University of Stuttgart
Institute for Building Energetics, Thermotechnology and Energy Storage (IGTE)

Sol 4 City

Development of Integrated Solar Supply Concepts for Climate-Neutral Buildings for the „City of the Future“

IEA SHC Task 66 „Solar Energy Buildings“, Meeting No 1

Online, July 1st, 2021

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Research Project Sol4City
Key Data and Objectives

Key Data

- joint project:
  Austria – Germany
- 8 partners from industry & research

AEE INTEC, IGTE, iPMT, VIESMANN, KIOTO PHOTOVOLTAICS, KREISEL, GREENoneTEC SOLAR COLLECTORS, SONNENKRAFT

- duration:
  Dec., 2019 - Nov., 2023

Sol4City

development of integrated solar supply concepts for climate-neutral buildings for the „city of the future“

Objective

covering

- 100% cooling demand
- 60% electricity demand
- 85% heating demand

with

- highly efficient energy supply systems
- decentralized heat pumps
- solar radiation and environmental heat as main energy sources

integrated solar supply concepts for **climate-neutral** buildings for the „city of the future“

climate neutral means, that we do not release more CO_2 equivalents than nature degrades in the same period of time

→ That's about 2 tons of CO_2 eq. per year and person

Stefanie Lott
Harald Drück

Research Project Sol4City

Overview

Regenerative **energy sources** to use **solar** radiation & **environmental** heat

adaptive & predictive supply **system control**

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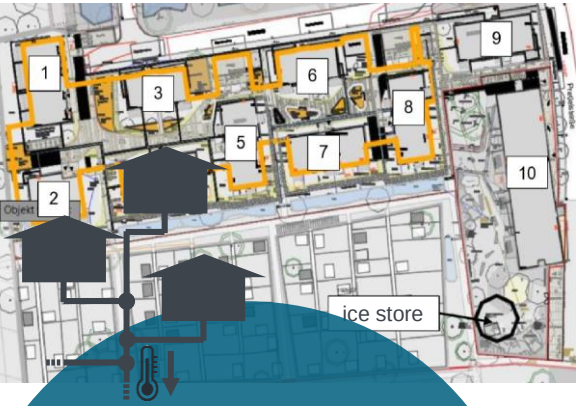
anergy supply network / cold district heating network

detection of the **charge status** of ice stores

Highly efficient heat stores with **vacuum thermal insulation**

supply **system simulation** – modeling, validation & analysis

Related Work (1/6)



anergy supply network / cold district heating network

T = -5°C to 20 °C

decentralized supply concepts – field test system „Ludwigsburg“

solar technology	store	heat/cold generation	store	heat/cold generation

PV generator + sun-air collector (SLK)

(battery)

highly efficient heat store

heat pump

highly efficient heat store

heat pump

ice store (central)

H/C

H/C

3 more cold district field test systems in preparation

Related Work (2/6)

regenerative **energy sources** to use **solar** radiation & **environmental** heat

- identification of a reliable numerical collector model
  - sun-air collectors: TRNSYS Type 832
  - photovoltaic-thermal collectors: TRNSYS Type 835
- characterization of different collectors via quasi-dynamic outdoor measurements according to ISO 9806

Charger without and with cover

SLK 600

Alu-Absorber

Related Work (3/6)

- identification of **most promising sensor technologies** for the detection of the charge status of latent heat stores

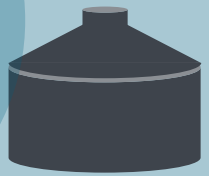
- sensor technologies are investigated for their

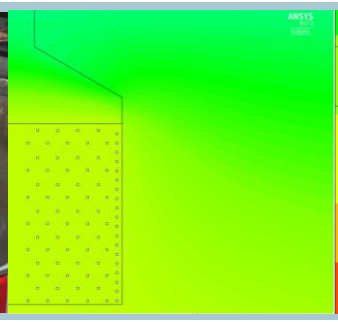
general suitability & measurement uncertainty	long-term stability real operation conditions	detailed thermodynamic behavior

