UNIKASSEL VERSITÄT

EuroSun2022

SOLAR.
UNI-KASSEL.DE

# Solar district heating versus renovation of buildings as measures for decarbonization of heat supply in rural areas

**J. Kelch**, O. Kusyy, J. Zipplies, J. Orozaliev, K. Vajen

1) Introduction
2) Concept description
3) Concept comparison
4) Conclusion

University of Kassel, Institute of Thermal Engineering

# Introduction

## Background: Case study for Bracht

- Citizens want to implement a solar district heating system with a seasonal storage
- 294 buildings in two districts → 90% before 1980
- ~180 consumers → connection rate 61%

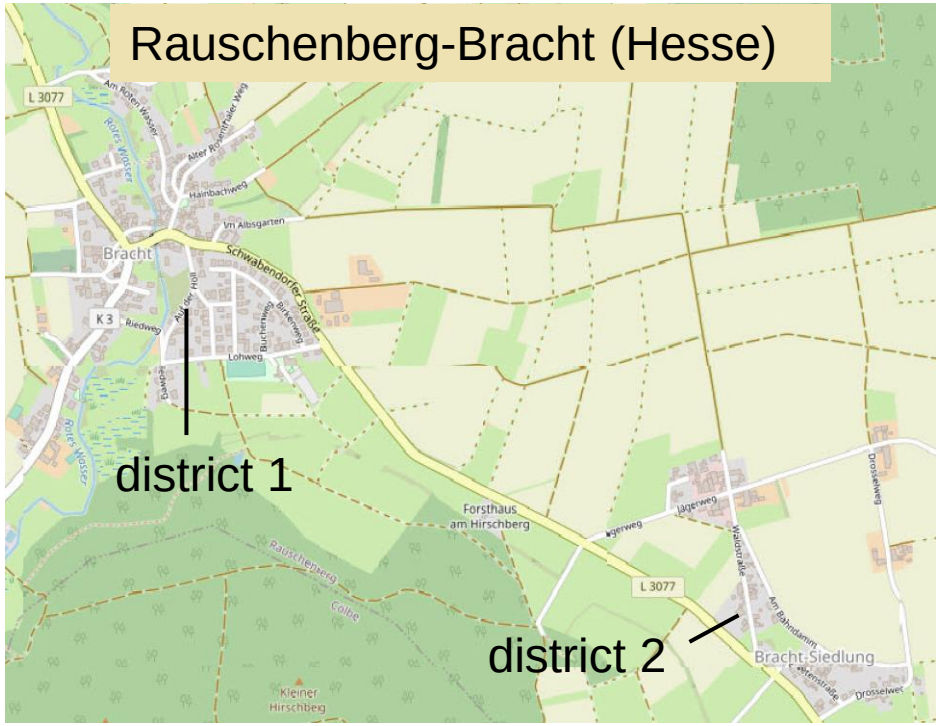
## Research question:

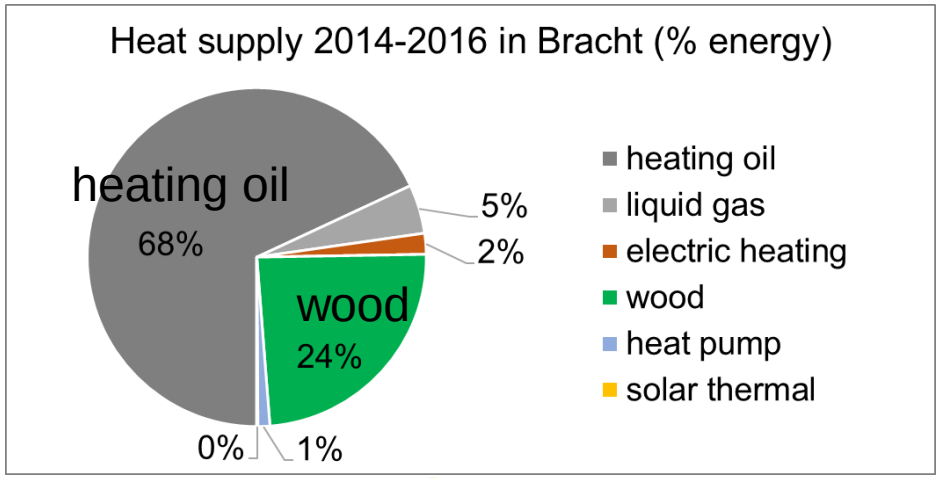
How competitive is solar district heating (centralized solution) compared to profound renovation of buildings + heat pumps (decentralized solution)?

