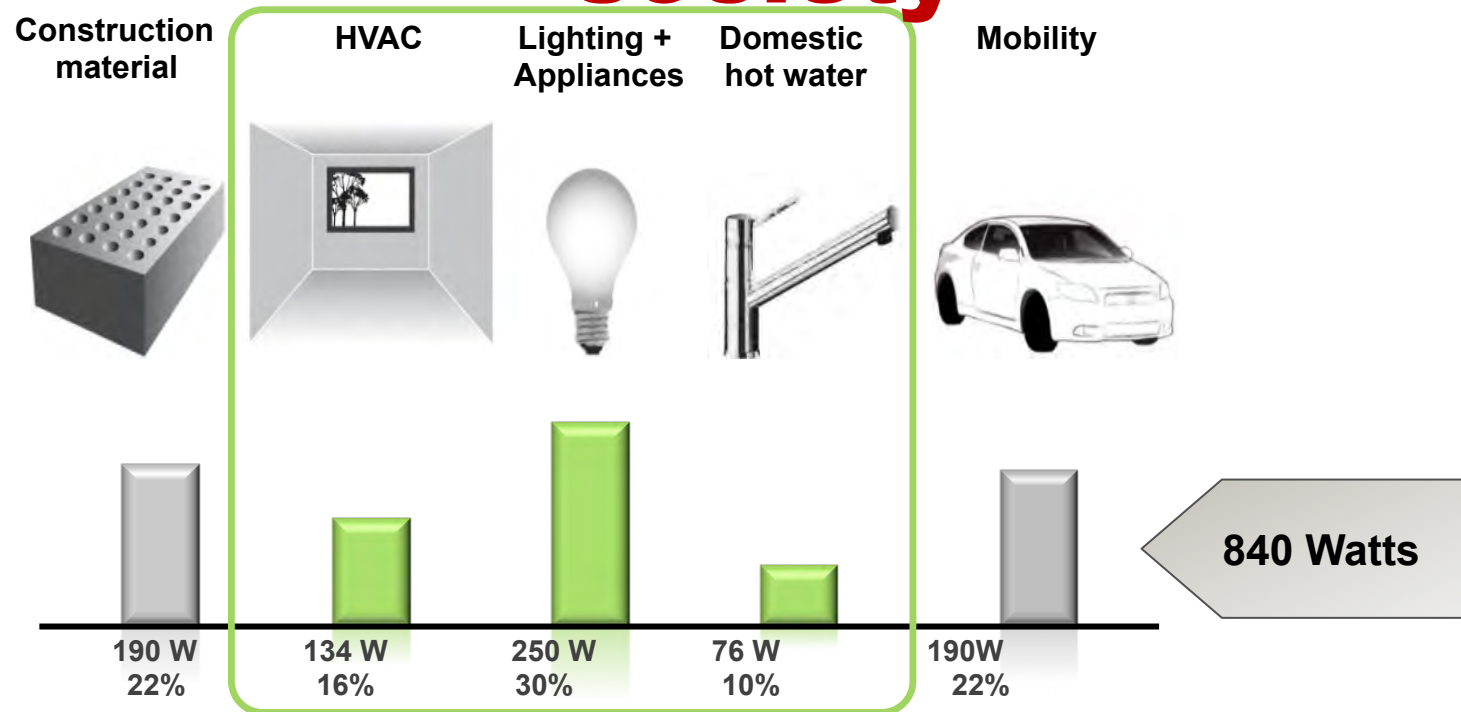


**SB13 Graz – Session D1**

# **Assessment of the relevance of “embodied energy” in the building stock of the city of Zurich**

Holger Wallbaum  
September 25, 2013

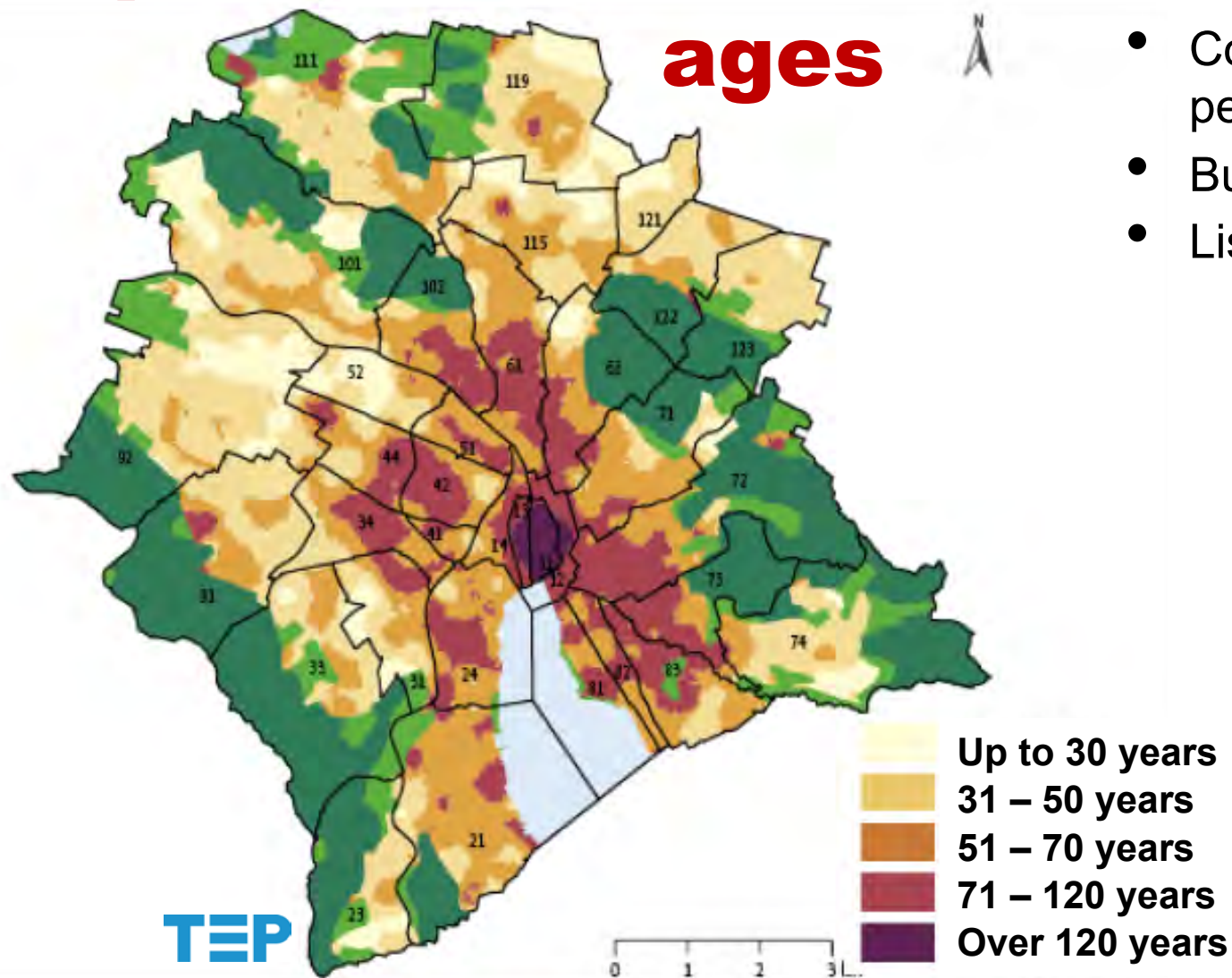
# Ambitious goals of the 2000 W- society