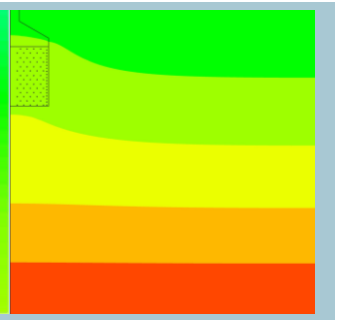
- investigation methods

model ice store sound level test bench	real-scale ice store (10m³)	computational fluid dynamic simulations of the ice store and the surrounding soil

detection of the **charge status** of ice stores







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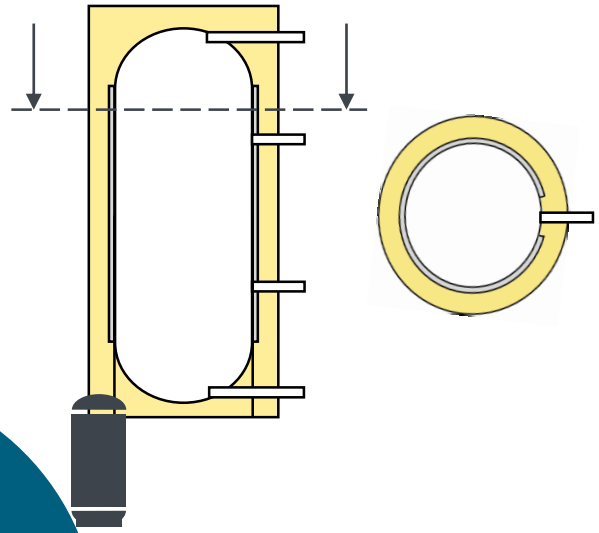
Related Work (4/6)

- Identification of existing thermal insulation concepts for water heaters with ErP label A or A+

  (according to EU Regulation No. 812/2013 supplementing Directive 2010/30/EU)

- Thermal insulation concepts
  - Identification of optimization possibilities of existing concept
  - Requirements of the ErP label depending on the store volume
  - Simulation study on the insulation effort for larger storage volume

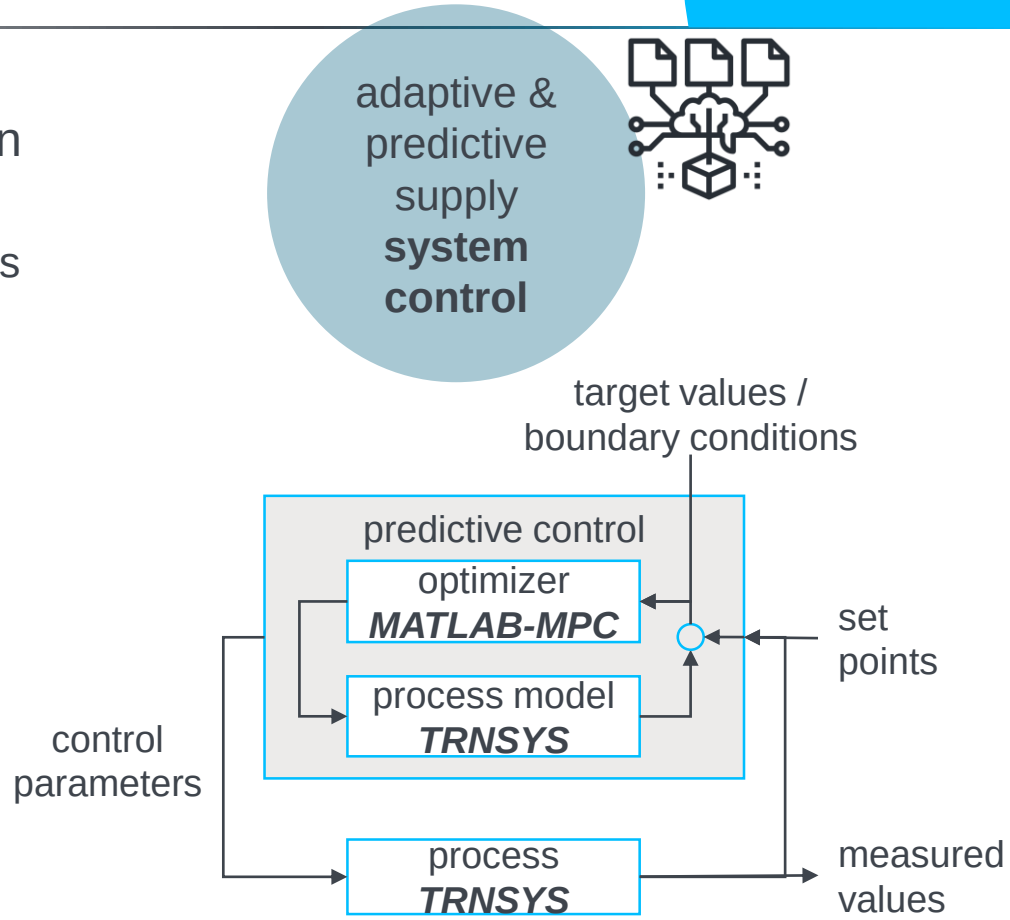


Highly efficient heat stores with **vacuum thermal insulation**

Related Work (5/6)

conceptual idea

- Model Predictive Control or Receding Horizon Control
  - Software: MATLAB coupled with TRNSYS models for building and energy supply system
  - using weather and user data forecasts and influenced load profiles
  - Definition of time horizon and estimation of data uncertainty
  - Specify target values and boundary conditions in the form of limit values
- extension of adaptive control
  - artificial neural network
  - training data from simulation studies