## Goal:

Comparison of the two heating concepts on the example of Bracht under same boundary conditions:

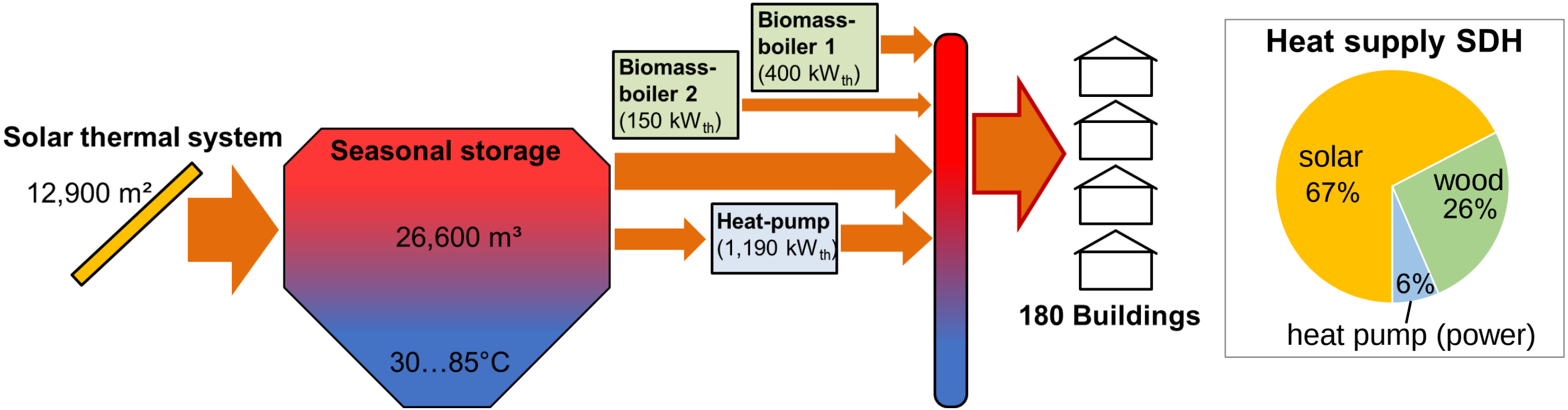
1) Heat supply of 180 buildings
2) Fossil-free heat supply
3) No more use of biomass than today



# Solar district heating

## Solar district heating system (SDH)




- Heat pump discharges seasonal storage to 30°C → storage: capacity ↑, volume ↓, costs ↓
- Biomass boilers as auxiliary heating of the heat pump → heat pump‘s efficiency ↑
- Dimensioning by Simulation in TRNSYS and algorithm based optimization to minimize heat costs

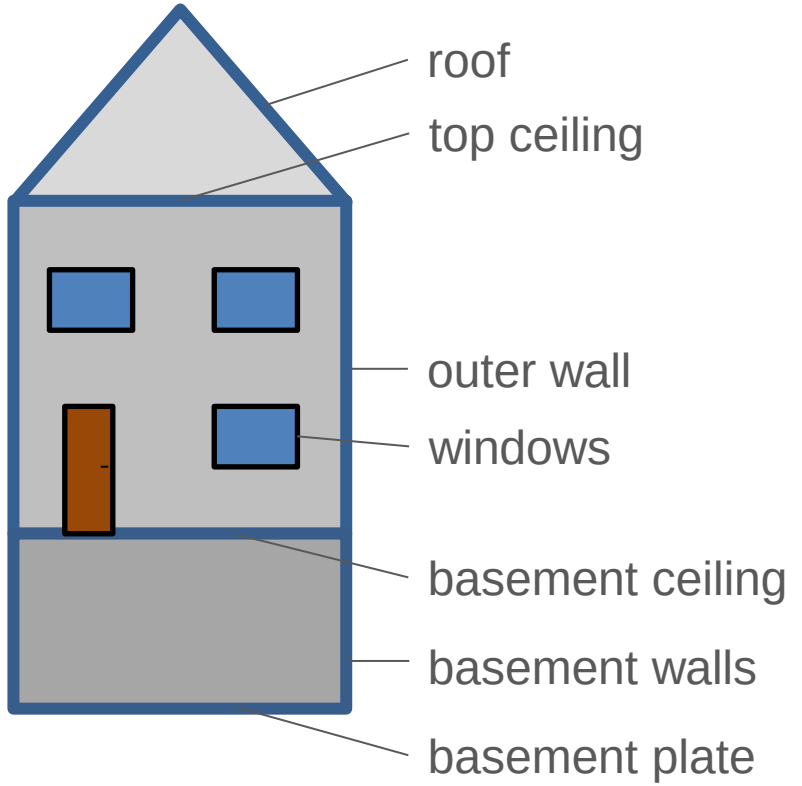
**→ Reduction of $CO_2$e emissions about -98% compared to now**

