Buildings and Energy Day June 14, 2018

SONTE Sondierung Smarte Modernisierung Terrassenhaussiedlung

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ige Institut für Gebäude und Energie TU Graz

Field of Expertise

Sustainable Systems

Introduction

Terrassenhaussiedlung Graz:
- 524 apartments, 800 owners, 1070 occupants
- 92807 m² building envelope
- 58 156 m² total floor area (TFA)
- 49 730 m² usable floor area (UFA)
- annual primary energy consumption: 314 kWh/m²$_{UFA}$
- complex geometry, many thermal bridges

Goals:
- Reduction of thermal energy demand by 45%
- Preservation of the architectural expression
- Refurbishment of individual apartments
- User participation in the decision making process

Methods

Proposed and evaluated refurbishment strategies:
1. Exterior thermal insulation (fig. 6, 10, 14, 18)
2. Interior thermal insulation (fig. 7, 11, 15, 19)
3. Replacing light-weight elements (fig. 8, 12, 16, 20)

Methods used:
- Thermography
- Occupant survey (fig. 2, 3 and 24)
- Data collection (fig. 4-5)
- Analysis of thermal bridges (fig. 14-17)
- Thermal simulation of apartment types (fig. 18-21)
- Calculation of total energy demands (fig. 25)
- Analysis of annual solar irradiation (fig. 22-23)

Results

- All proposed strategies close to 2020 requirements but not fully reached (fig. 25).
- Requirements reachable for Strategy 1 and 2 with further measures on building systems.
- Strategy 2 reaches the lowest heating and primary energy demand, Strategy 3 the highest
- Highest impact of thermal bridges in Strategy 3: 4-9% of total thermal losses.
- Potential for building integrated photovoltaics (PV): 4.7 kWh/m²$_{UFA}$ or 15% of annual electricity demand.
- Potential for building integrated solar thermal energy production: 18.9 kWh/m²$_{UFA}$ or 77% of annual warm water energy demand.

Conclusions and Outlook

- Strategy 1: Highest impact on visual appearance, does not allow refurbishment of individual apartments but most uncritical in terms of building physics.
- Strategy 2: Lowest heating energy demand, allows refurbishment of individual apartments, lowest impact on visual appearance, but most critical in terms of building physics.
- Strategy 3: Highest heating energy demand but potentials for passive solar energy use which should be further investigated.
- Condition of exposed concrete elements is unclear. Possible conservation measures should be elaborated before final recommendations can be made.

Fig. 1: View of Terrassenhaussiedlung Graz, © Helmut Tezak

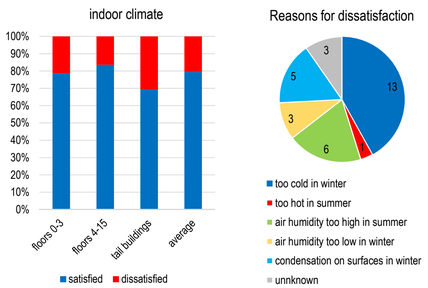


Fig. 2-3: Results of the first occupant survey: satisfaction with indoor climate.

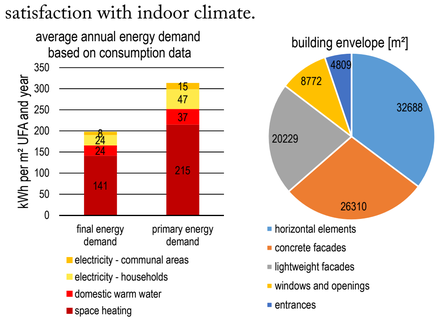


Fig. 4-5: Energy demand and total building envelope of the existing buildings.

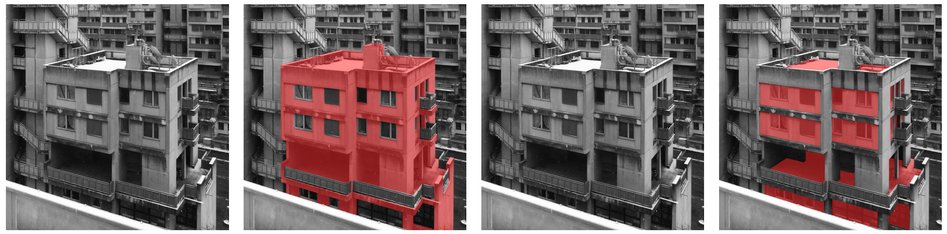


Fig. 6-9: Parts of the building envelope visually affected by the proposed thermal rehabilitation strategies (from left to right: existing building, strategy 1, strategy 2, strategy 3).

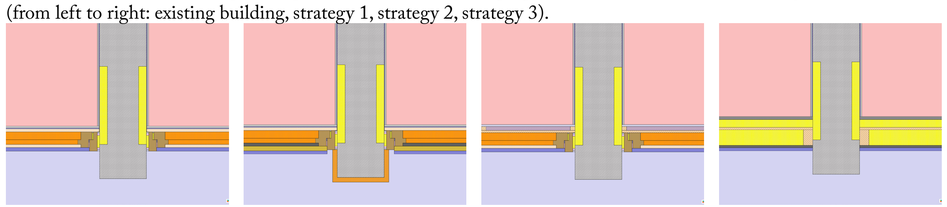


Fig. 10-13: Horizontal section through a light-weight facade with protruding concrete wall of the different proposed refurbishment strategies (from left to right: existing building, strategy 1, strategy 2, strategy 3).

