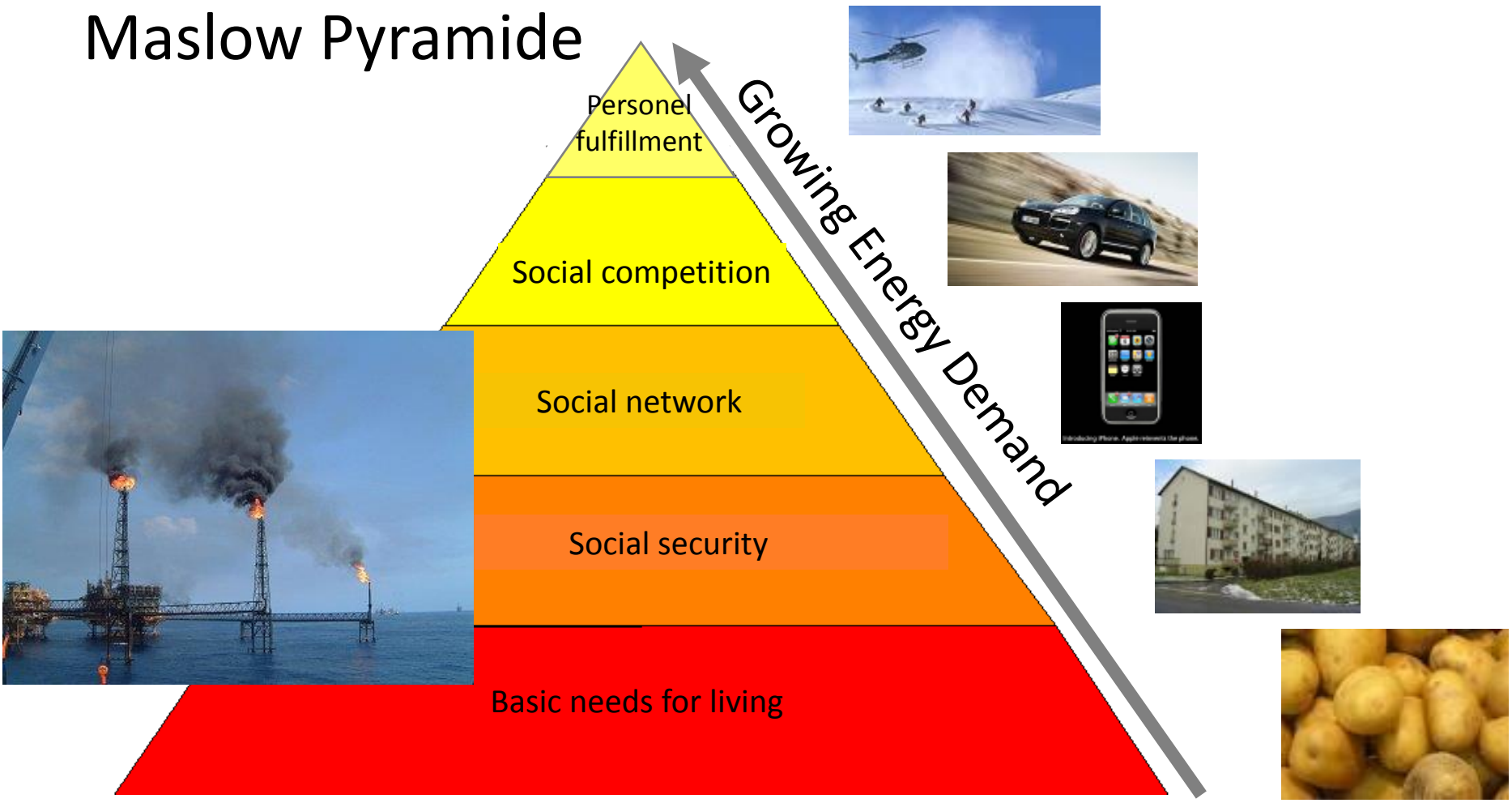
Role of prefabricated systems in massive Low Energy Renovation of Building

Mark Zimmermann
Empa

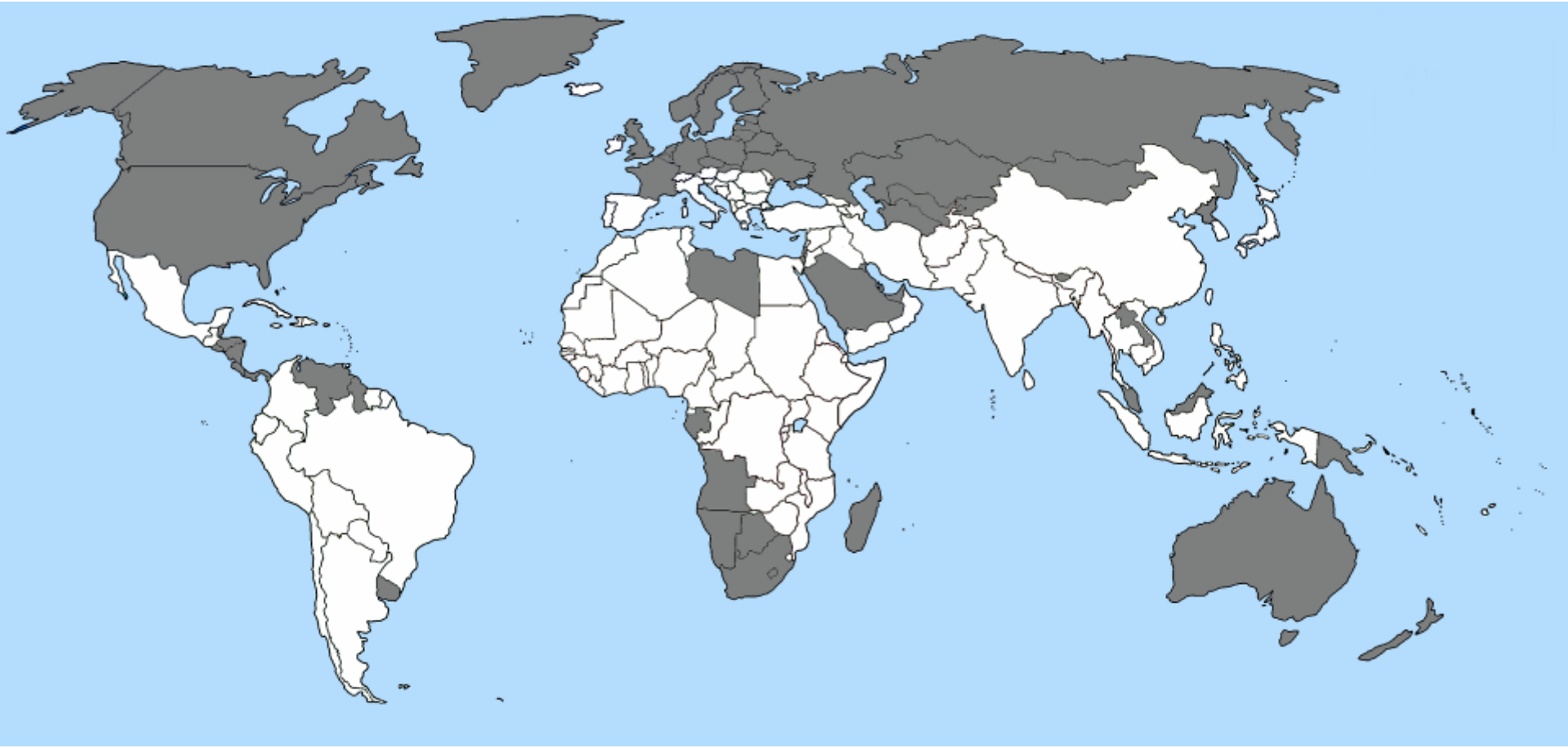
EMPA
Materials Science & Technology

How much energy do we really need ?

