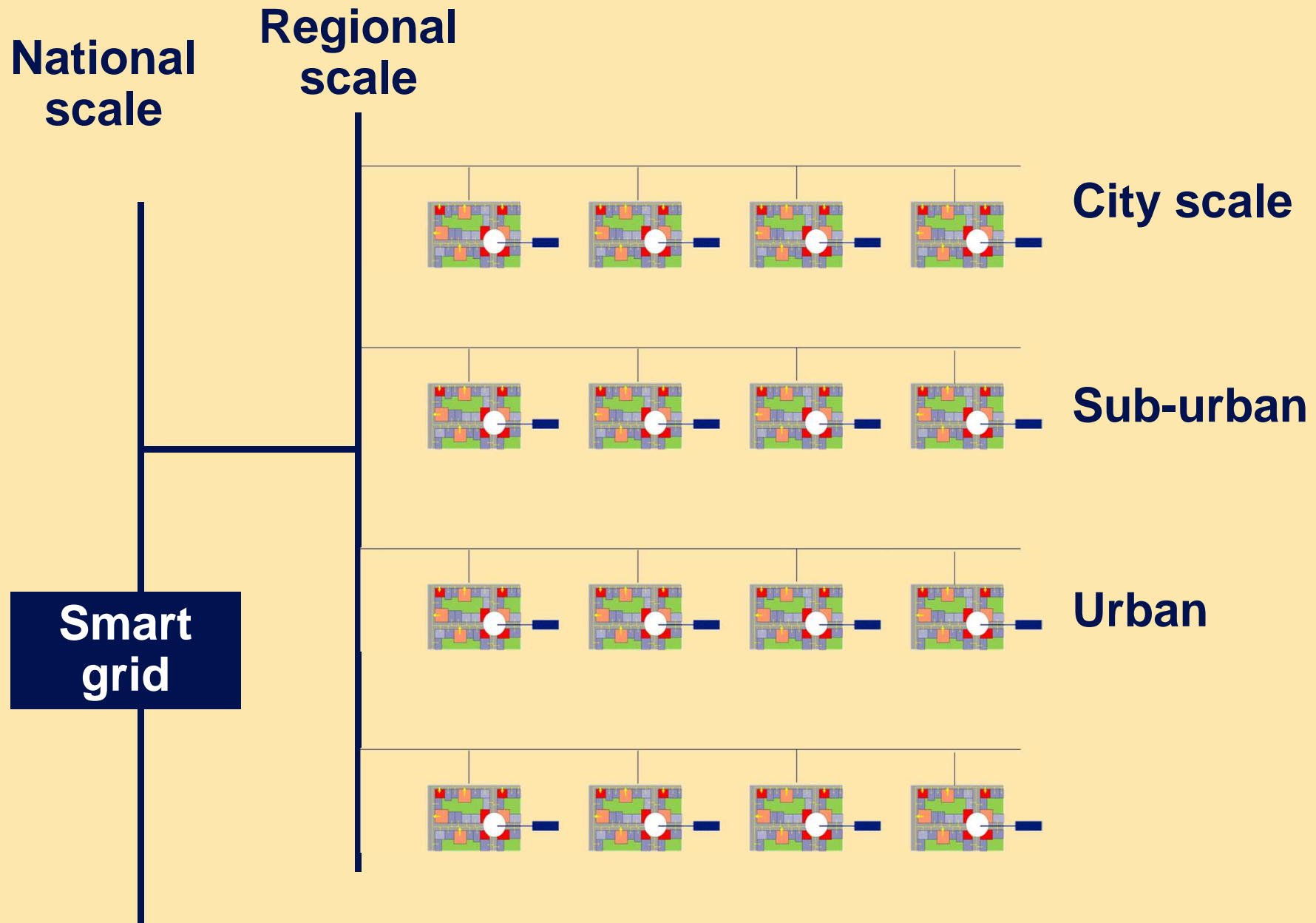
City scale



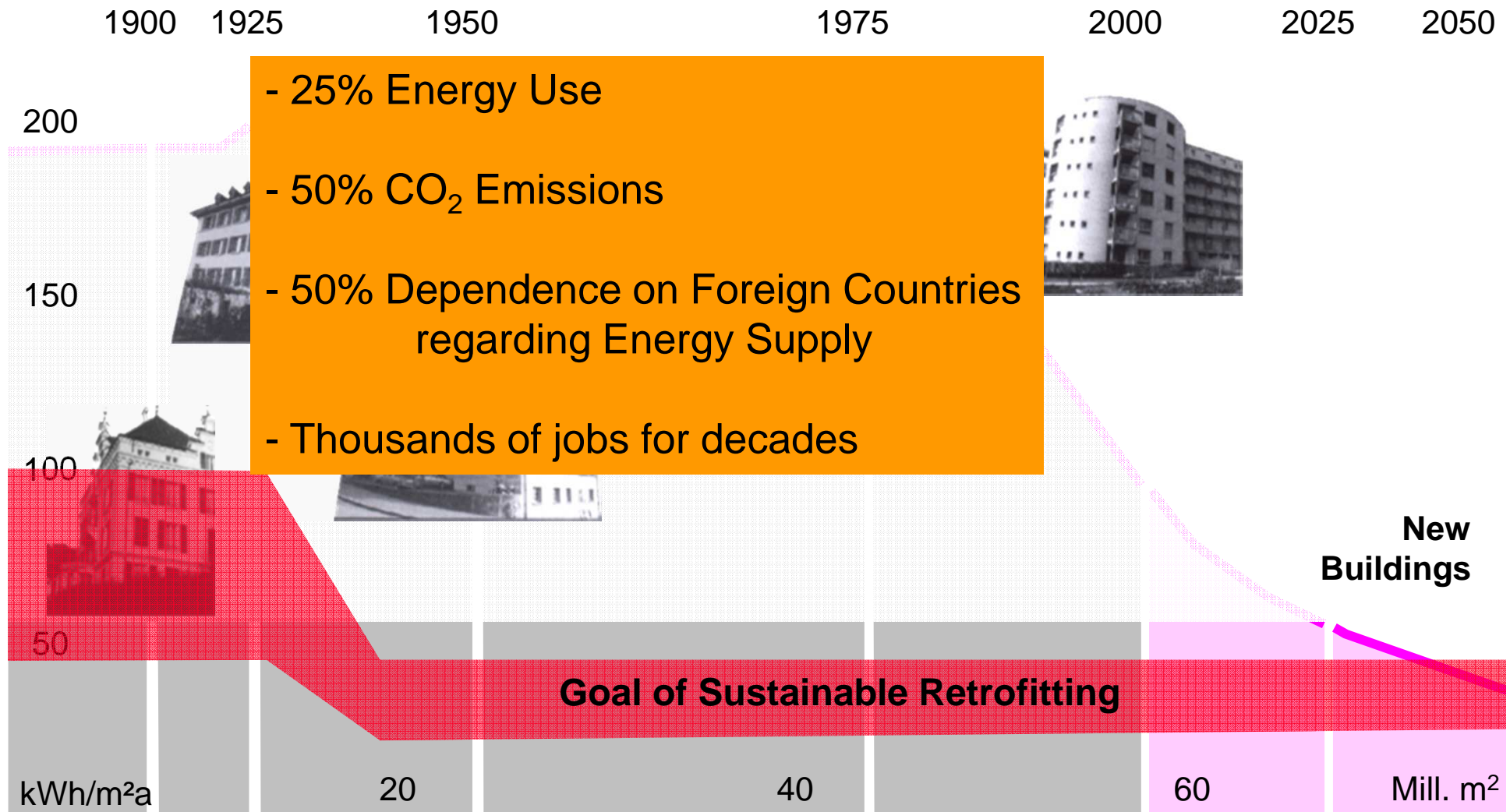
community



Adaption of communities towards SELF-REGULATING ENERGY systems



Energy Demand of Residential Buildings in Switzerland as Function of the Year of Construction



