Solar Energy Buildings in Central Europe - an energy efficient solution with cold district heating networks

Sol4City project

Bernd Hafner, IEA SHC Task 66 Solar Energy Buildings 23/03/2022, Industry Workshop No 1

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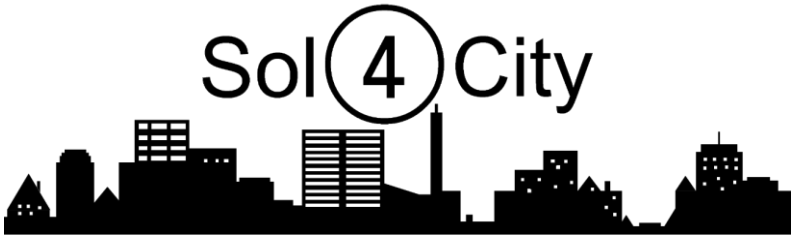
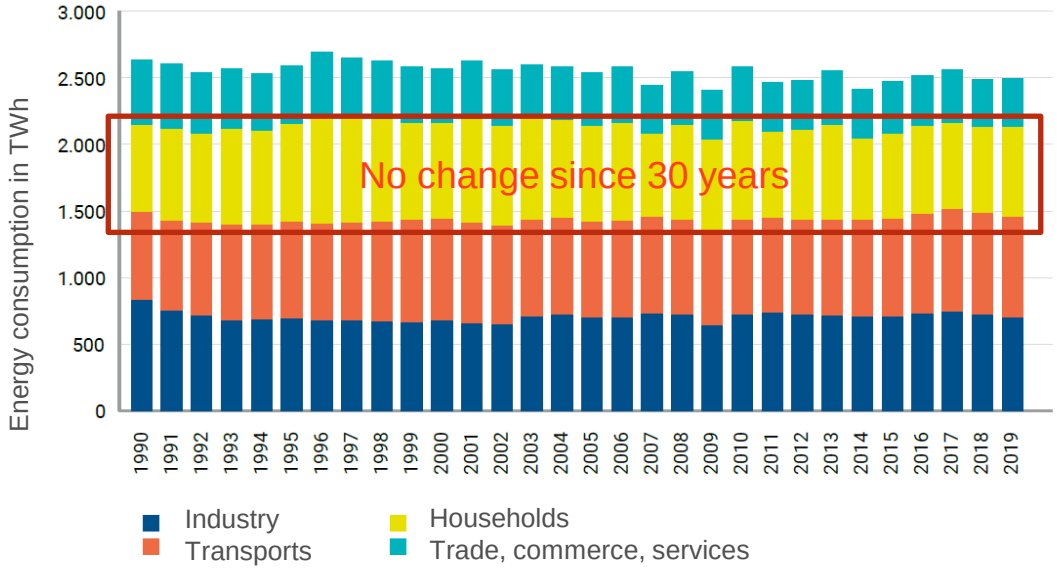
Research project “Sol4City”

Development of integrated solar heating and cooling concepts for climate neutral buildings in the „City of the Future“