Switzerland	Status 2005	Goal 2050	2050 / 2005
Primary energy, overall [W/P]	6300	3500	-44%
Primary energy, non-renewable [W/P]	5800	2000	-66%
GHG-emissions t [CO <sub>2</sub> -eq./P]	8.7	2.0	-77%

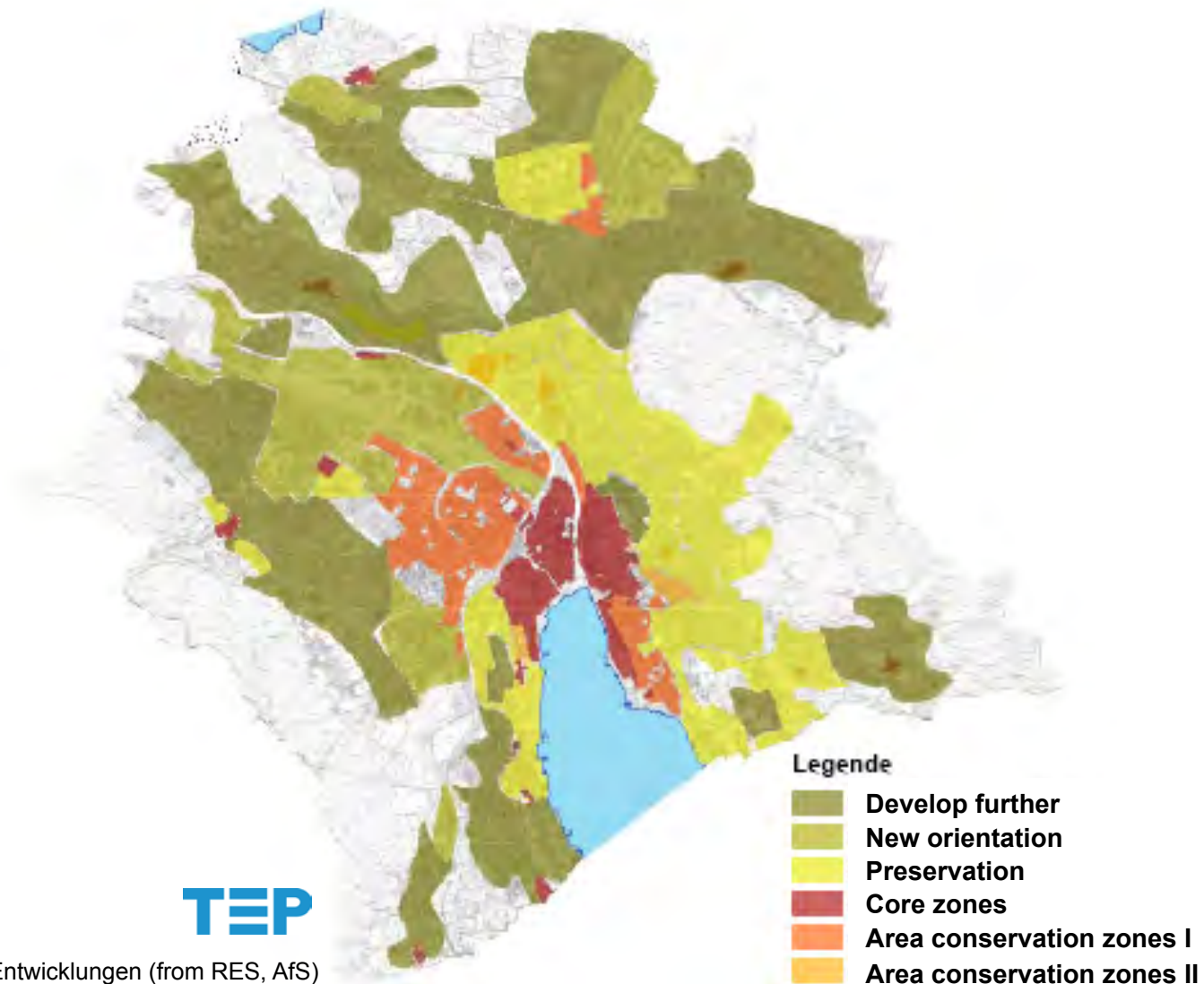
# Spatial distribution of building ages

- Construction period
- Building type
- Listed



Quelle: Statistik Zürich (2005)