Content

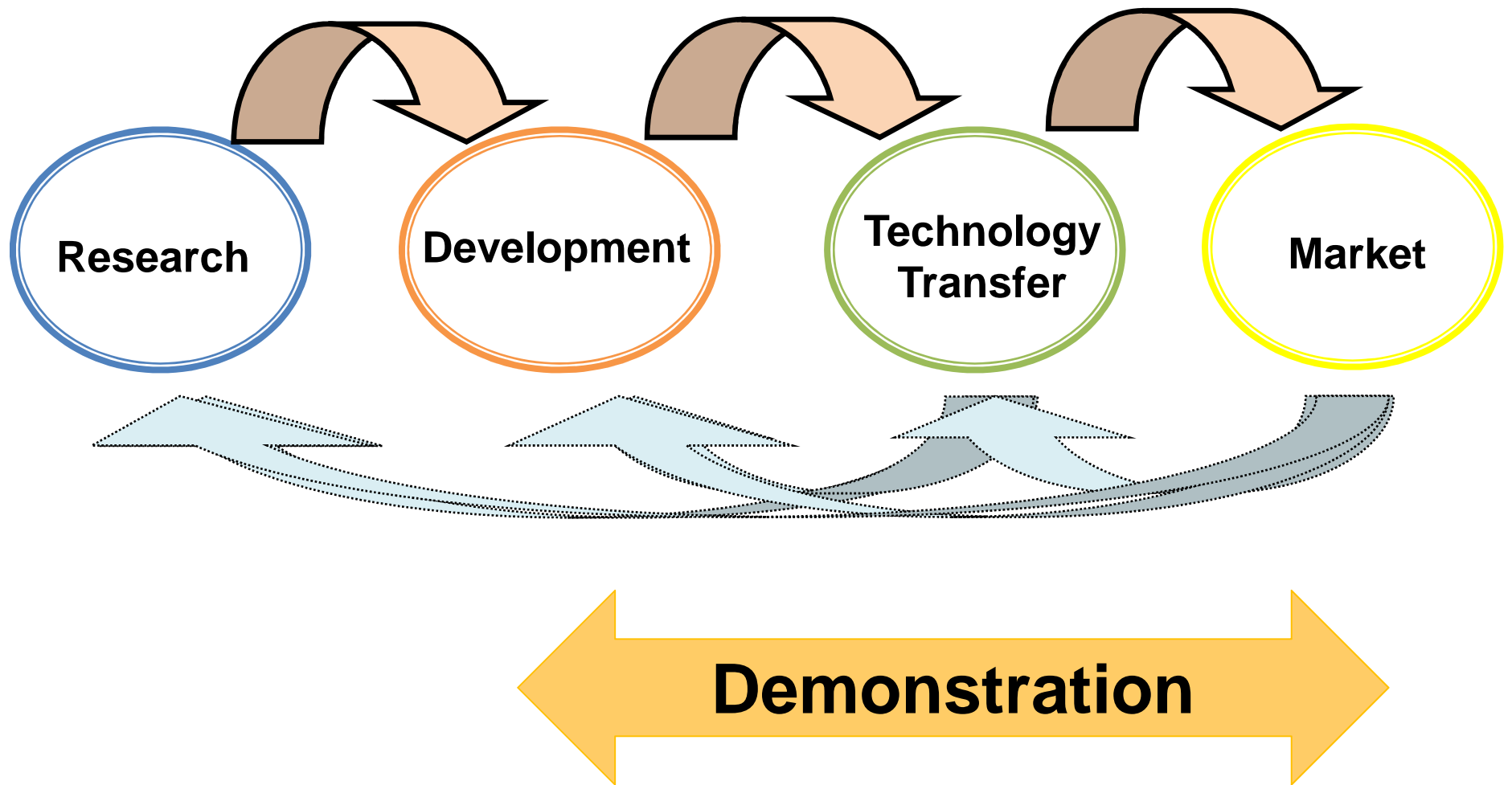
- Buildings

 - Materials

 - Systems

 - Cities

- Boosting Technology Transfer



Vision NEST: Center for Sustainable Construction Science and Engineering

Large scale research backbone, a kind of inverse Lab that enables:

- Holistic research: materials → components → systems → users (incl. living and working environment, e.g. guest house)
- Provides real life conditions (scale, environment, users)
- Dynamic, adaptable, flexible and modular
- Attractor for national and international partners from academia and industry

Benefits:

- Boosting innovative edge of (Swiss) construction industry
- Technology Transfer Platform
- Development and demonstration of new solutions for local and global challenges in the built environment with clients













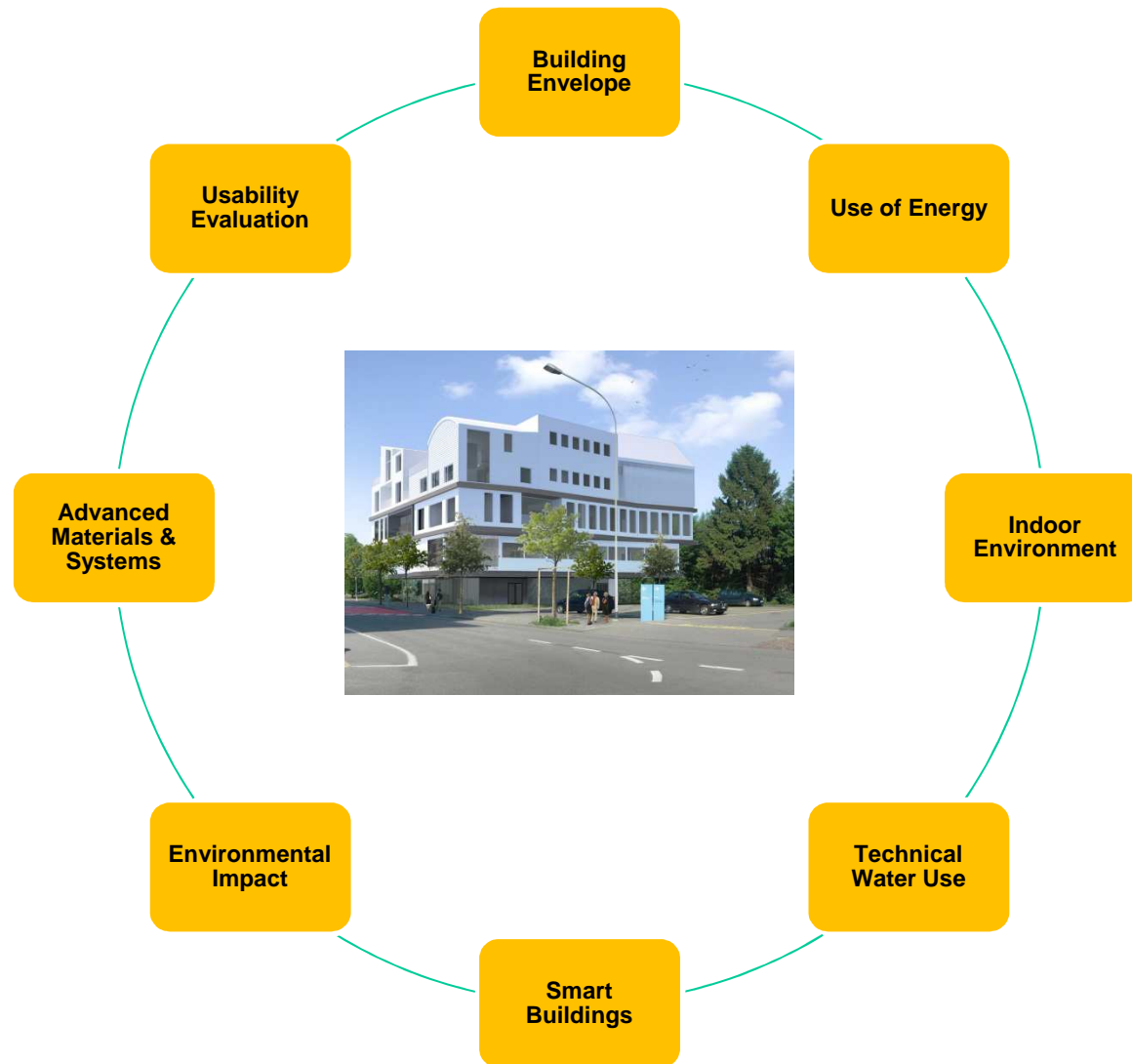








A Holistic and Sustainable Approach





Thank you for your much-
appreciated Attention