Maslow Pyramide

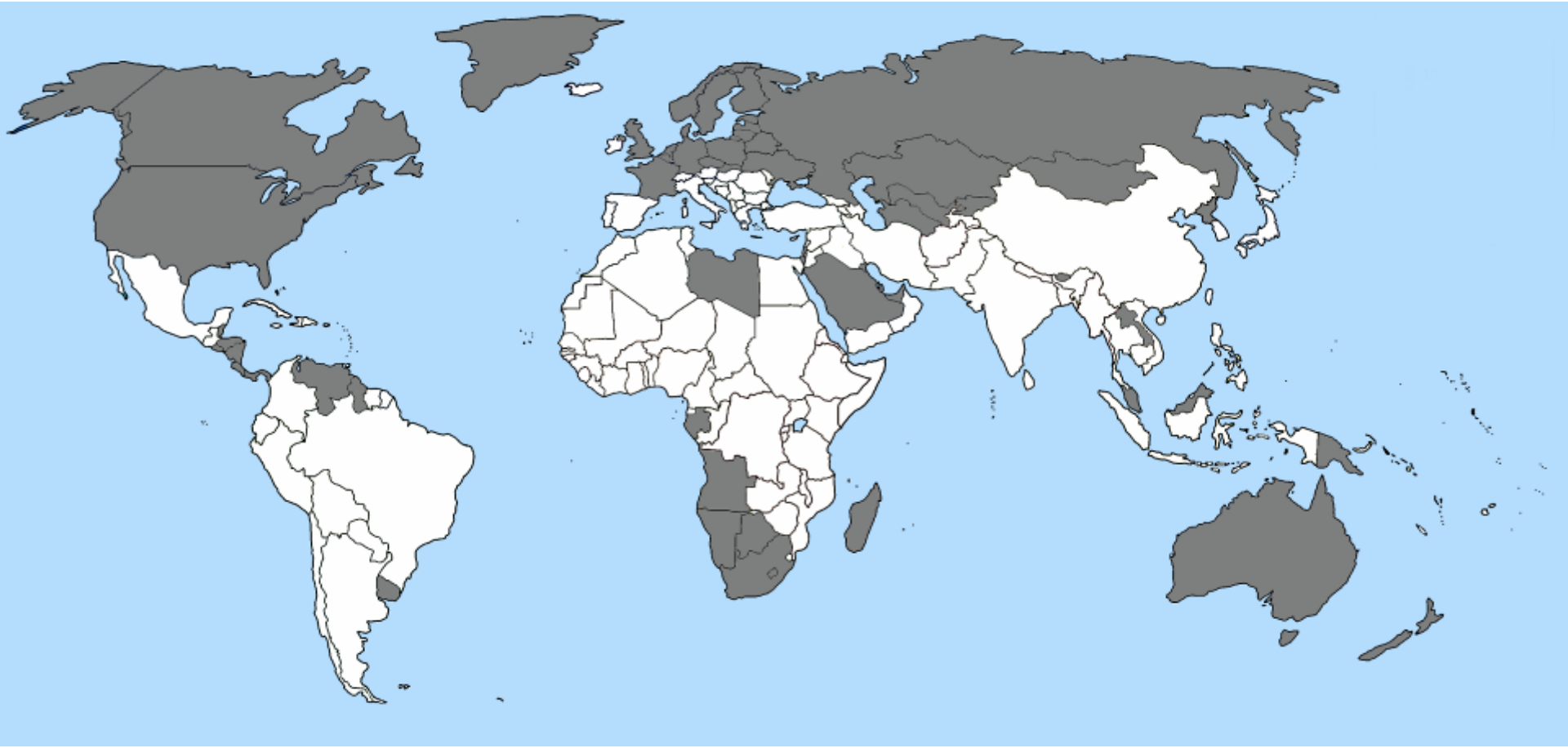


Countries with Highest CO2 Emissionen per Capita



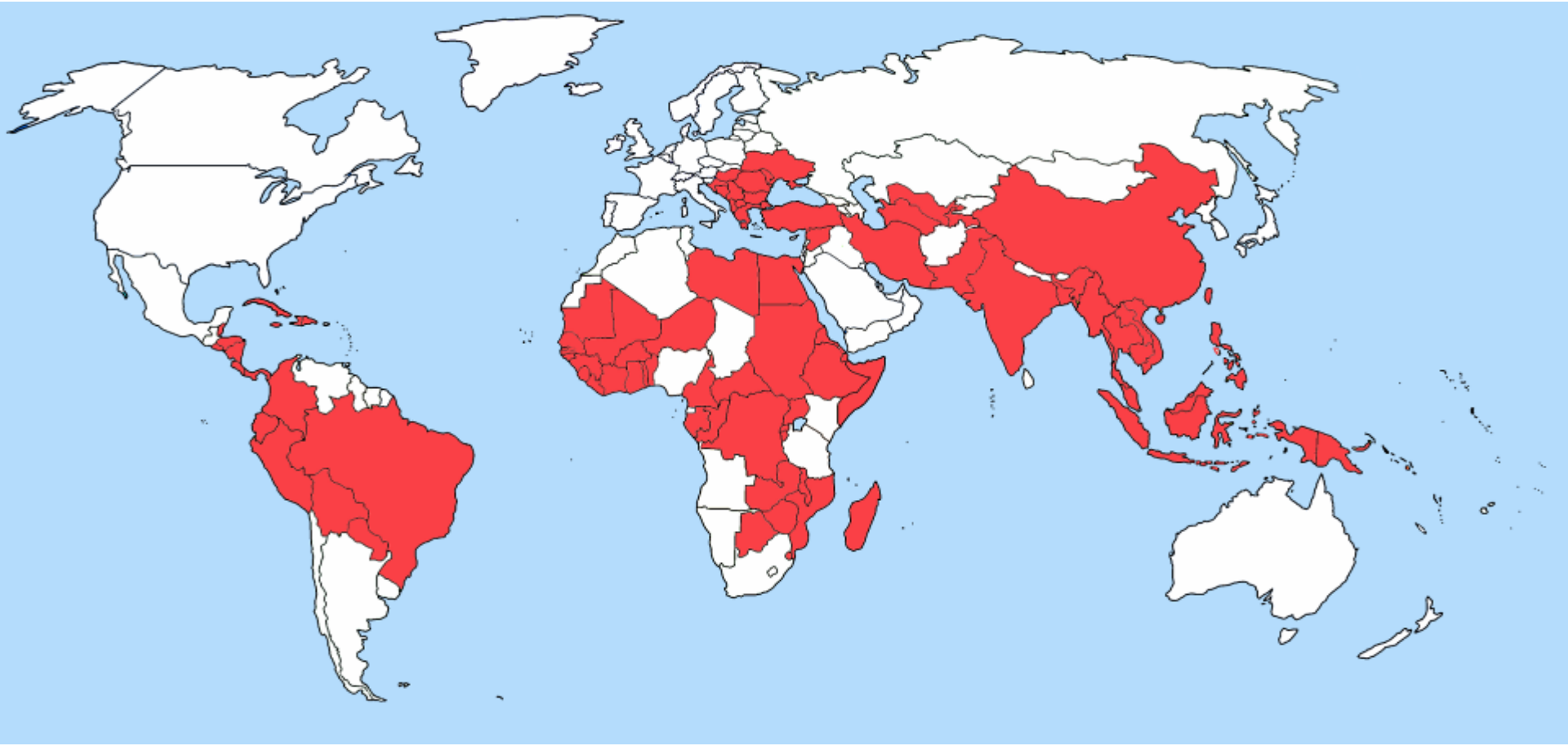
Source: UN Scientific Expert Group Report on Climate Change and Sustainable Development

Countries with Highest CO2 Emissionen per Capita



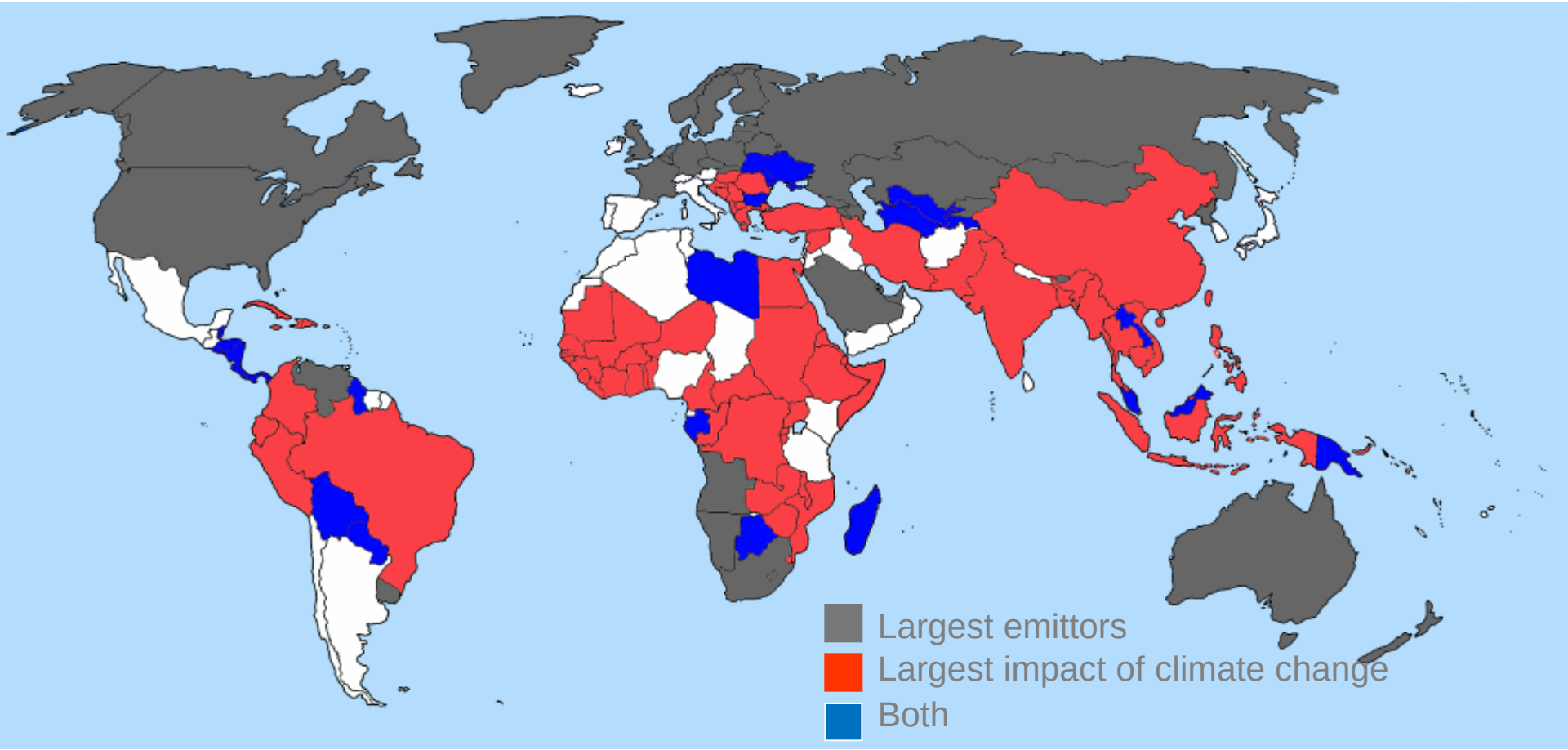
Source: UN Scientific Expert Group Report on Climate Change and Sustainable Development