# Efficiency potentials, new buildings, densification

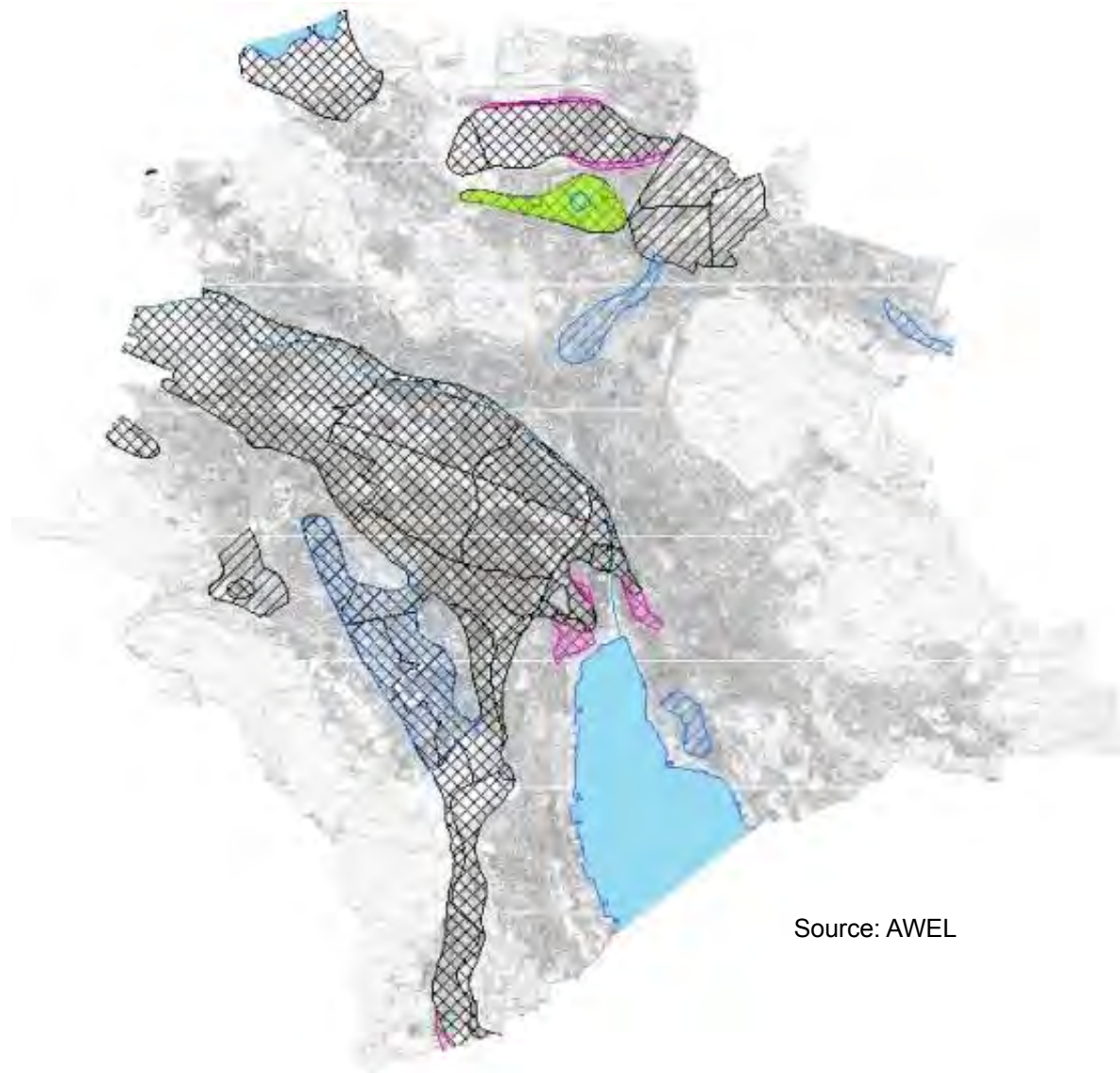


TEP

Source: Gebietsspezifische Entwicklungen (from RES, AfS)