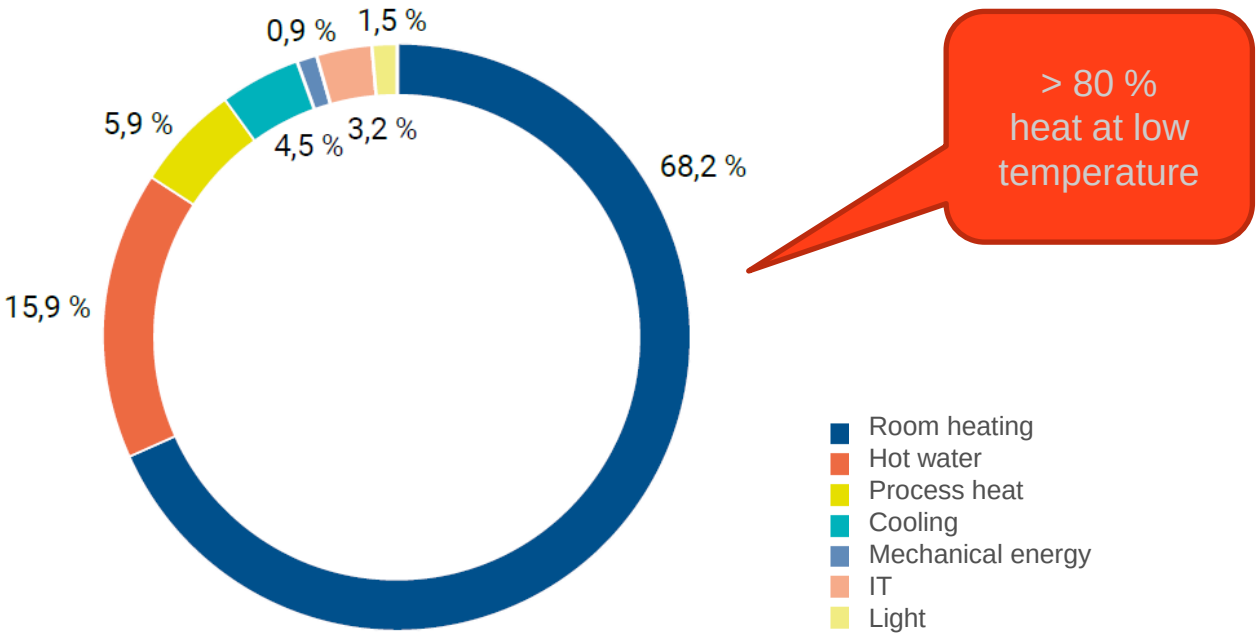


Energy consumption by sector (Germany)



Source: https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2021/dena-Gebaeudereport_2022.pdf

Share of heating and cooling



Source: https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2021/dena-Gebaeudereport_2022.pdf

Existing building stock

How to bring the renewable energy to this building?

Climate Neutral – What does it mean?

- **Approach 1: Virtual „Bronze“**

Compensation of the $CO_{2\text{-eq}}$ – emissions by certificates

+ cheap at the beginning

- not neutral on a global level

- **Approach 2: Balance „Silver“**

Balance of the $CO_{2\text{-äq}}$ - emissions over the year by exporting and importing green energy

+ relatively cheap

- works only with green energy also in winter

- **Approach 3: Real „Gold“**

The $CO_{2\text{-äq}}$ - emissions are zero at any time of the year

+ complete climate neutrality

- seasonal storage necessary

- quite expensive

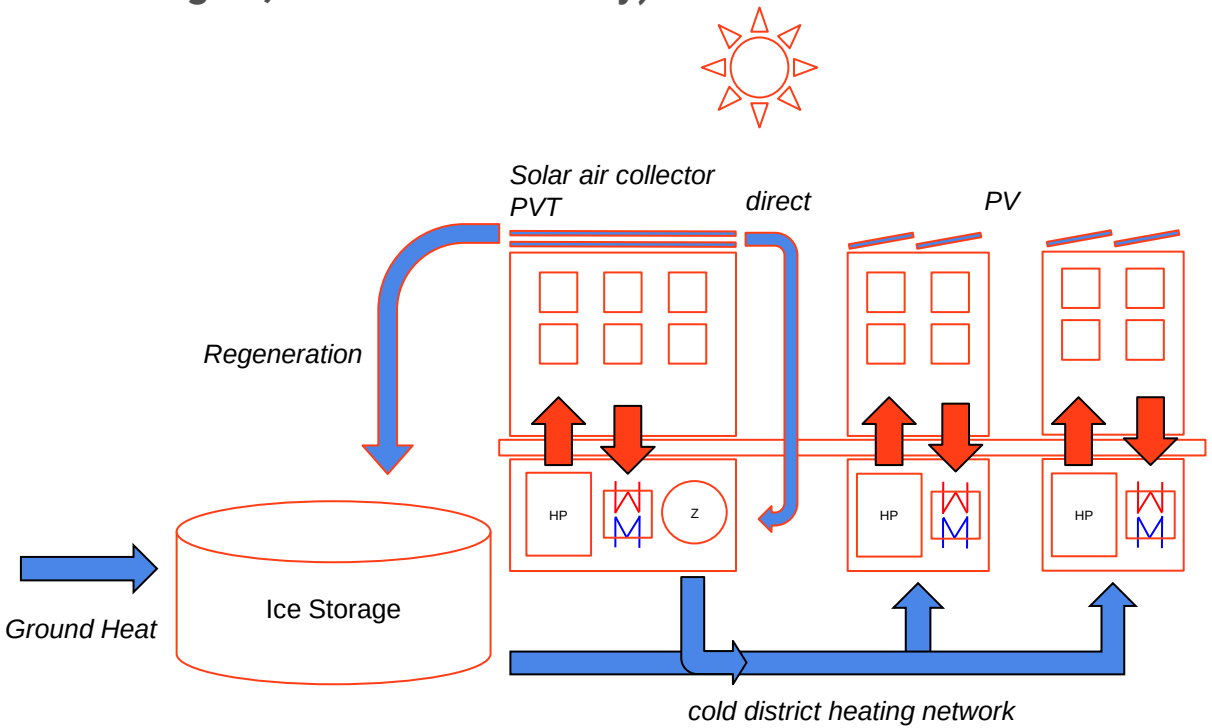
 (source: Drück/Hafner: Berliner Energietage • 22.04.2021)