# Approach for decentralized renovation

**→ Renovation + change to air heat pump or wood fired boiler**

1. Estimation of measures for 27 buildings per building:
   - Energy consultations by the Energy Agency of Hesse
   - Detailed information available:
     - Areas of thermal building envelope
     - Heat transfer coefficients
2. Extrapolation of these measures to 180 buildings by building category:
   - After 2000
   - 1980 till 2000
   - Before 1980

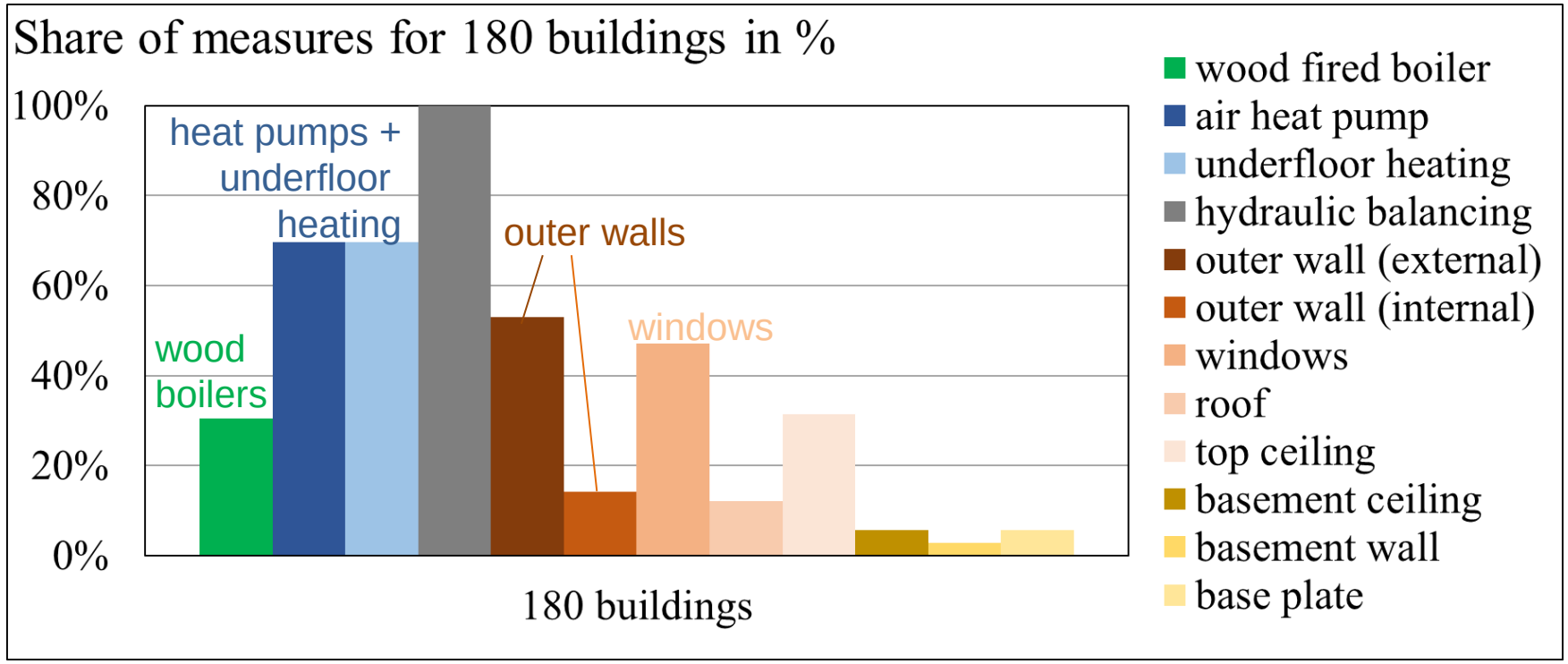
**Insulation measures**



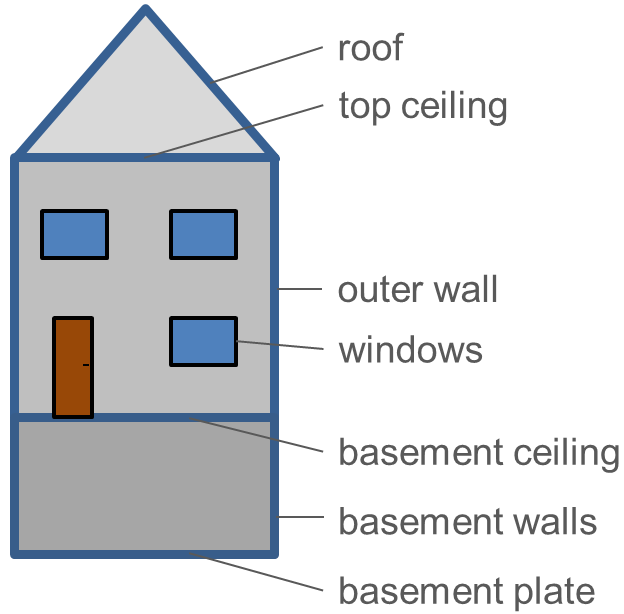

**Further measures:**

- Underfloor heating in case of heat pump