# Local availability of renewable energies

## Heat pipe prohibition and water protection zones

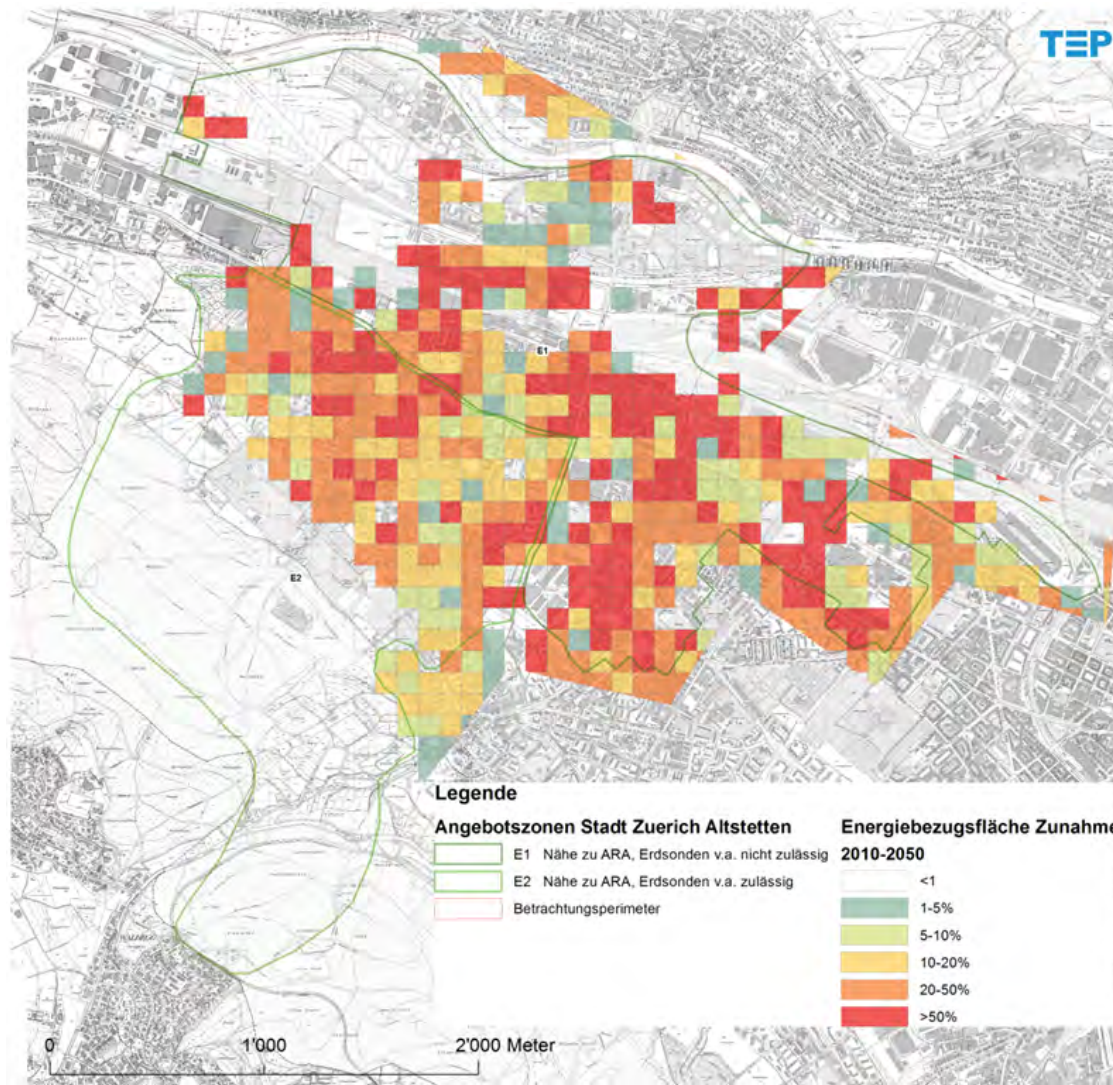


Source: AWEL

### Legend

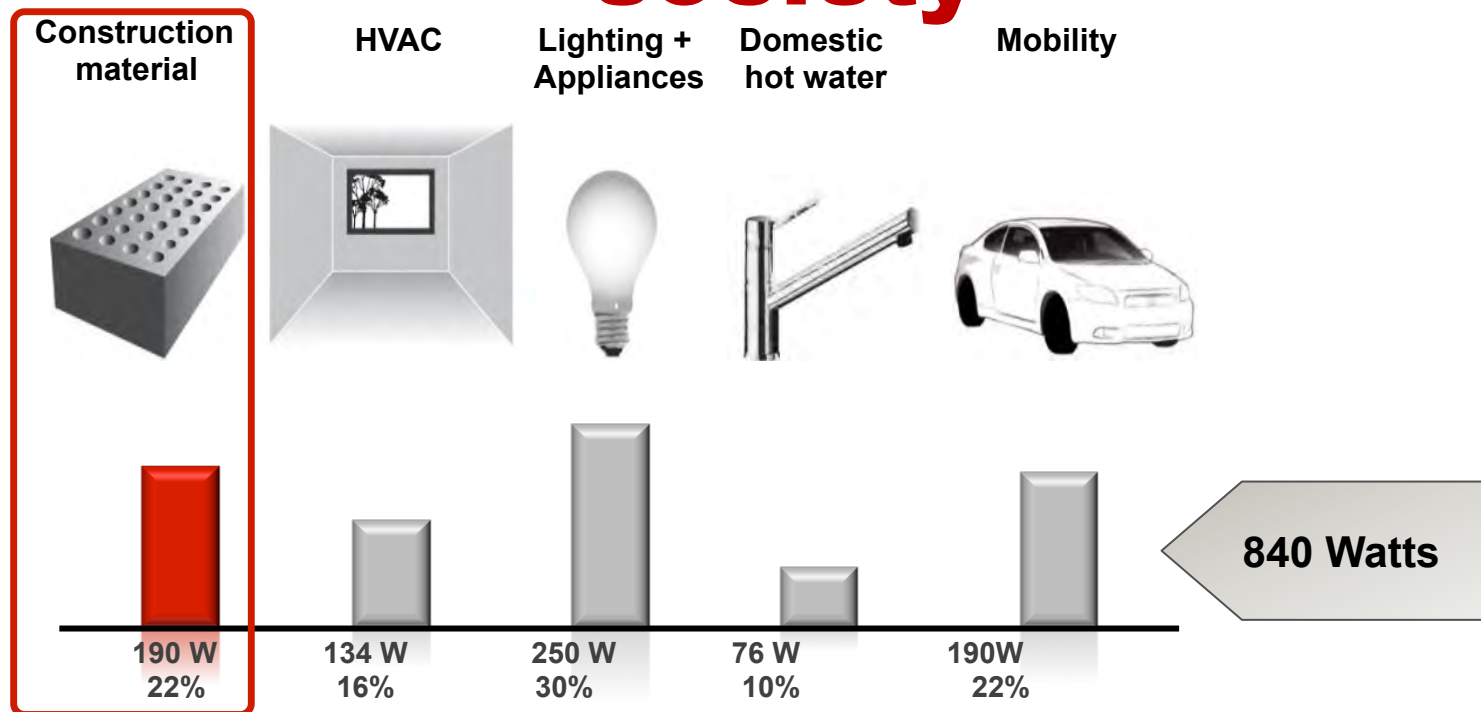
-  Heat pipes, not allowed
-  Heat pipes, not allowed, cancelled
-  Heat pipes, not allowed, expanded
-  Heat pipes, with additional restrictions
-  Heat pipes, with additional restrictions, expanded

# Development of the heated floor area between 2010 and 2050 in ZH-Altstetten



Source: Jakob, Wallbaum et al. (2013), CISBAT Proceedings, EPFL, Lausanne, Switzerland.