Countries with Largest Negative Climate Impact



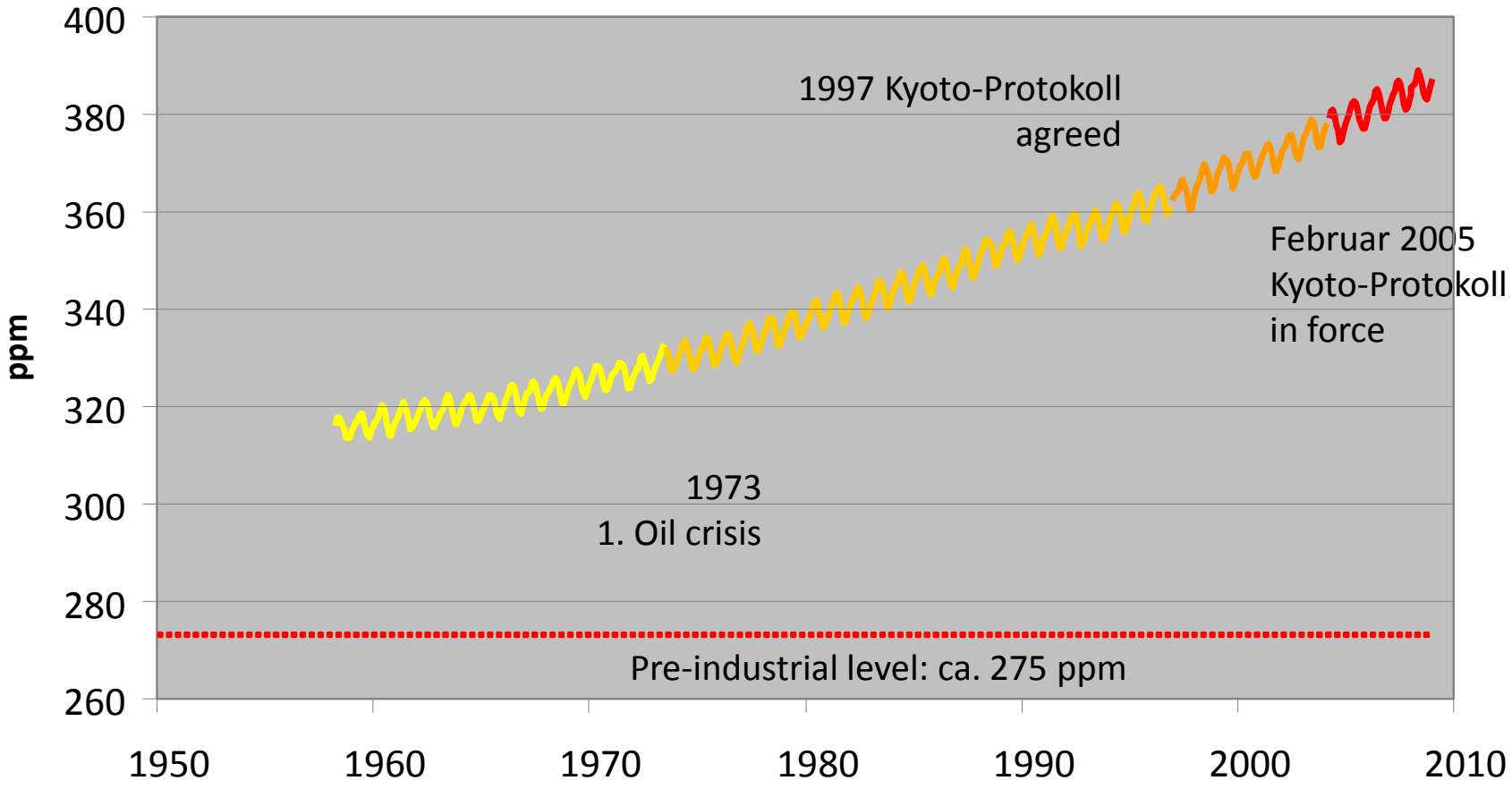
Source: UN Scientific Expert Group Report on Climate Change and Sustainable Development

Loosers and Winners



Source: UN Scientific Expert Group Report on Climate Change and Sustainable Development

Global CO2-Concentration



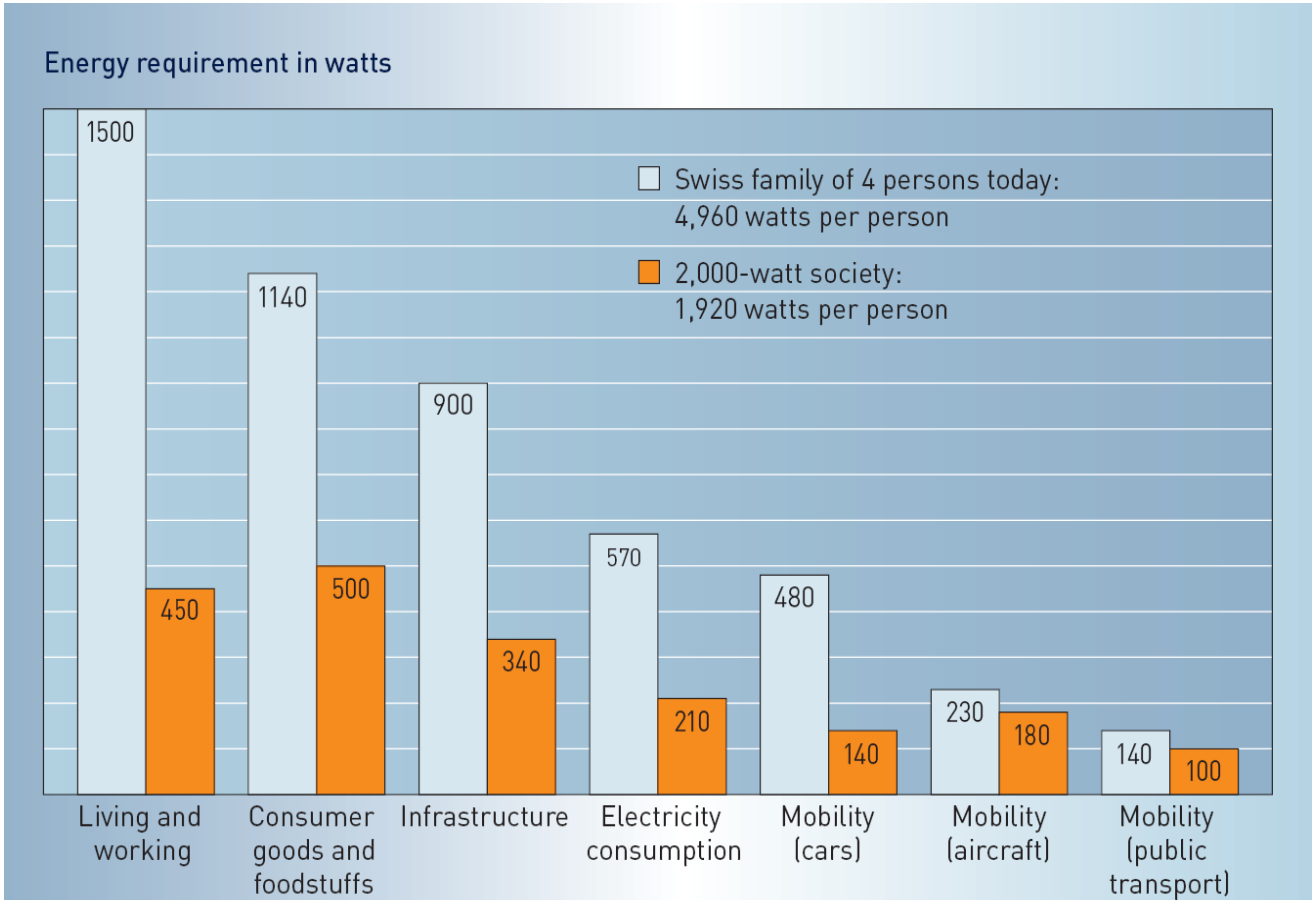
Source: Dr. Pieter Tans, NOAA/ESRL (http://www.esrl.noaa.gov/gmd/ccgg/trends/)

The 2000 Watt Concept

- About 2'000 Watt per capita (17'500 kWh/a) are needed, to ensure a healthy society that achieves a reasonable level of prosperity
- In order to achieve also the goals of IPCC (Intergovernmental Panel for Climate Change) of 1 ton CO_2-emissionen per capita, only 500 W may come from fossil fuels, 1'500 W have to come from renewable, CO_2-free energy resources.

ETH-RAT PAUL SCHERRER INSTITUT PSI EMPA EAWAG WSL

Aimed Distribution of Energy



Source: Novatlantis, www.novatlantis.ch

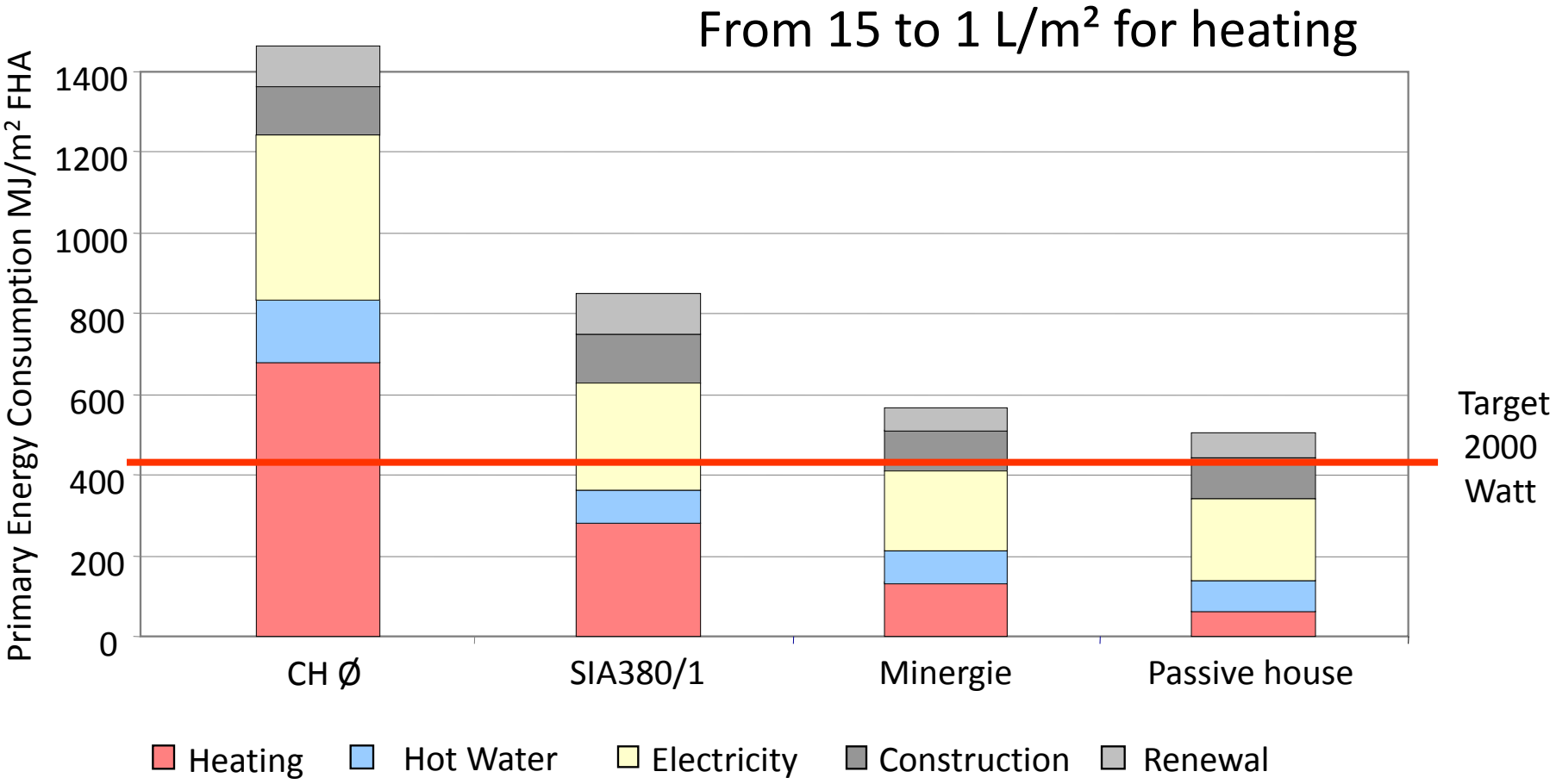
Passive Houses fulfil 2000 Watt-criteria