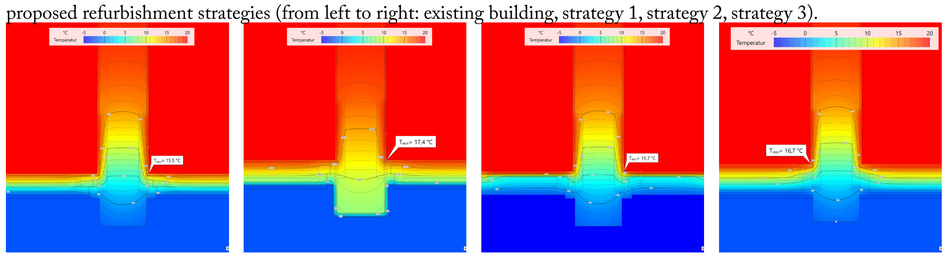


Fig. 14-17: Simulation results: temperature profiles of the different proposed refurbishment strategies. (from left to right: existing building, strategy 1, strategy 2, strategy 3).

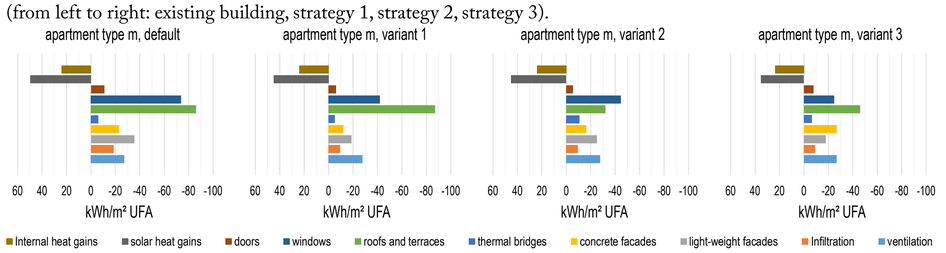


Fig. 18-21: Simulation results: heat balances of the proposed thermal rehabilitation strategies for apartment type *m* (from left to right: existing building, strategy 1, strategy 2, strategy 3).

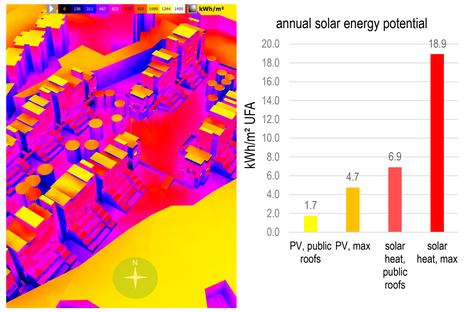


Fig. 22-23: Insolation study and annual solar energy production potential for the entire estate, based on UFA.

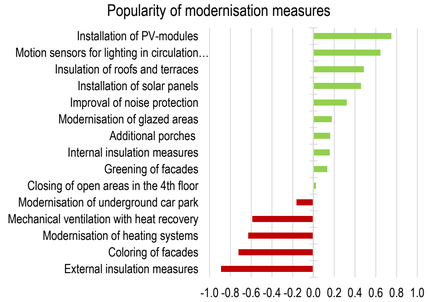
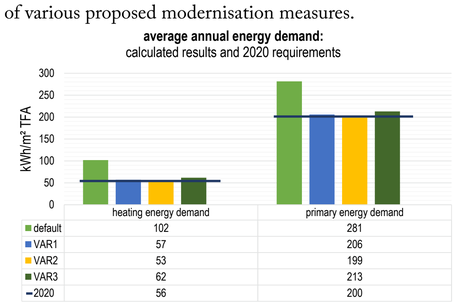


Fig. 24: Results of the second occupant survey: popularity of various proposed modernisation measures.



	heating energy demand	primary energy demand
default	102	281
VAR1	57	206
VAR2	53	199
VAR3	62	213
2020	56	200

Fig. 25: Heating energy demand and primary energy demand of the proposed refurbishment strategies, in comparison to Austria's 2020 requirements.

Executive summary

The present study proposes and evaluates different thermal rehabilitation scenarios for a housing estate Terrassenhaussiedlung Graz - a late Modernist housing estate in Graz, Austria, and a rare example of Brutalism and Structuralism in this country. These scenarios were developed as part of a larger research project in a participatory process with the involvement of the inhabitants of the estate.

Striving for an appropriate refurbishment strategy that lowers the energy demand significantly, respects the cultural significance of the building and allows a gradual rehabilitation of the estate at the same time, three potential thermal rehabilitation scenarios are being proposed and further investigated: Interior insulation, exterior insulation and the replacement of non-structural elements. These strategies are evaluated and discussed in terms of their impact on energy efficiency, building physics, architectural appearance and their practicability. Special attention was given to the many thermal bridges caused by the exposed concrete structure of the estate, moreover the potential for building-integrated energy production was investigated. Results were derived by different simulation methods, including small scale hygrothermal simulations and large scale dynamic thermal simulations.

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