# Ambitious goals of the 2000 W- society



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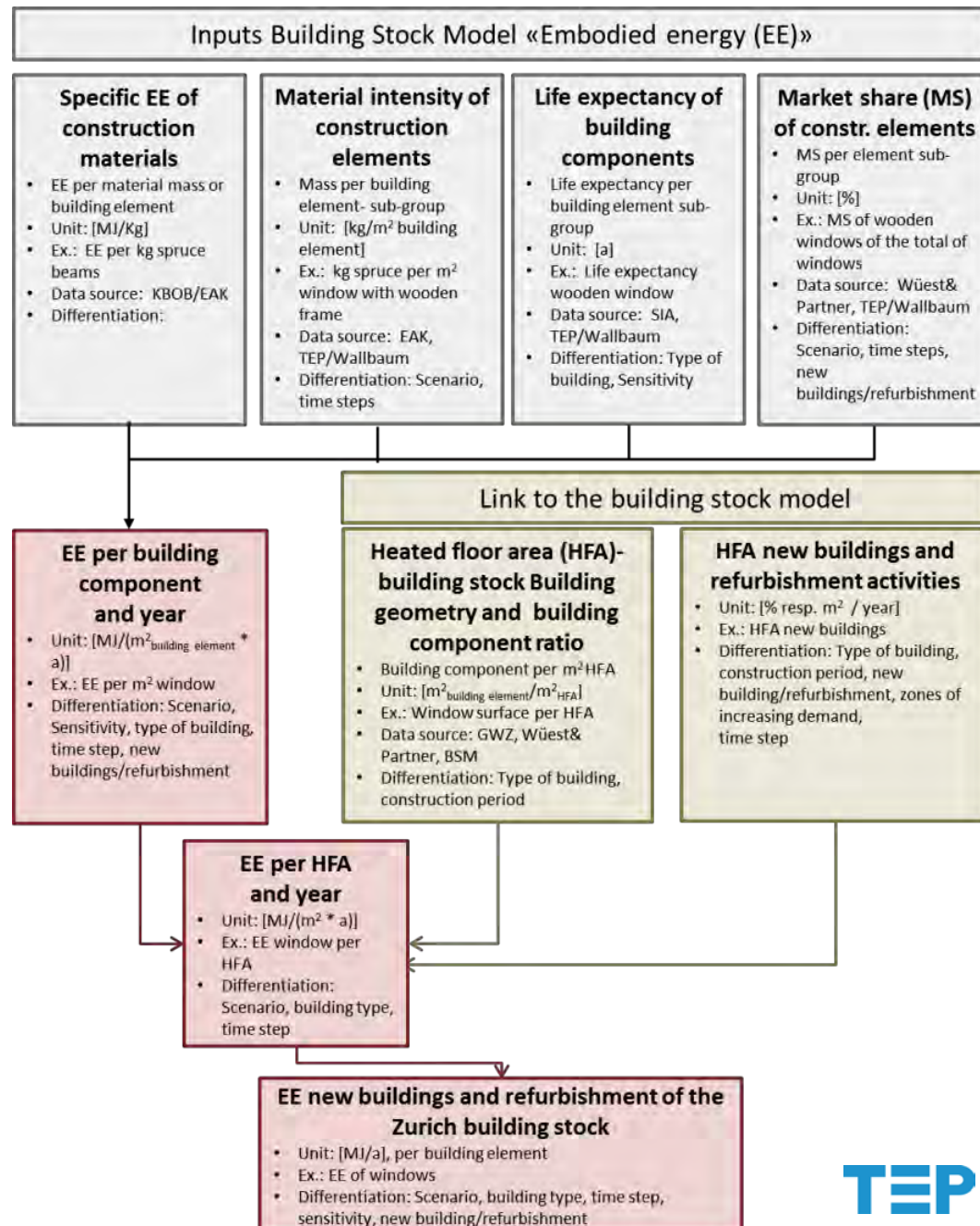
# Purpose of the project

Quantification of the embodied energy through new construction and renovation activities differentiated by constructions elements in time from 2010 to 2050:

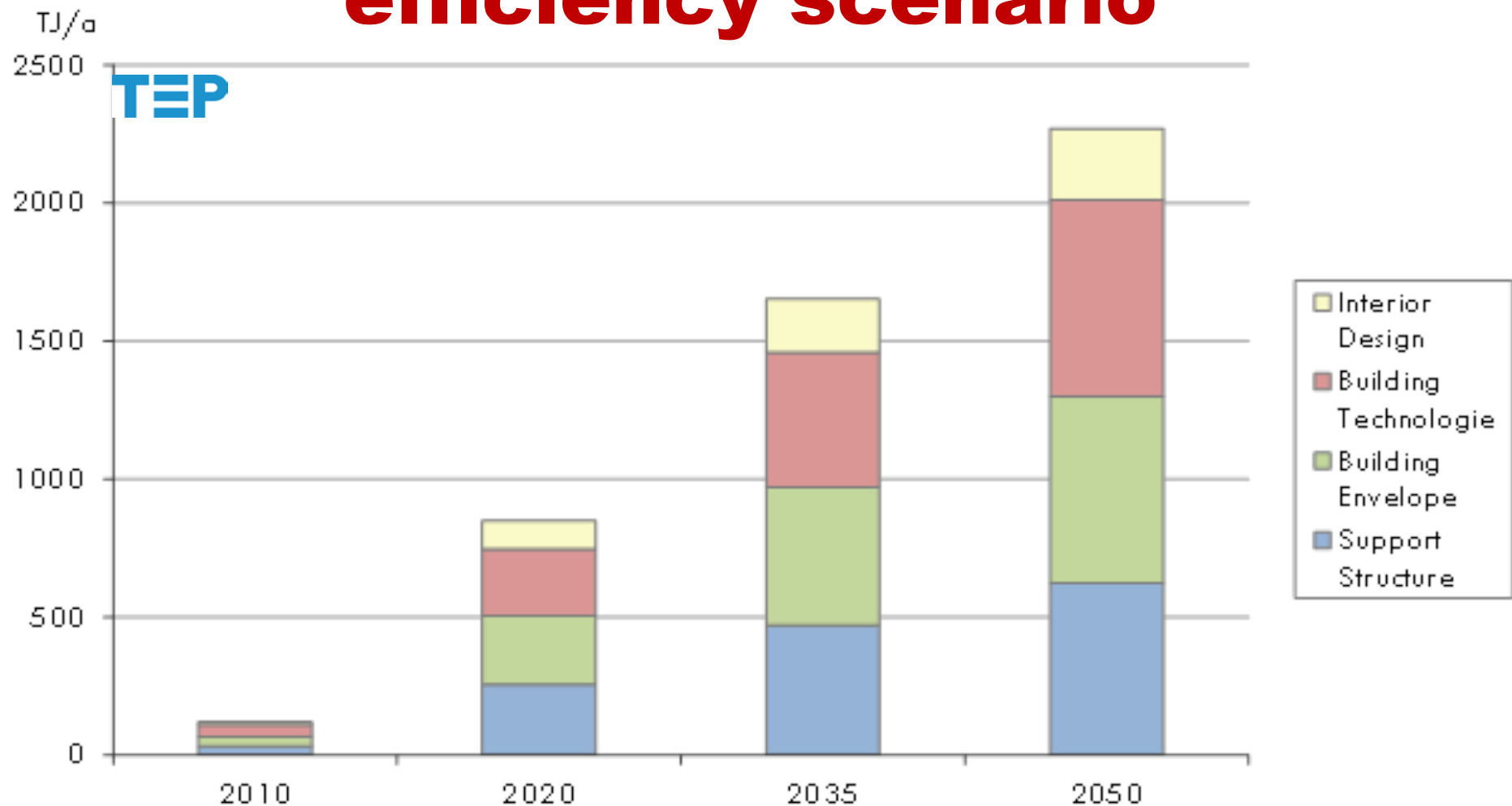
1. A **reference scenario** represents a moderate development of energy efficiency.
2. An **efficiency scenario** reflects a profound effect of strict policies promoting high energy efficiency (electricity and heat) and the use of renewable energies.
3. An **ecological efficiency scenario** assumes along with improving energy efficiency also increased diffusion of design and energetic refurbishment measurements and building elements and construction materials with lower material intensity and a lower content of environmental impacts (GHG, PE, UBP).