- Max. Heating load < 10 W/m^2
- Heating power < 10 kWh/(m^2·a)
- Air leakage of envelope n_{L50} < 0.6 /h
- Efficient, electrical appliances (A label)

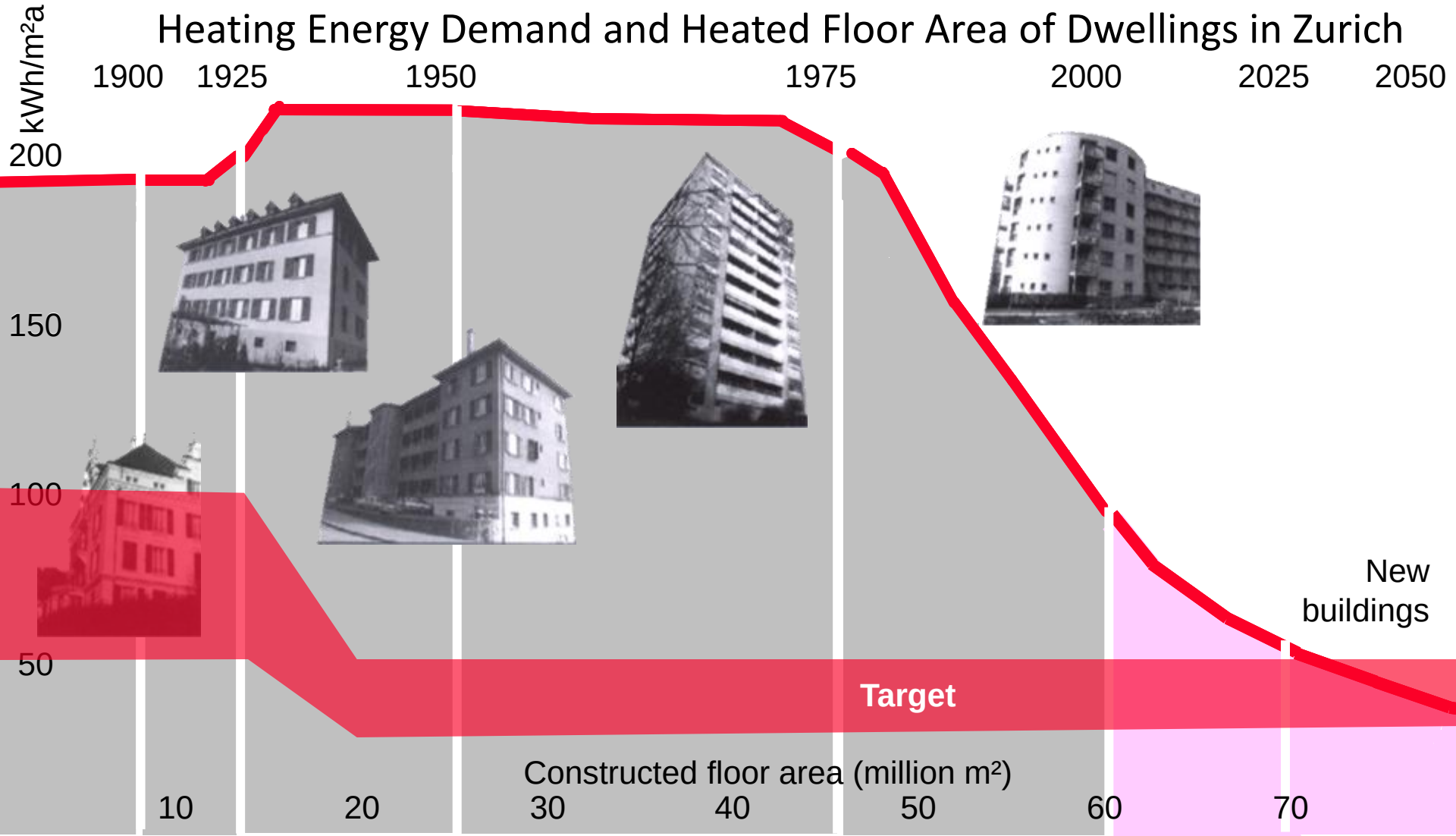
About 30‘000 housing units built in D, A, CH

Sunnywoods, Architekt Beat Kämpfen

Efficiency Curve of Buildings



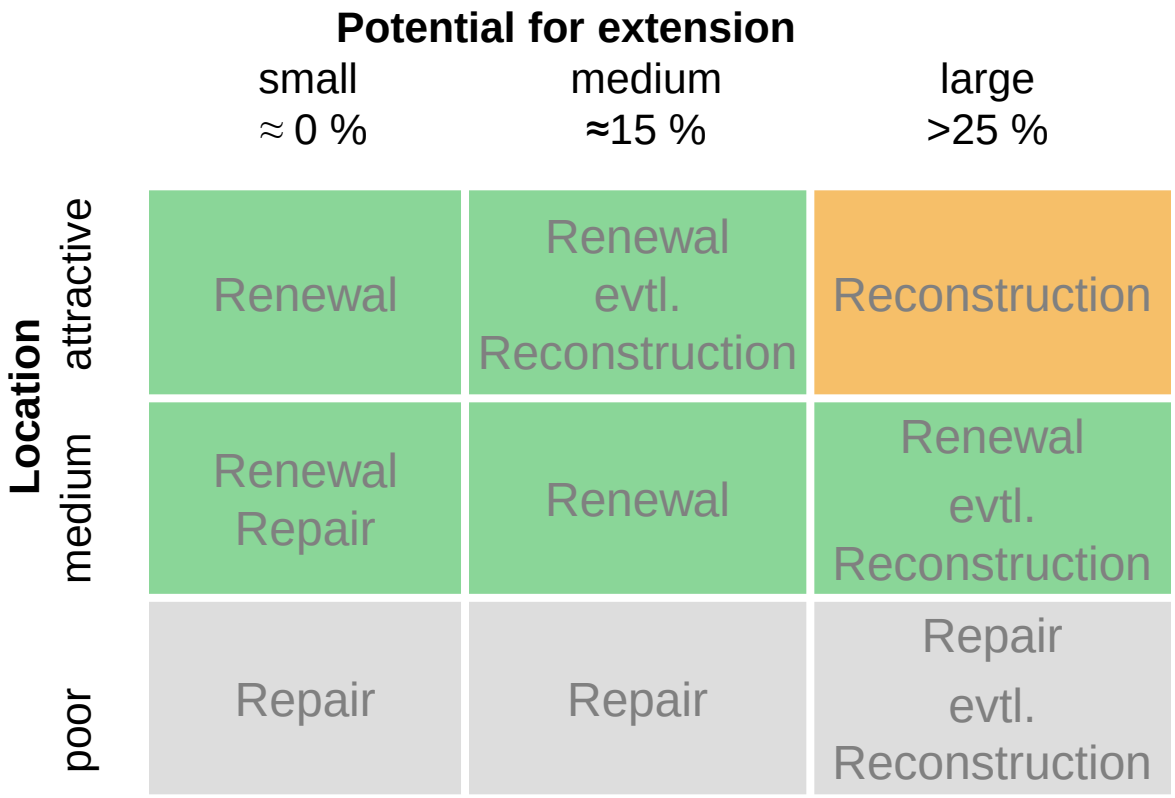
Heating Demand of Building Stock



What is an optimal renovation strategy?

Repair – Renewal – Demolition ?

Renewal or Reconstruction?



… also to be considered

- Usability / flexibility / Demand
- Construction quality, sound protection, earthquake safety
- Integration in neighborhood, historic value
- Tenant situation

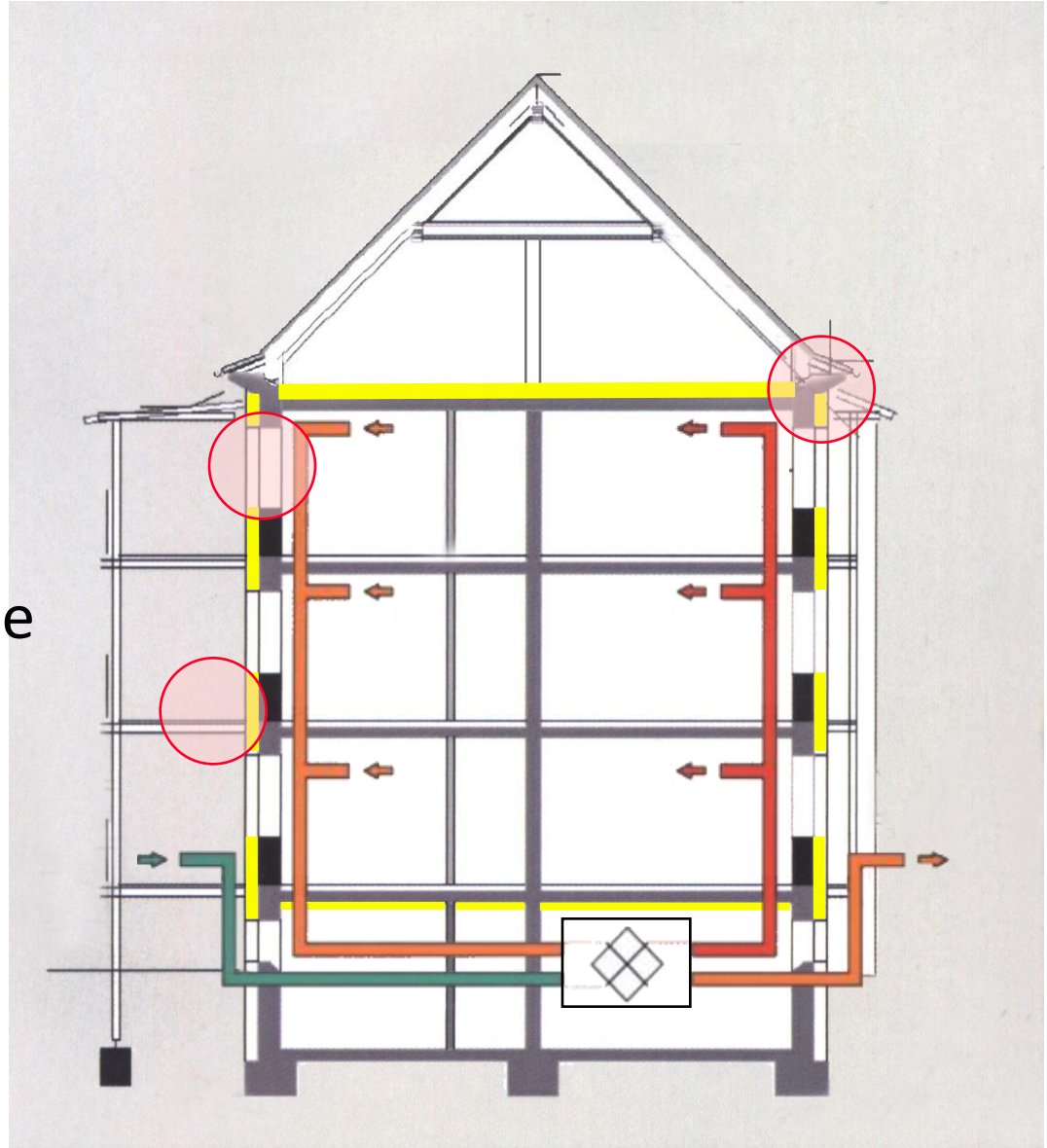
Deep Building Renovation

Building renewal with prefabricated elements

80-90 % energy savings + added values (room extension, attic apartment)