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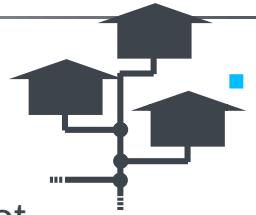
Related Work (6/6)

- definition of boundary conditions
  - reference buildings/districts
  - reference load profiles (heating, cooling, hot water, electricity)

  →related to a literature research and market experience of Viessmann

- measurement data evaluation to validate existing numerical ice store models
  - ice store volumes: 10 m³ to 1.000 m³ water volume
  - numerical models: TRNSYS type 343 & Simulink ice store model – *validated for 10 m³*



- TRNSYS model for the field test system “Ludwigsburg” to:
  - simulate and compare different solar collectors and their supply system effect
  - determine various key performance indicators
  - validate simulation results with measurement data

supply **system simulation** – modeling, validation & analysis

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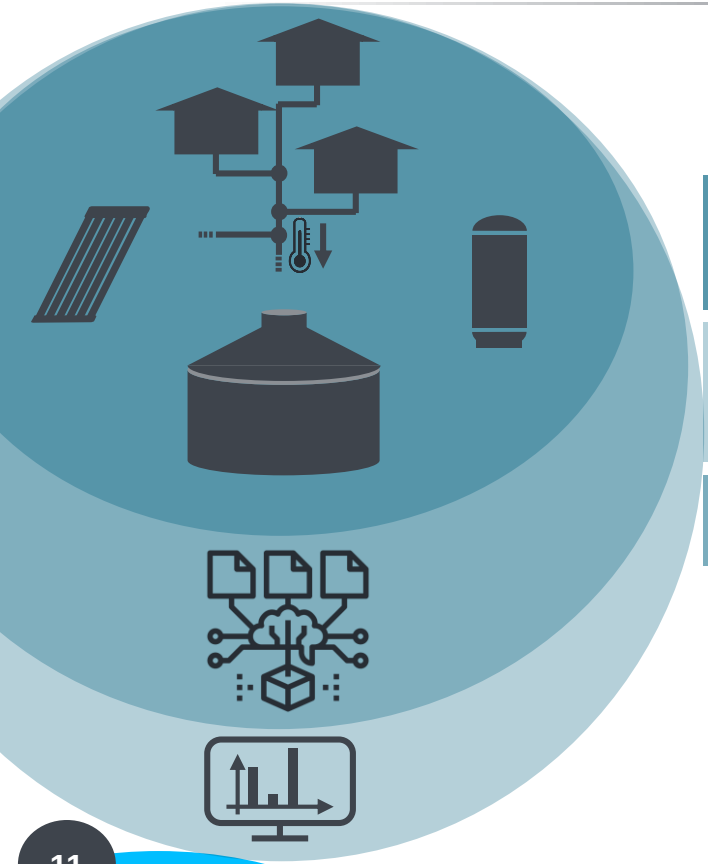
Planned Work



continuously

- measuring, simulating, evaluating and optimizing single system components and entire energy supply concepts
- evaluation and analysis of measurement data from field test systems
- definition of uniform KPI´s
- development and implementation of predictive & adaptive control
- exchange with Austrian and industrial project partners as well as with the Task 66

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thank you!

Project Partners

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VIESSMANN

Viessmann Climate Solutions SE

Funding

The project Sol4City (Development of integrated solar supply concepts for climate-neutral buildings for the "city of the future") is being supported by the Federal Ministry for Economic Affairs and Energy (BMWi) based on a decision of the German Bundestag by Projektträger Jülich (PtJ) under grant numbers 03ETW019 A\B. The authors gratefully acknowledge this support and carry the full responsibility for the content of this presentation

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

ptJ Projektträger Jülich Forschungszentrum Jülich

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An der Universität Stuttgart wurden zum 1.7.2018 das Institut für Gebäudeenergetik (IGE), das Institut für Thermodynamik und Wärmetechnik (ITW) mit seinem Forschungs- und Testzentrum für Solaranlagen (TZS) sowie das Institut für Energiespeicherung (IES) zusammengeführt. Das neue Institut für Gebäudeenergetik, Thermotechnik und Energiespeicherung (IGTE) wird die bestehenden Forschungs- und Prüftätigkeiten der drei Institute weiterführen.