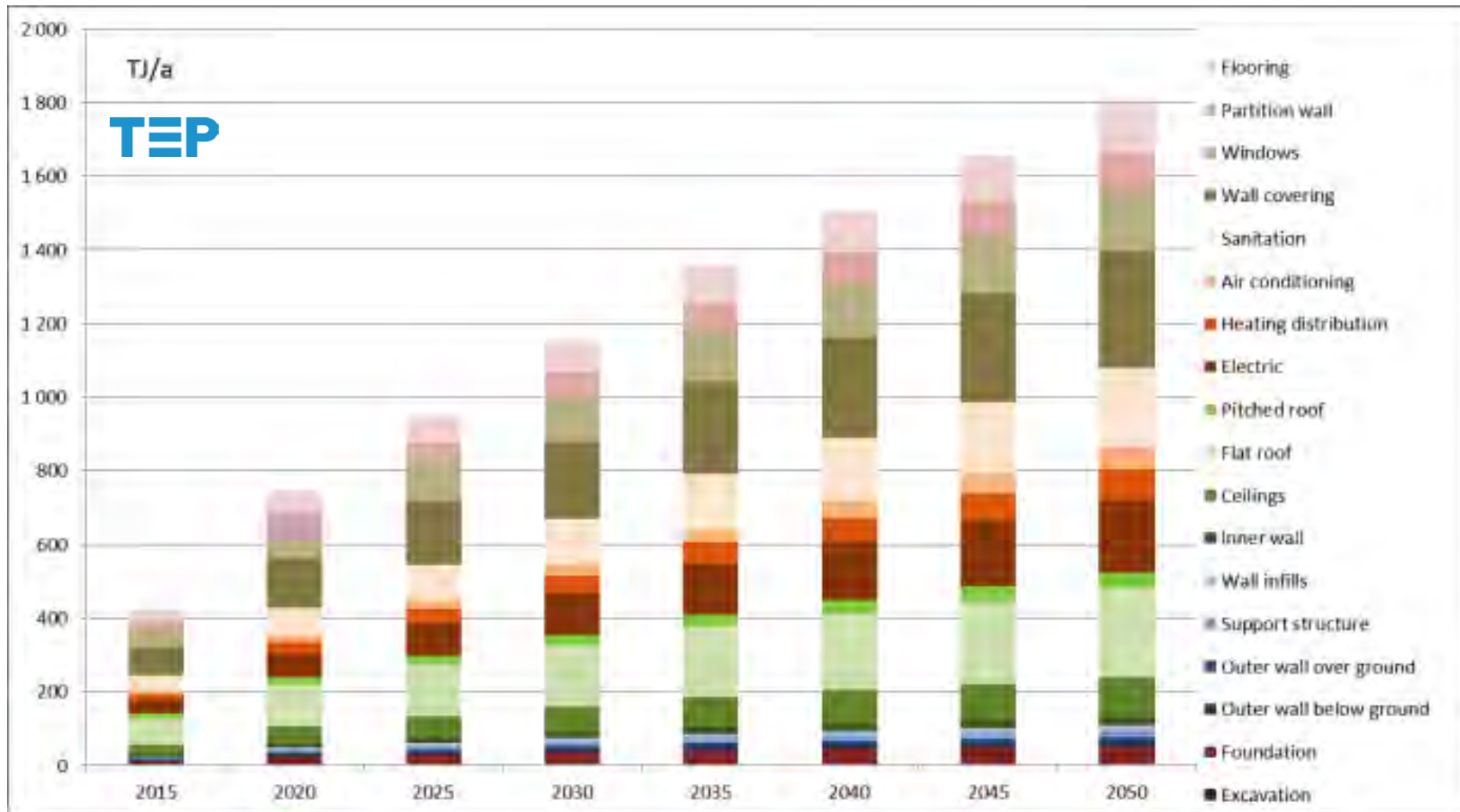
# System boundaries

- As far as possible, the entire building is considered but
- due to the presumed large heterogeneity and diversity, lack of data on quantity structure and characteristics and presumably little influence on the overall results, the following elements in this project are also not accounted for:
  - balconies,
  - roof installations and
  - part of the interior (kitchen, interior wall and ceiling finishes, appliances, etc.).
- However, regarding the interior finishing the flooring, the heating distribution as well as electrical and plumbing installations is considered.