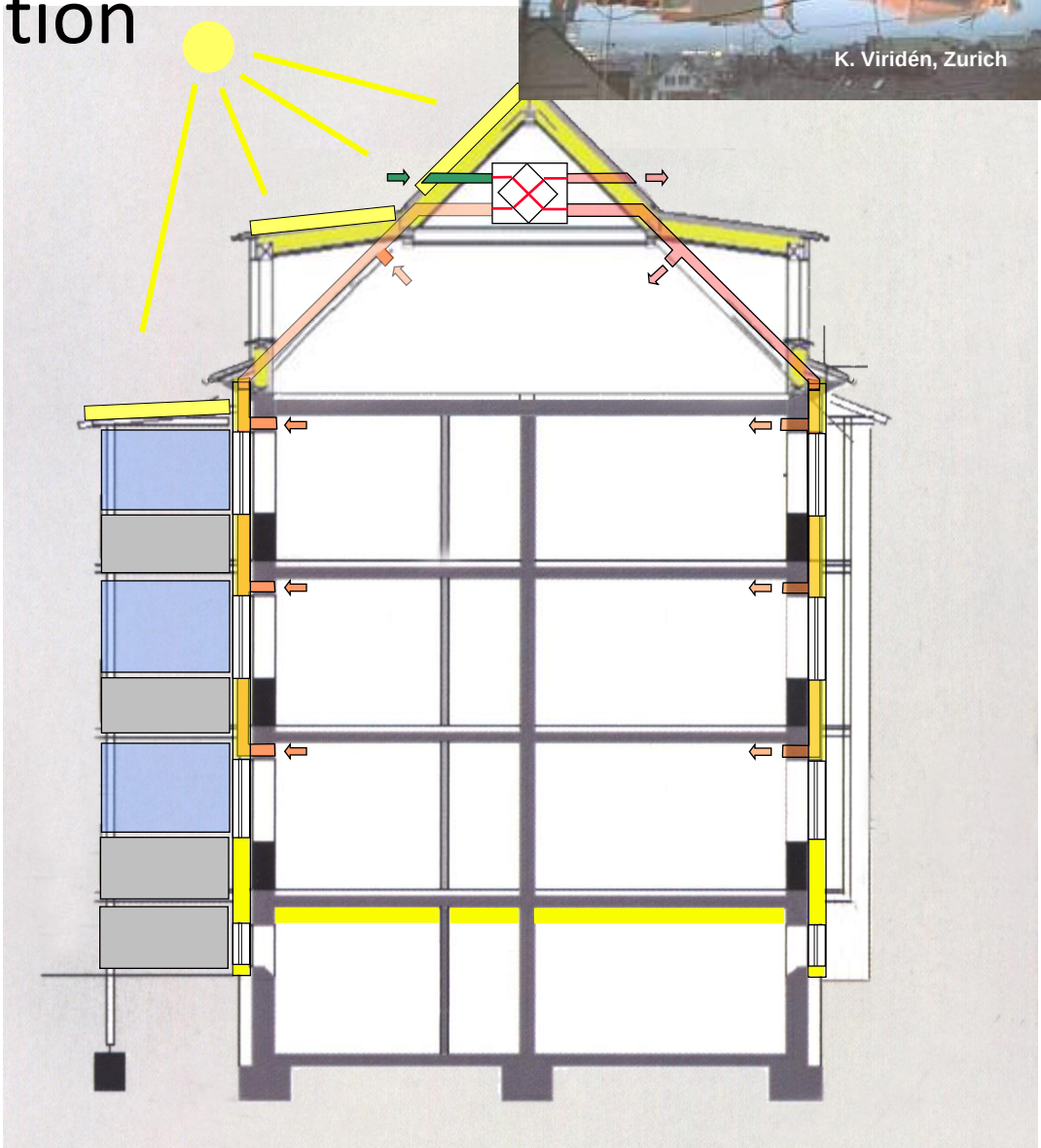
Traditional Renovation

- hardly future oriented
- too many technical compromises
- to many craftsman involved
- poor coordination on site
- low quality level
- inefficient construction processes



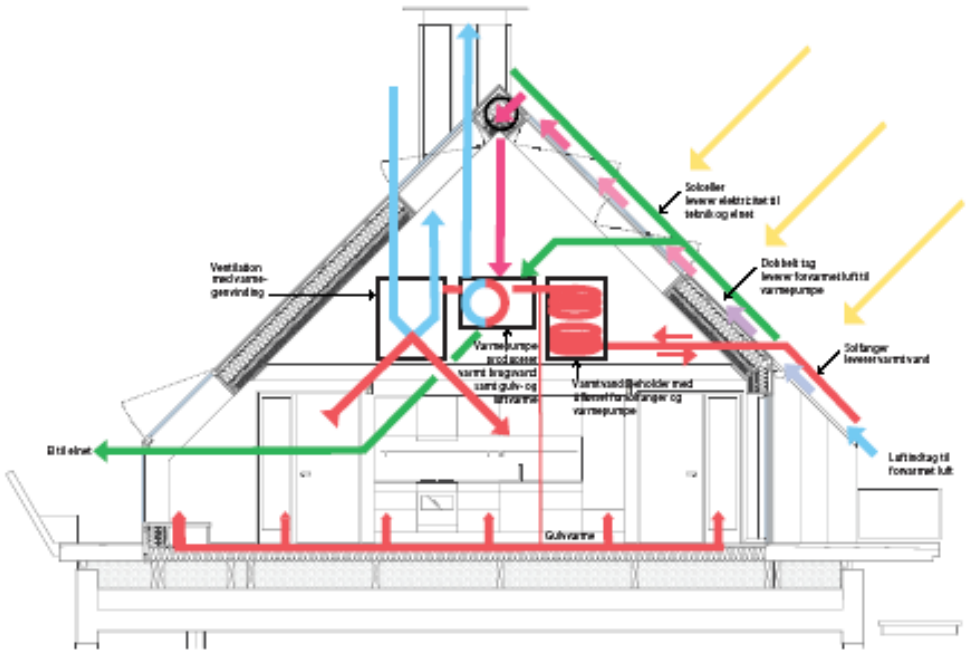
Prefab Building Renovation

- Whole building concept
- no technical compromises
- few companies involved
- well coordinated modules
- quality assurance
- rapid construction processes