- Hydraulic balancing

# Resulting measures for decentralized renovation

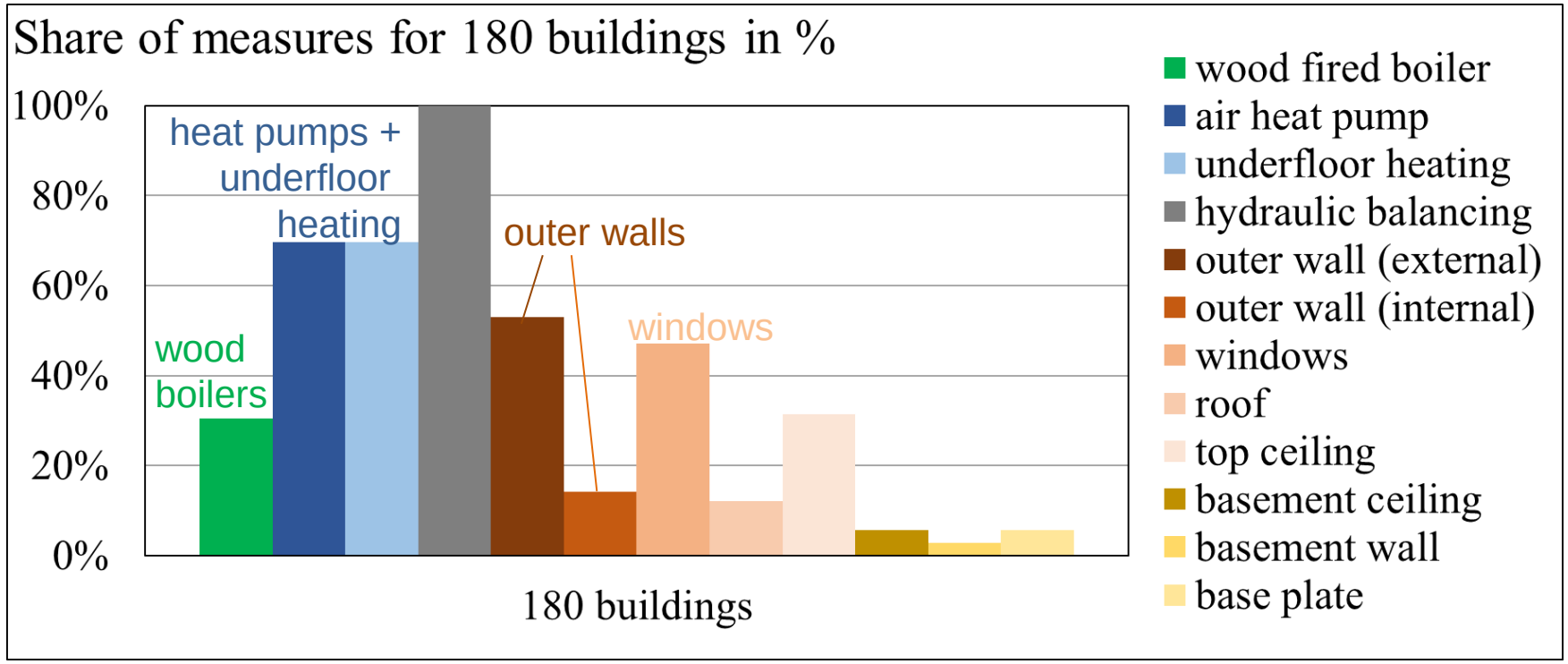


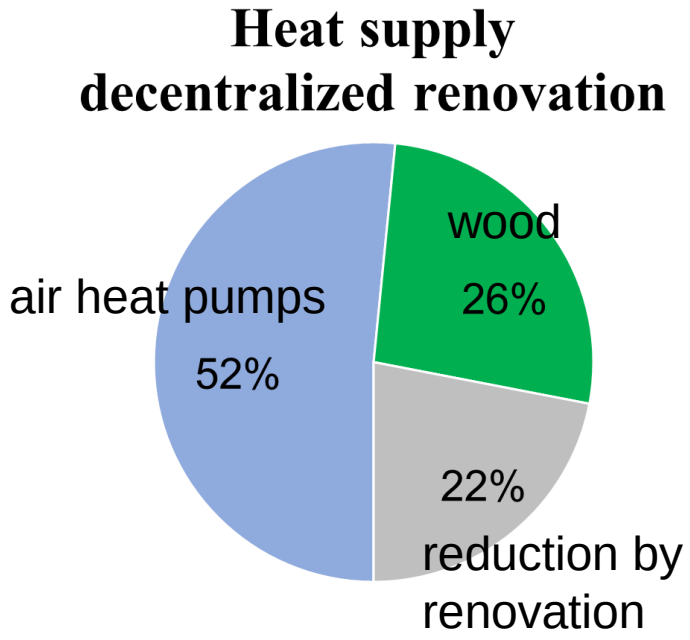

**Insulation measures**




- Outer wall insulations and replacements of windows have high shares and high specific costs
  → relevant for investment costs