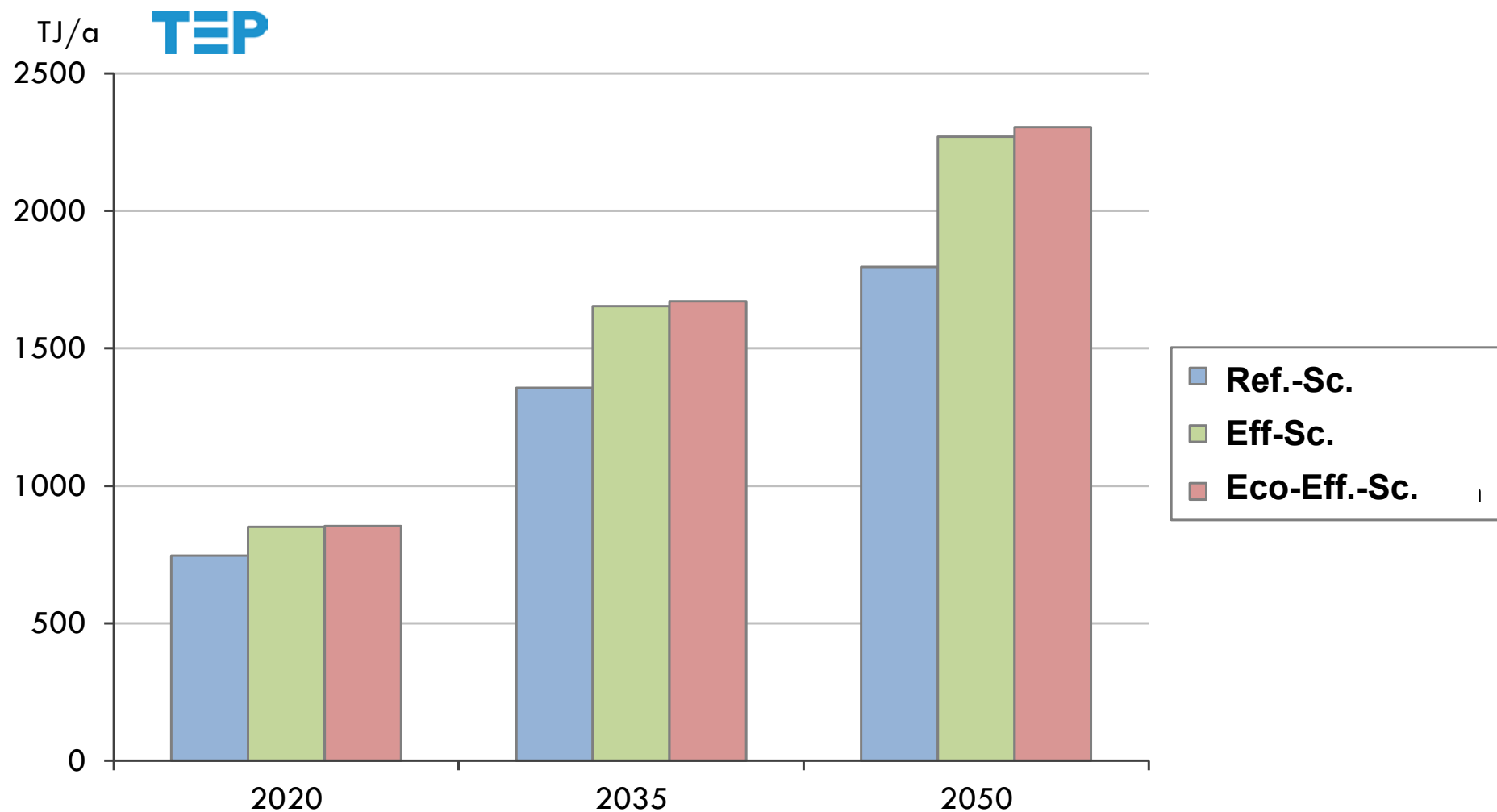


# Embodied energy of the building stock over time to 2050 in the efficiency scenario

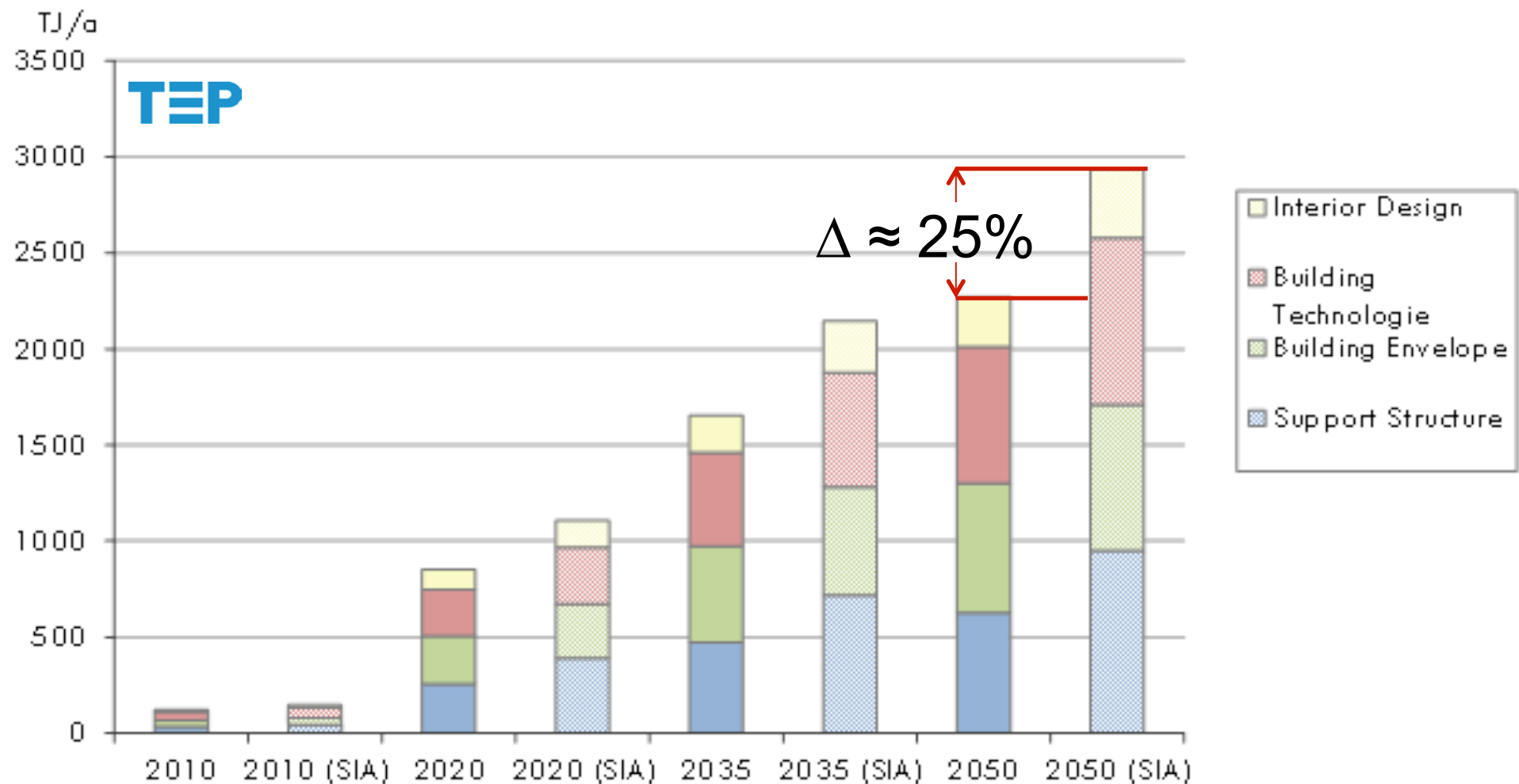




# Comparison of the embodied energy in TJ/a



# Embodied energy in TJ/a (Eff.-Sc.)– own assumptions vs. SIA 2032



## Main findings

- The embodied energy in Zurich building stock by building new construction and renovation cumulates to TJ 1'796 (Reference scenario), TJ 2'270 (Efficiency scenario) and TJ 2'304 (Eco-efficiency scenario) in 2050.
- Around 190 watts per person (or already appr. 10% of the target value of 2000 watts per capita in the year 2050) and 0.48 tonnes of CO<sub>2</sub> per person in 2050 for the efficiency scenario.
- Roughly 10% of the operating energy.
- “Grey greenhouse gas emissions” amount to almost 90% of greenhouse gas emissions from the operation in 2050.
- Eff.-Sc.: higher embodied energy values mainly because of the high material intensity of building envelopes of high energetic standards.