Prefab Building Renovation

SOLTAG VELUX®



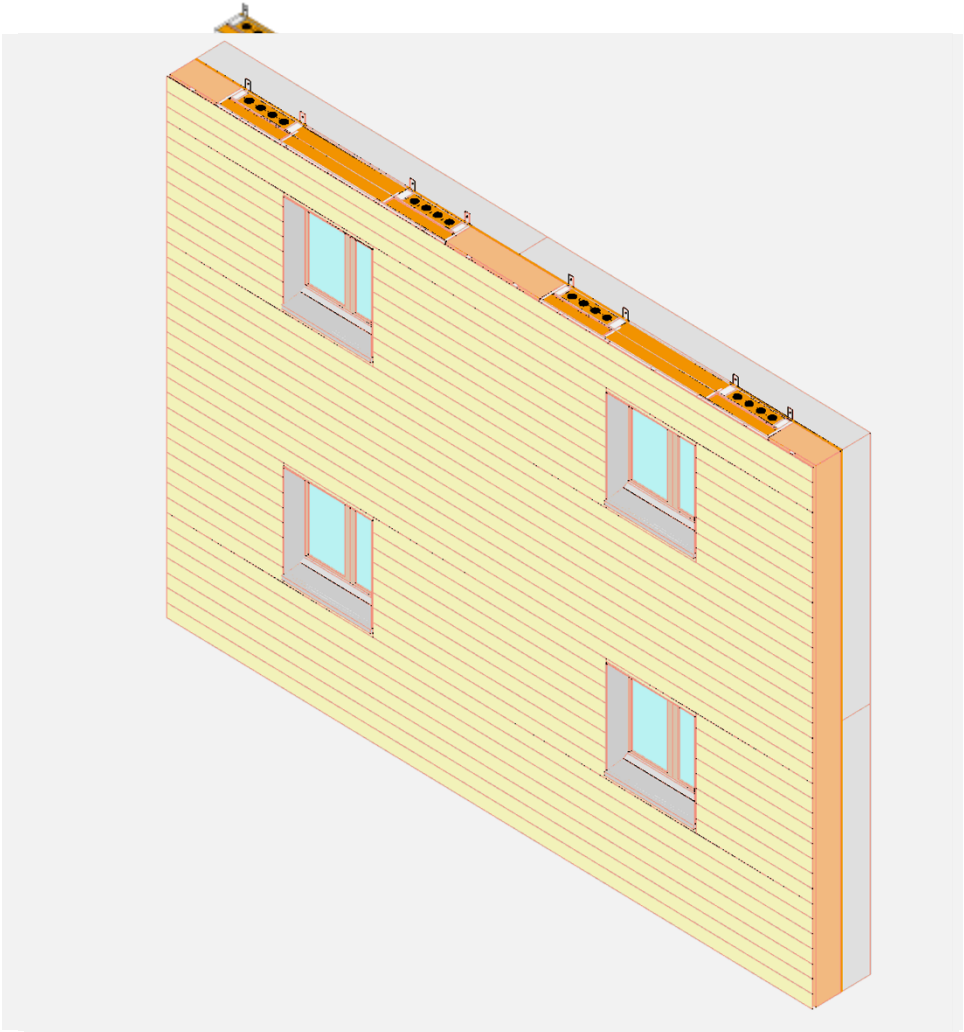
Prefab Building Renovation

Soltag project by Velux, Copenhagen Denmark

Austrian Façade Elements

Large size modules developed by Austrian team

Swiss Façade Elements



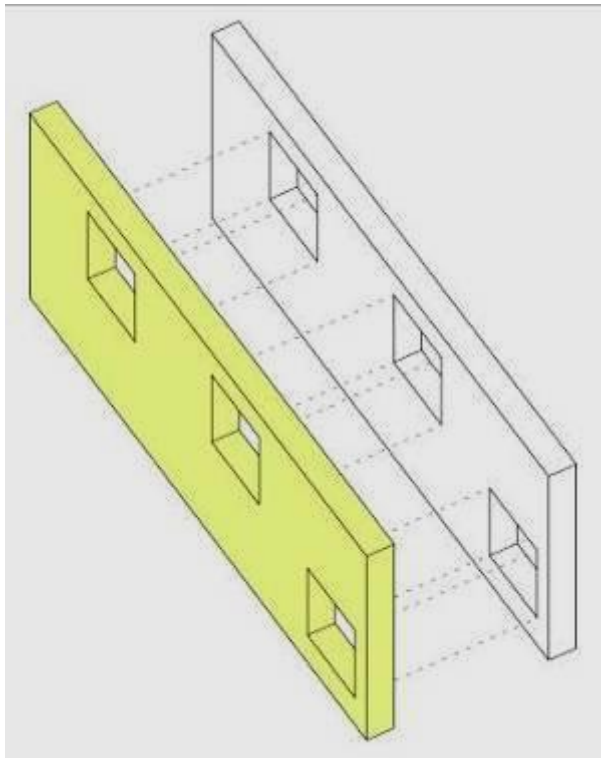
Small size modules developed by Swiss team

French Façade Elements

Large size prefabricated steel frame retrofit modules

Challenge of Pre-Fabrication

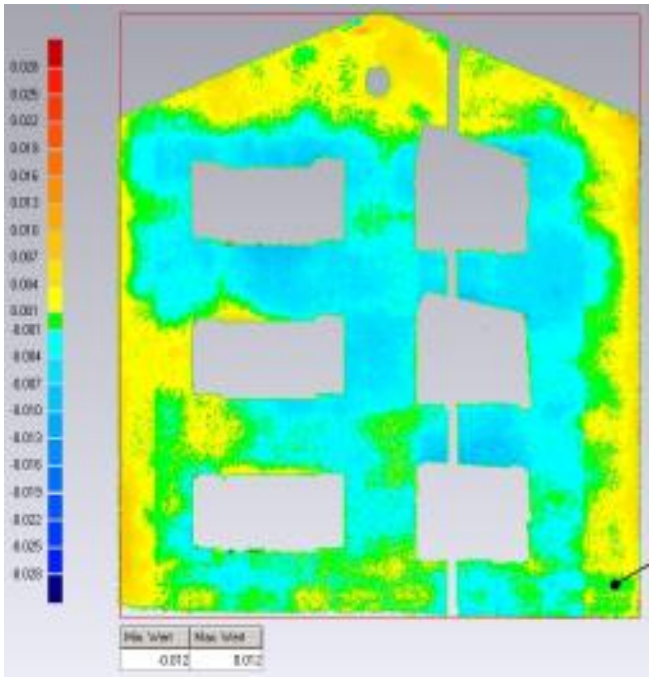
Prefabrication of large elements has to ensure that the elements will fit to the existing building



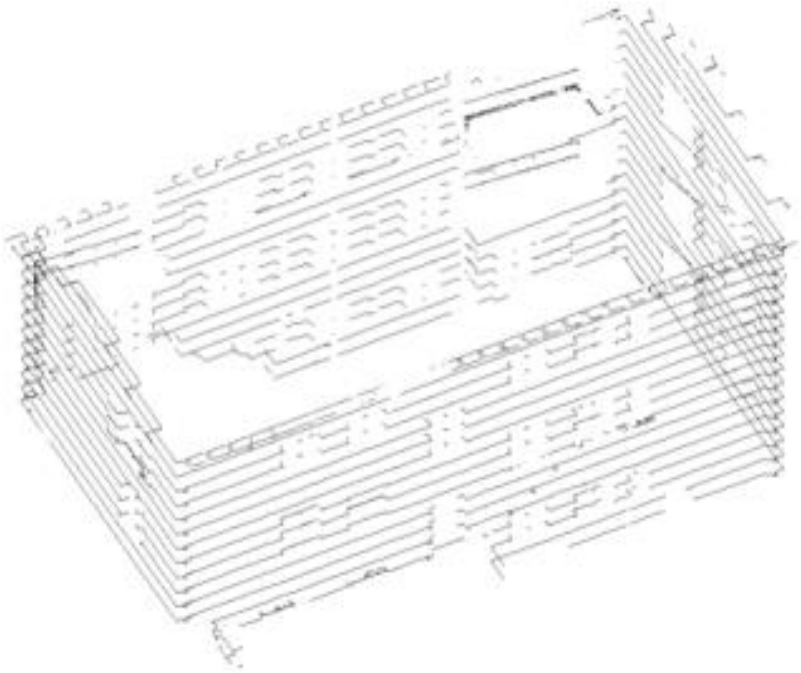
Picture: Wood-Wisdom, TES-EnergyFaçade


Mounting the pre-fabricated roof structure
calls for precision. And new ideas.

Laser Scanning – Design Support

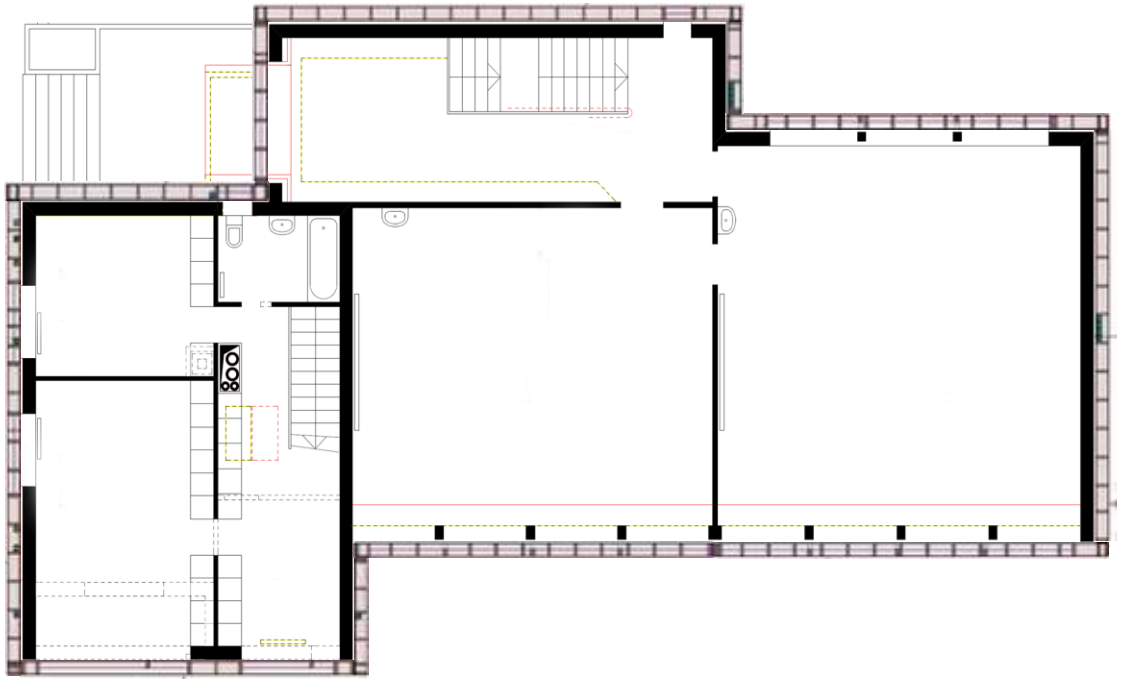


Planarity of façades



Horizontal sections

Planning of Façade Modules



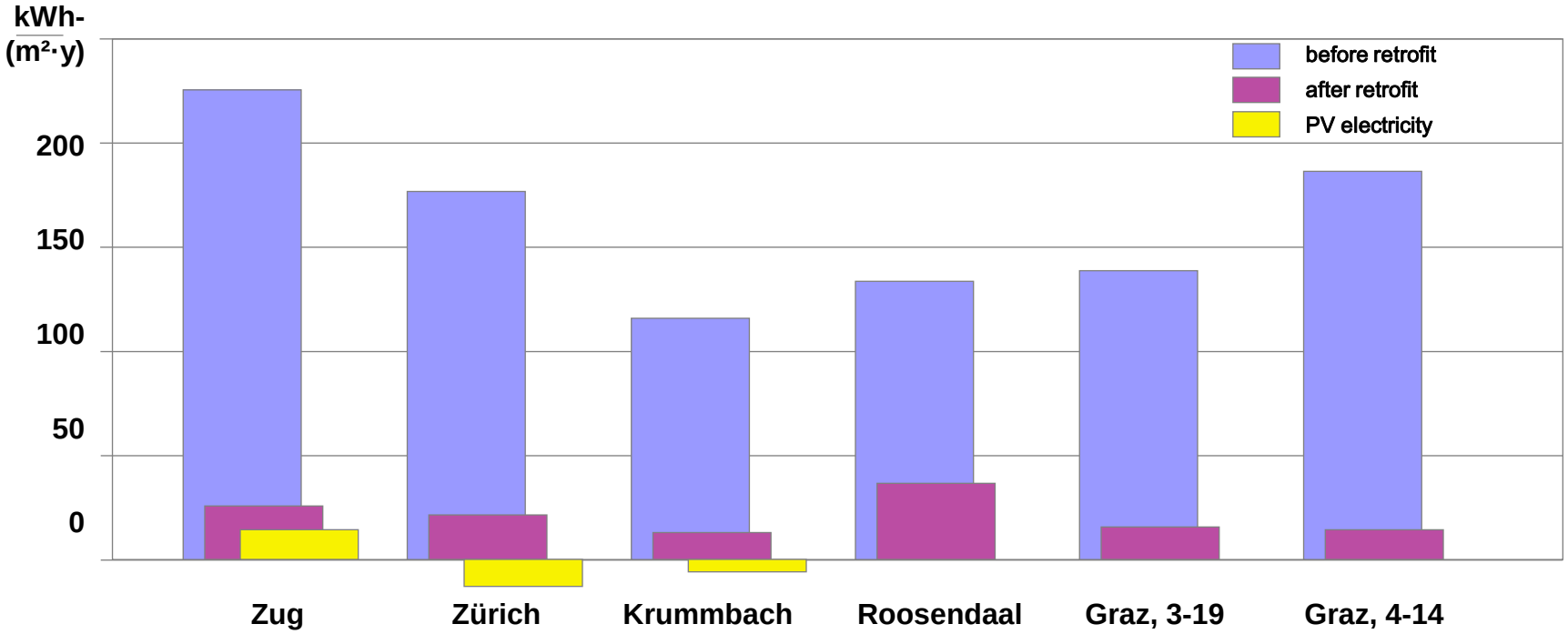
Prefabrication of Façade Elements

Mounting of Façade Elements

Krummbach School and Caretakers Building

IEA Demonstration Buildings

- Demonstration projects in Austria, Netherlands, Switzerland
- 6 Demonstration sites with totally 363 apartments and 1 school