Focus of the project

- Use renewable energy
  (100 % cooling, 85 % heating, 60 % electricity)
- Choose the best source: solar thermal, PV, ambient air
- PCM storage for decoupling the load (“ice storage”)
- Low temperature distribution networks (“cold district heating networks”)
- Decentralized heat pumps
- Decentralized thermal storage with reduced losses

Cold district heating network

Ludwigsburg (near Stuttgart, southern Germany)

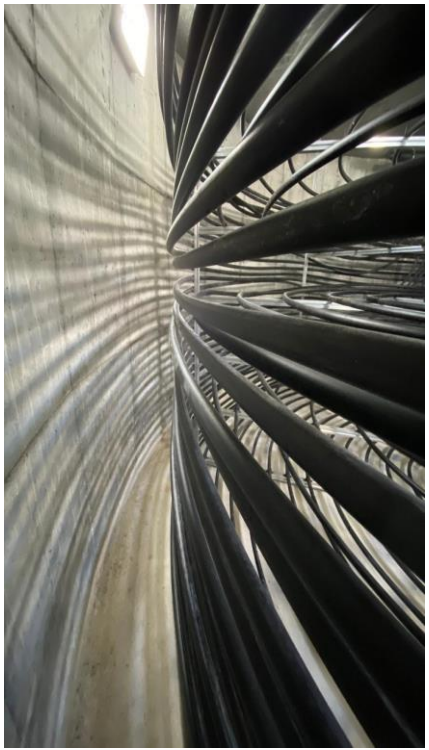


Ice Storage

Volume:
30 m³ up to
2000 m³

… similar to a
rainwater cistern …

Heat Exchanger



Solar Thermal Air Collector

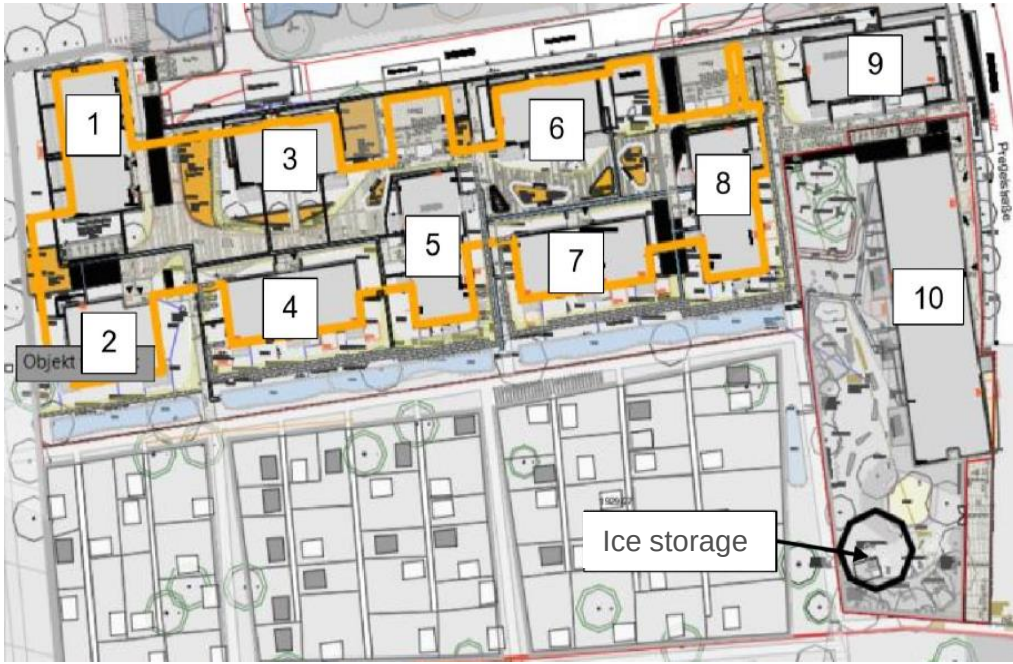
A cost-efficient source of renewable energy.