# Resulting measures for decentralized renovation

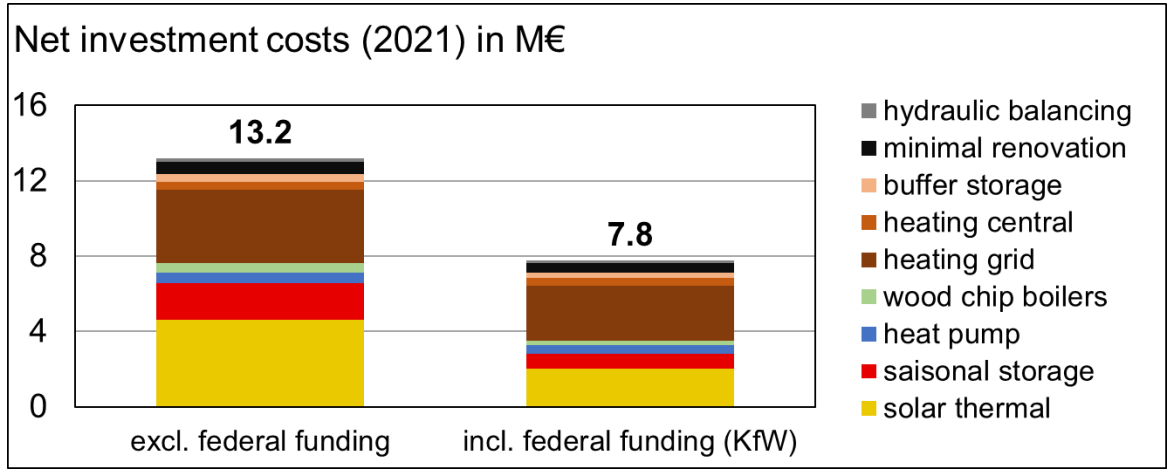


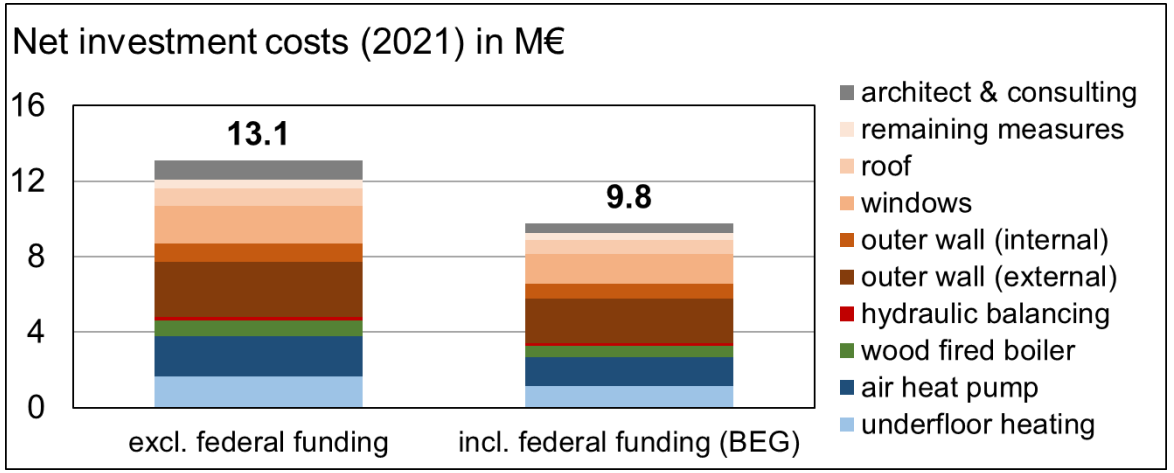

- Outer wall insulations and replacements of windows have high shares and high specific costs
  → relevant for investment costs
- **Reduction of $CO_2e$ emissions is about -95% compared to now**

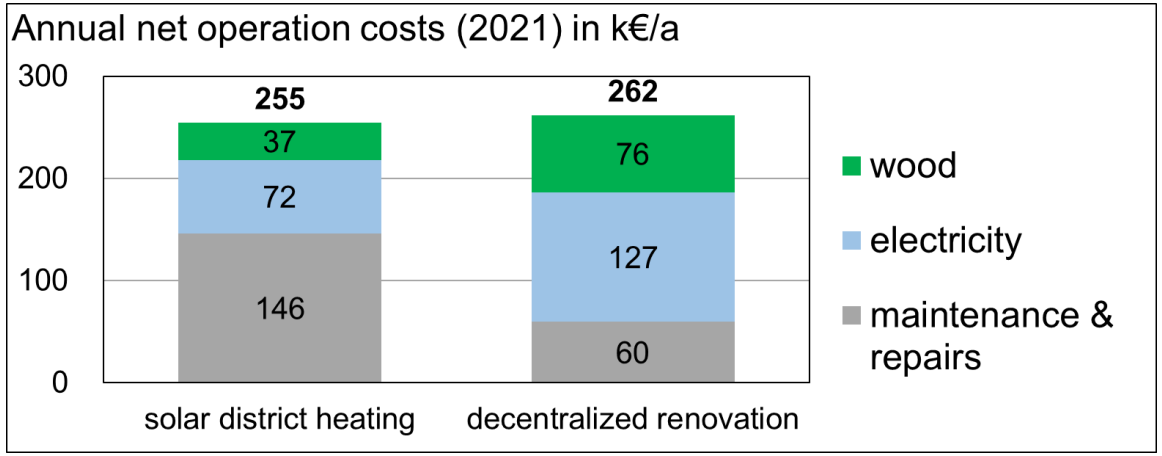
# Comparison of net investment and operational costs