Energy consumption for heating ventilation, hot water

Austrian Demonstration Buildings

Renovation of 3 apartment buildings (1959) completed 2008, GAP-Solution / AEE INTEC

Austrian Demonstration Buildings

Renovation of 2 apartment buildings (1970) completed 2009, GAP-Solution / AEE INTEC

Austrian Demonstration Buildings

Renovation of row houses buildings (1952) completed 2009, GAP-Solution / AEE INTEC

Swiss Demonstration Buildings

Renovation of apartment building (1952) completed 2009, Miloni Architects

Swiss Demonstration Buildings

Renovation of apartment building (1952) completed 2009,
Beat Kaempfen Architects

Swiss Demonstration Buildings

Renovation of school building (1952) completed 2011, Bruno Thoma / Alexander Ritz

Dutch Demonstration Buildings

Renovation of residential area by DAT archiecten / Trecodome

E2ReBuild

DE EN FR

Start | Building | Finances | Repair | Retrofit | Reconstruction | Results | End

start

Project name
Address
Autor
Date 2015-10-22
Country Switzerland

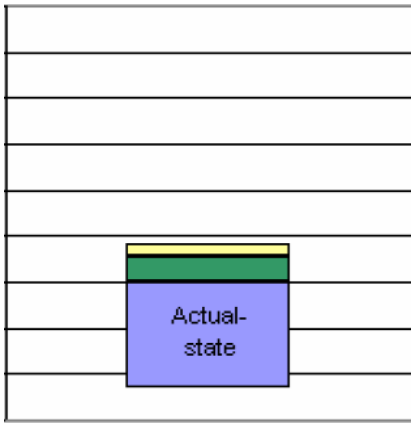
Simple, detached suburban apartment building, constructed about 1930 Simple to avarage standard, relatively small apartments, normally 3 stories, raised ground floor, massive wall construction, artificial stone reveals, overhanging balconies, roof space not or little used as living space, simple staircase without elevator.

back

next

European Retrofit Advisor

Actual state

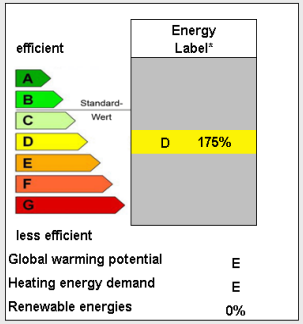


Society **Environment** **Economy**

Retrofit Advisor

Description of reference building

Building type 1:
Simple, detached suburban apartment building, constructed about 1930
Simple to avarage standard, relatively small apartments, normally 3 stories, raised ground floor, massive wall construction, artificial stone reveals, overhanging balconies, roof space not or little used as living space, simple staircase without elevator.



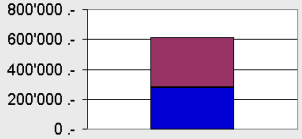
* Indicative, no official label

Information about your own building

Default values of the selected building type will be used for missing information. The more information you can give, the more precise the evaluation will be.

Building data		
Heated floor area	m²	380
Unheated floor area	m²	165
Room height (in apartments)	m	2.45
Floors (ground floor and above)	Number	3.0
Elevator	yes/no	no
Plot size	m²	680

Market value €



t Advisor

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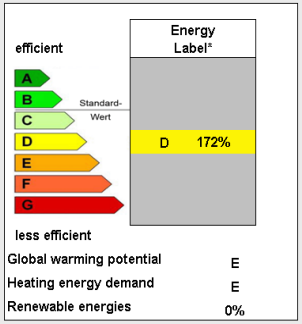


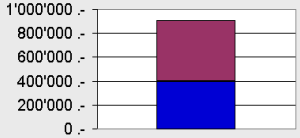
* Indicative, no official label

Information about your own building

Default values of the selected building type will be used for missing information. The more information you can give, the more precise the evaluation will be.

Building data		
Heated floor area	m²	540
Unheated floor area	m²	186
Room height (in apartments)	m	2.45
Floors (ground floor and above)	Number	4.0
Elevator	yes/no	no
Plot size	m²	650

Market value €



Retrofit Advisor

Actual State

Standard renovation

SIA standard

Minergy

Minergie-P

Retrofit

New balconies

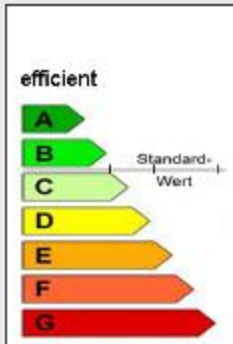
Steep roof attic

Flat roof attic

Room extention

1.2 Renovation of building envelope according to Minergie-standard:
Compact façade insulation 200mm, window replacement U=1.1 W/m²K, insulation of roof space and basement (ceiling), installation of a mechanical vetilation system with heat recovery, renovation of interior

Energy Label*



	Actual-state	Repair	Retrofit	Recon-struction
			A 49%	A 39%
		C 146%		
	D 172%			
Global warming potential	E	D	C	A
Heating energy demand	E	D	A	A
Renewable energies	0%	0%	0%	35%

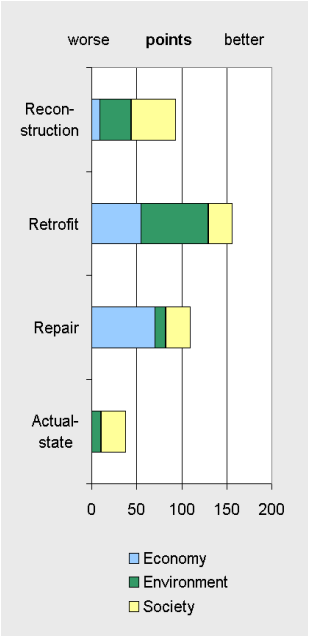
* Indicative, no official label

European Retrofit Advisor






Prefab Retrofit with Room Extension



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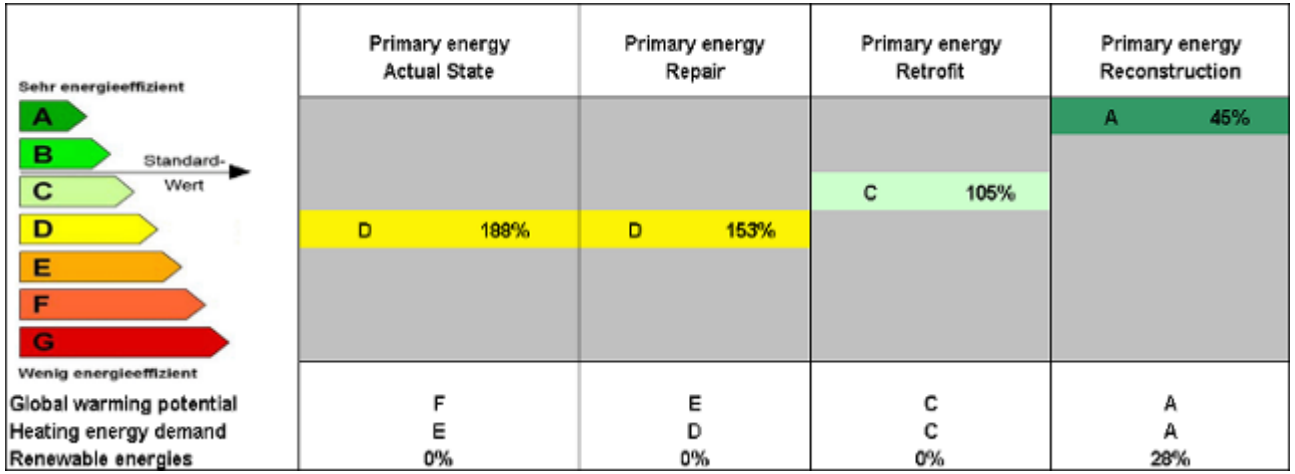
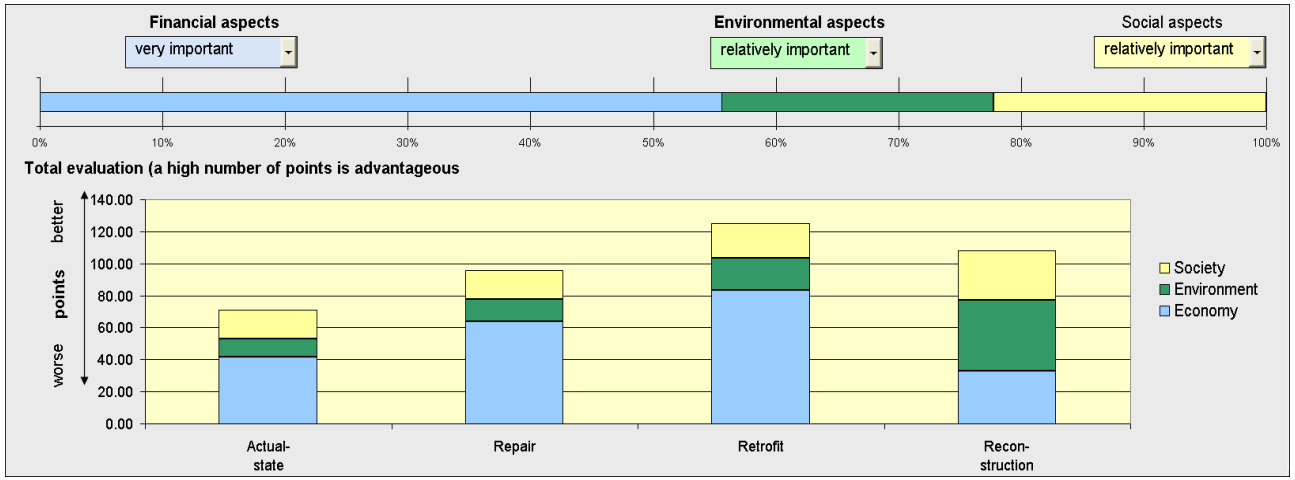
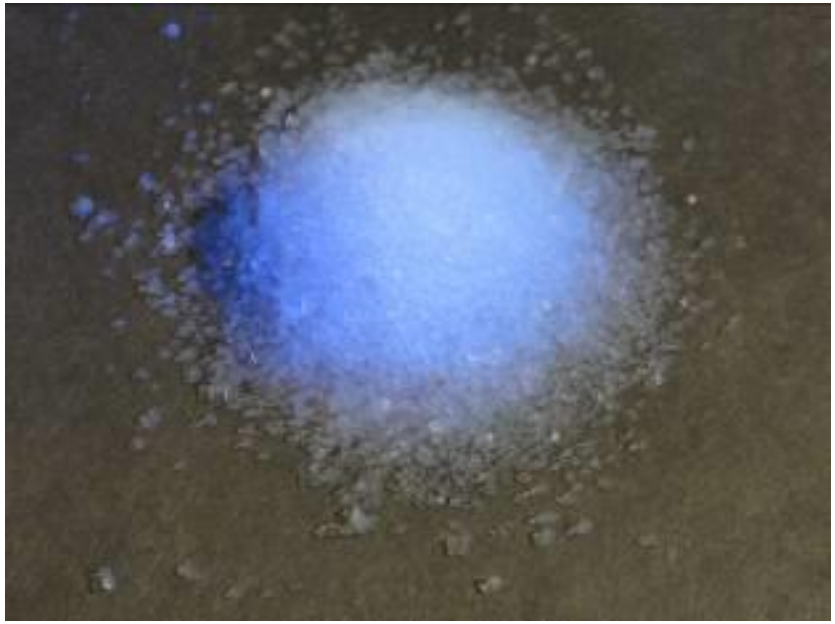