Photovoltaic Thermal Collector (PVT)

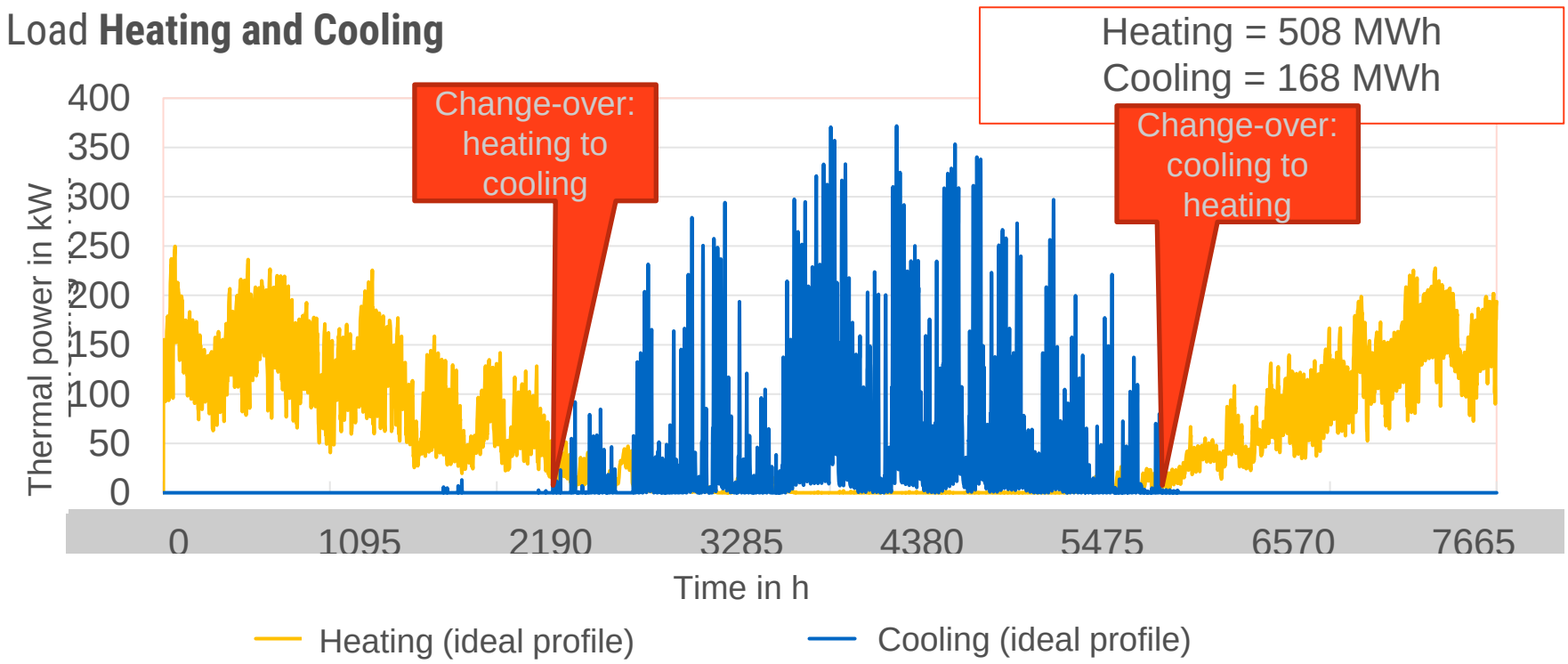
Double use of the surface to produce electricity and heat.

Cold district heating network Ludwigsburg

- 45 kW(th) heat pump per building
- 1,5 m³ buffer storage per building
- 137 m² solar air collectors
- 700 m³ ice storage
- 1500 m cold district heating network
- Minimized thermal losses due to cold distribution temperatures and efficient decentralized thermal storage



Cold district heating network Ludwigsburg



Summary

- Major challenge : renewable energy supply for the existing buildings
- Various renewable sources: solar thermal, PV, ambient air
- Cold district heating networks for an efficient transport of the thermal energy
- Demand in the districts is heating and cooling
- Ice storage
  - decoupling the load (source during the “cold winter night”)
  - energy efficient cooling in summer

Thank you for your attention !

Project partners

Universität Stuttgart, Institut für Gebäudeenergetik, Thermotechnik und Energiespeicherung (IGTE)

VIESSMANN

Viessmann Climate Solutions SE

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