## Solar district heating




## Decentralized renovation

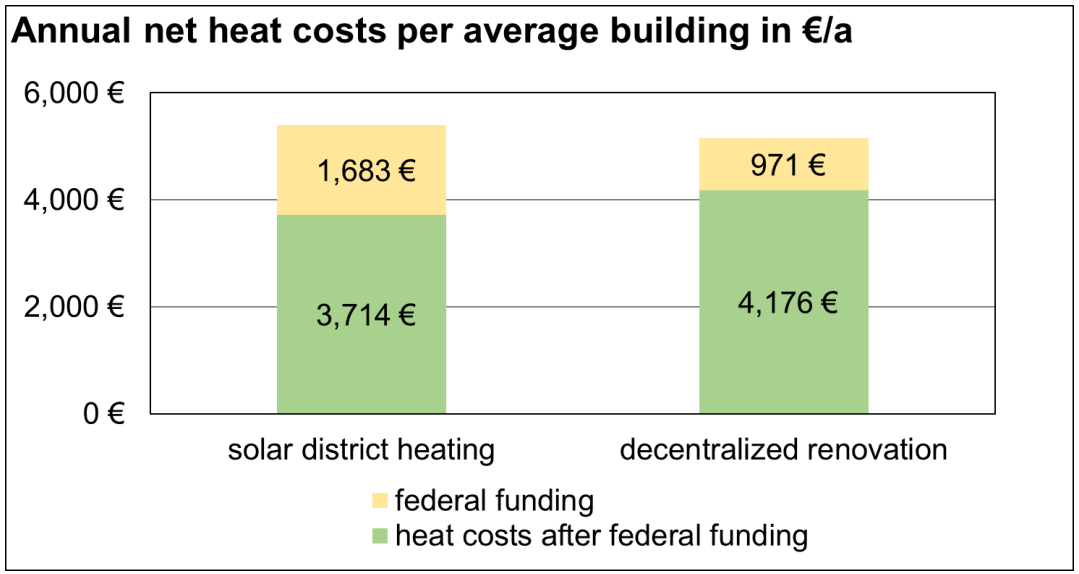


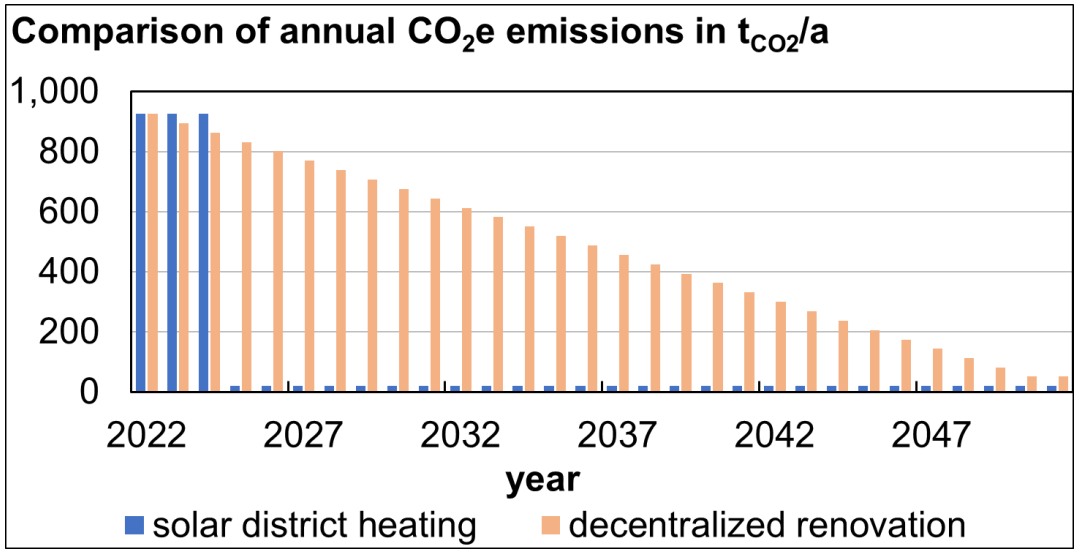




→ Net investment costs and annual operational costs of both scenarios are similar

→ Federal funding for investment is about 2 million € higher for solar district heating

# Conclusions




- Similar annual costs per average building for both scenarios
- Full reduction of $CO_2e$ emissions is reached with
  …solar district heating within a few years by starting operation
  …decentralized renovation after decades because of low renovation rates of about 2-3%/a
- Accumulated $CO_2e$ emissions for next 30 years
  - Solar district heating: 3,318 $t_{CO2}$
  - Decentralized renovation: 14,202 $t_{CO2}$ (+328%)

→ **Solar district heating is economically competitive and accelerates the decarbonisation of rural areas**

**Funding source:**
EUROPÄISCHE UNION:
Investition in Ihre Zukunft
Europäischer Fonds für regionale Entwicklung