Historical Buildings

Traditional buildings should be refurbished with traditional methods

New Insulation Rendering



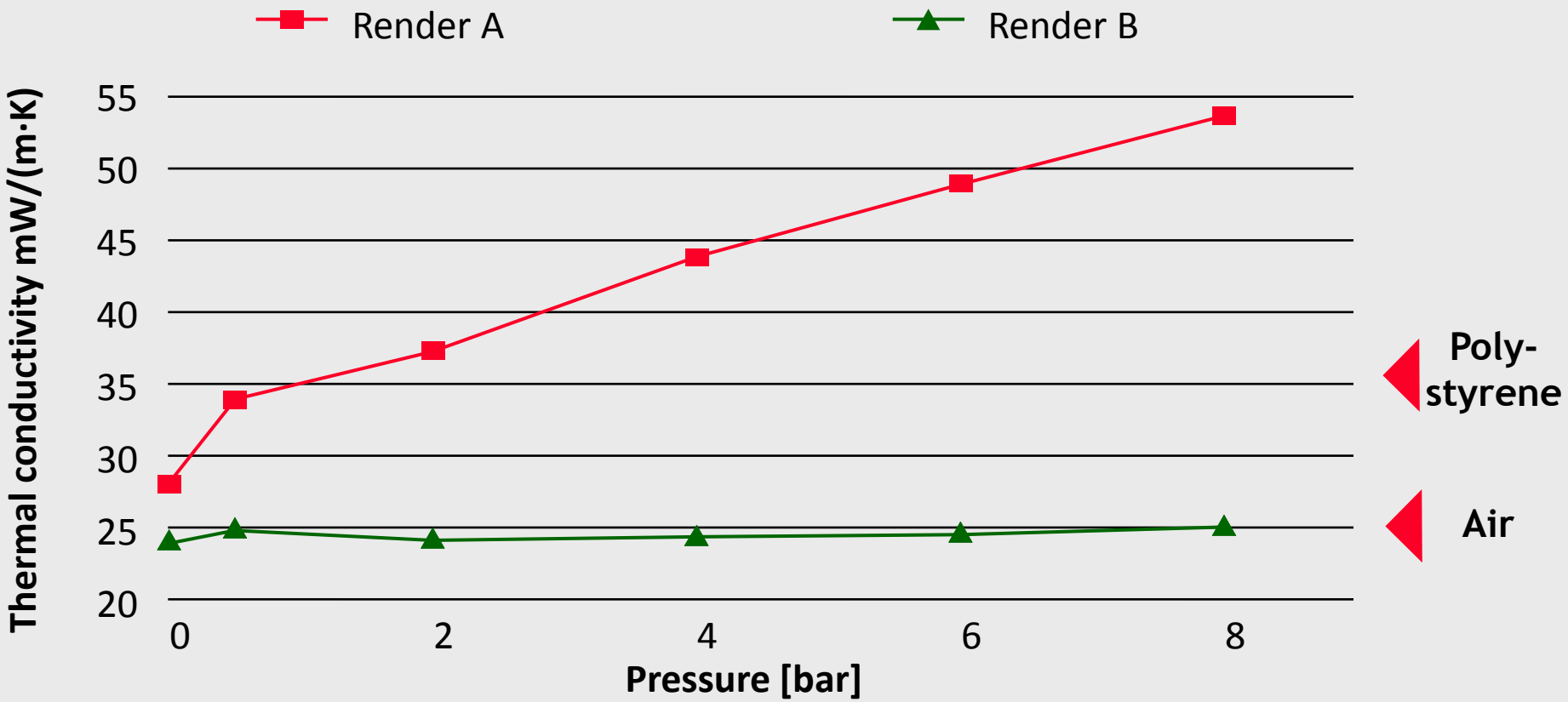
About 85% nanoporous aerogel granulate is used as additive for the light weight plaster

Mineral rendering that is insulating like air

New Insulation Rendering

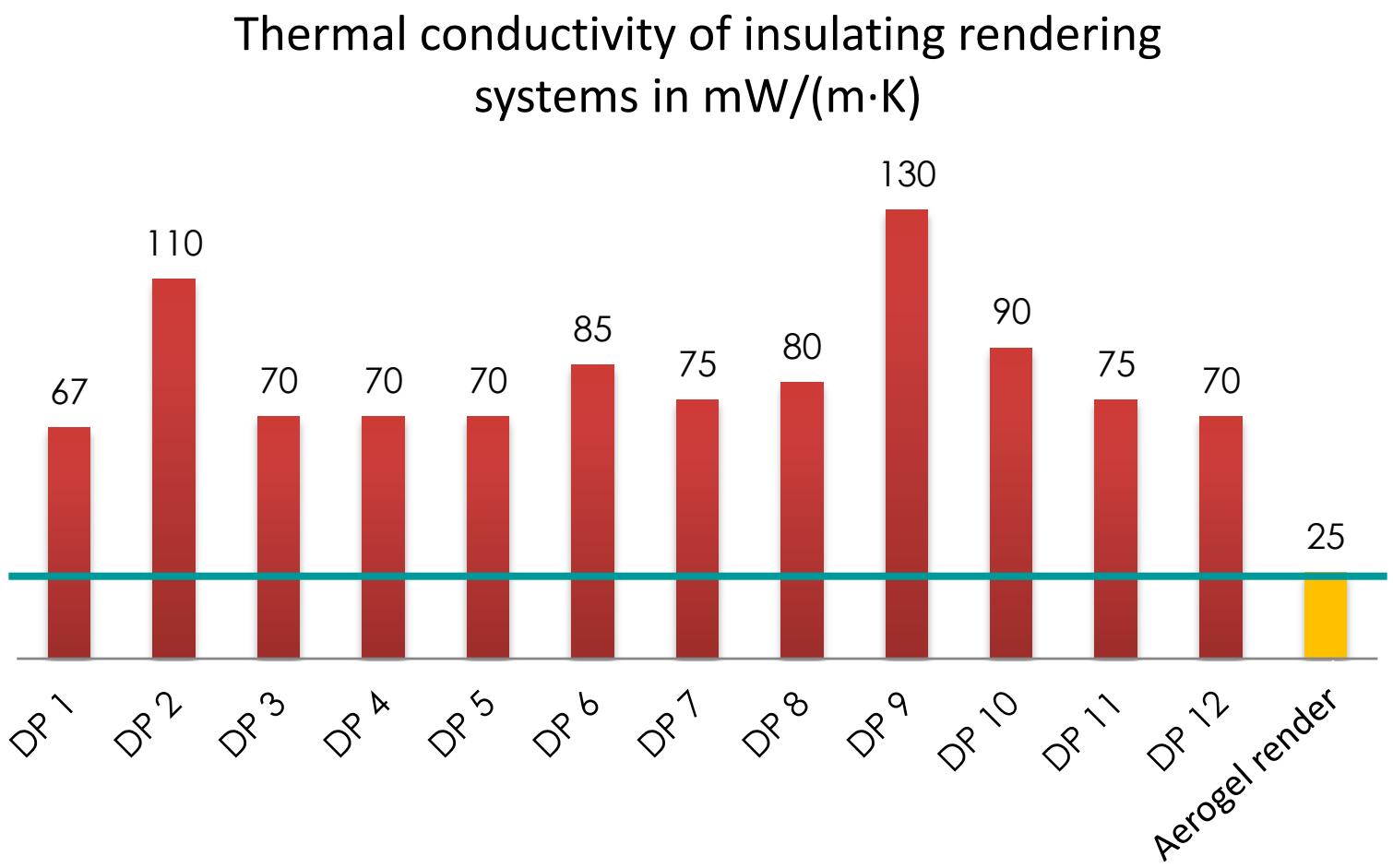
- Thermal conductivity < 30 mW / (m·K) in real application
- 60 – 80 mm thickness of one layer
- Sprayable with available rendering machines
- Vapour resistance μ < 5
- Purely mineral
- Low shrinkage
- Applicable in- and outside

Spraying of Aerogel Renderings



High pressures of approx. 8 bar press free water into the aerogel pores. If this happens, the thermal conductivity will increase rapidly.

Thermal Conductivity of Insulation Renderings



Summary Prefab Building Retrofit

- Prefab Retrofit suitable for deep renovation
- Energy savings > 80% are realistic target, potential for Zero or Plus-energy building
- Energy savings measures itself are hardly cost effective > added values needed
- Expected service life > 50 years
- Technologies are available

Social challenges for energy retrofit

- Financing situation for building renovation often difficult
- Additional legal requirements for comprehensive renovations (earthquake, fire, sound, energy, water management, electrical installations)
- Trend to self-owned apartments with emphasis on internal and step by step renovations
- Additional difficulties for inhabited construction sites, especially during winter time

Thank you for your attention!

www.empa-ren.ch/A50.htm
www.empa-ren.ch/ccem-surhib.htm
www.era.empa.ch