- Eco-eff.-Sc.: leads to the highest embodied energy values through an increased amount of wood (partly lower life expectancy than other construction materials and the currently used building material specific embodied energy values seem to be too high and need to be revised).

# Acknowledgement

The authors would like to thank the Municipal Building Department, Section of Sustainable Construction of the city of Zurich for financing the pilot study on the Zurich building stock model.

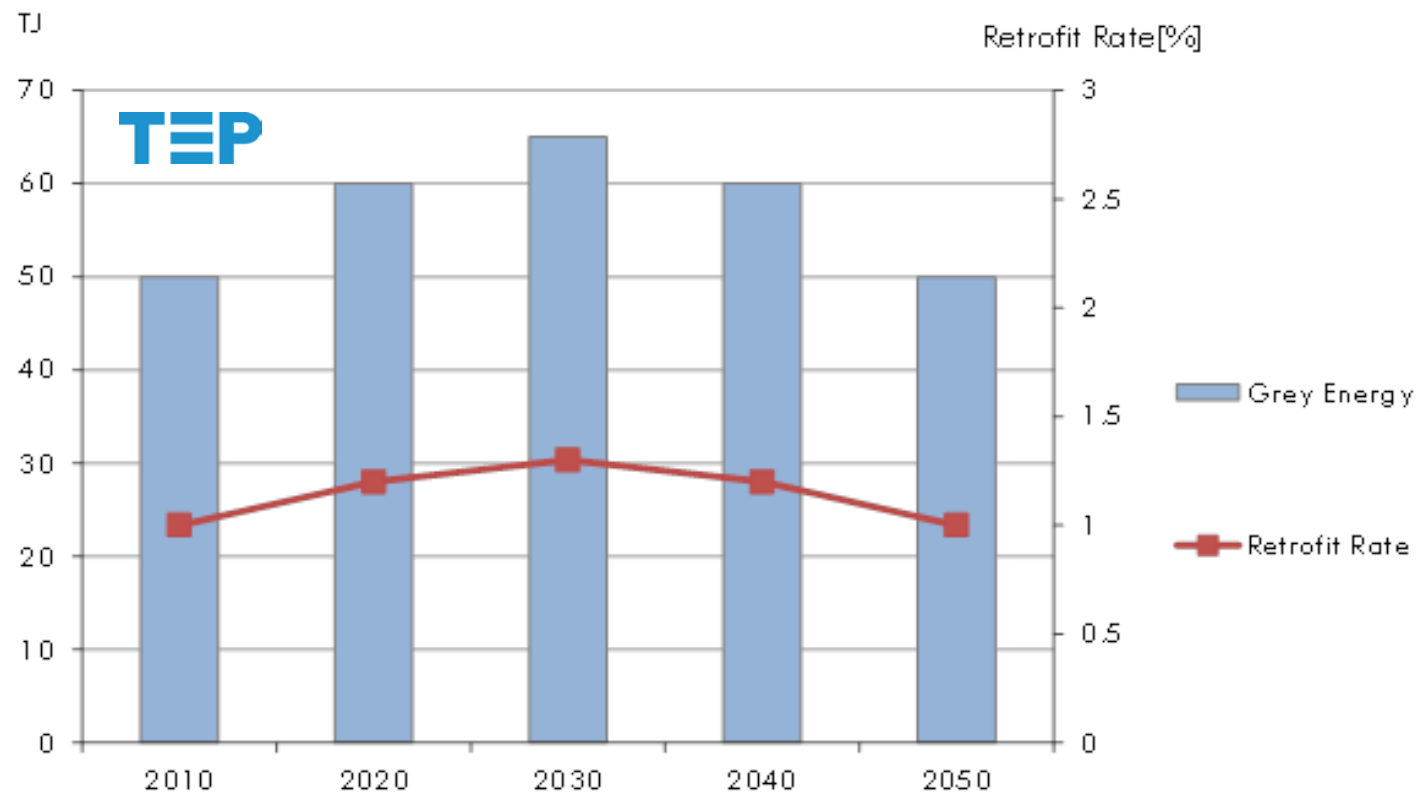
TEP Energy was mandated by the city of Zurich to develop an energy demand and supply concept with a spatially differentiated building stock model, which the authors gratefully acknowledge.

# CHALMERS

*for a sustainable future*

# Allocation method (1/2)

- Investment principle: the grey environmental impact is fully attributed to the time of actual construction.



## Allocation method (2/2)

- Depreciation principle: the grey environmental impact is equally distributed over the expected life time of the construction.

