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TRI-HP PROJECT

Trigeneration systems based on heat pumps with natural refrigerants and multiple renewable sources

Dr. Daniel Carbonell, Dr. Mihaela Dudita

SPF Institute for Solar Technology
Eastern Switzerland University of Applied Sciences (OST)

SPF INSTITUT FÜR SOLARTECHNIK

TRI-generation systems

- Based on electrically driven **natural refrigerant heat pumps (HPs)** coupled with PV to provide **heating**, **cooling** and **electricity** to multi-family residential **buildings**

- Targets:
  - **80 % renewable on-site share** with net-zero energy concept (20 % exchanged with the grid)
  - **Cost reduction by 10 – 15 %** compared to current HP technologies with same energetic efficiency
  - **75 % GHG emissions reductions** respect to gas boiler and air chillers with grid purchased electricity.

www.tri-hp.eu

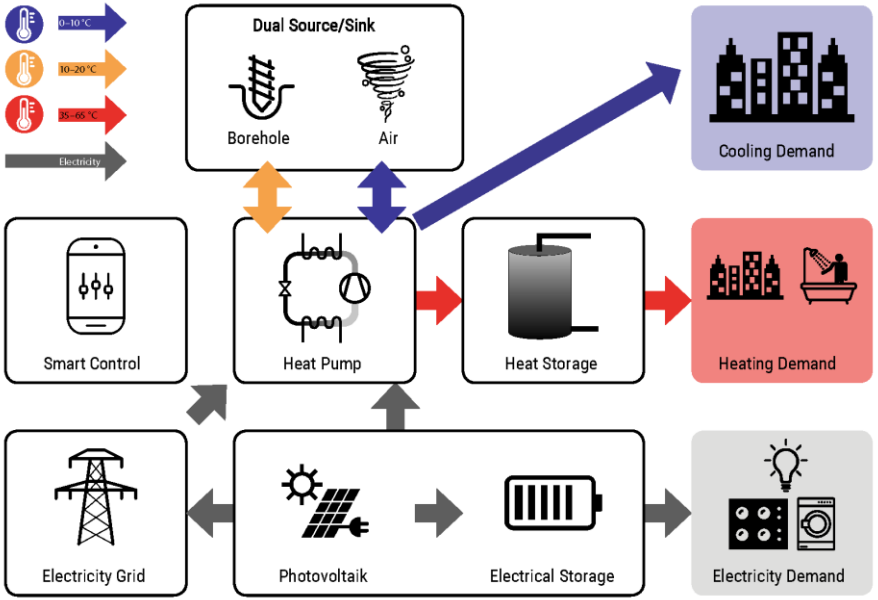
TRI-HP systems for multi-family residential buildings

- New building in Zurich (CH) - 30 kWh/(m^2·year)
- High share of DHW compared to heating/cooling

- Refurbished building - 90 kWh/(m^2·year) ZH (CH)
- High share of space heating/cooling compared to DHW

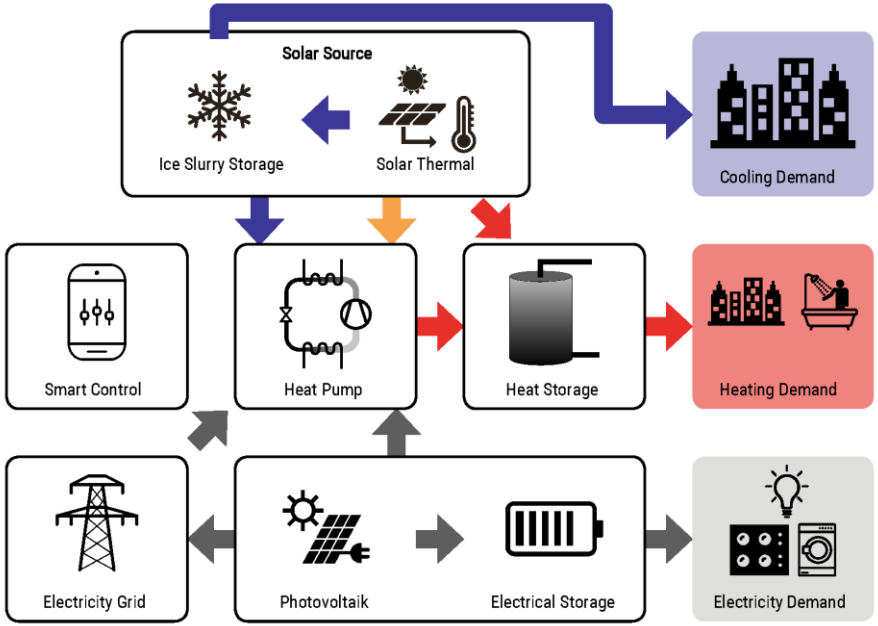
Dual source/sink system

- Source: ground and air
- Heating and cooling with reversible HP

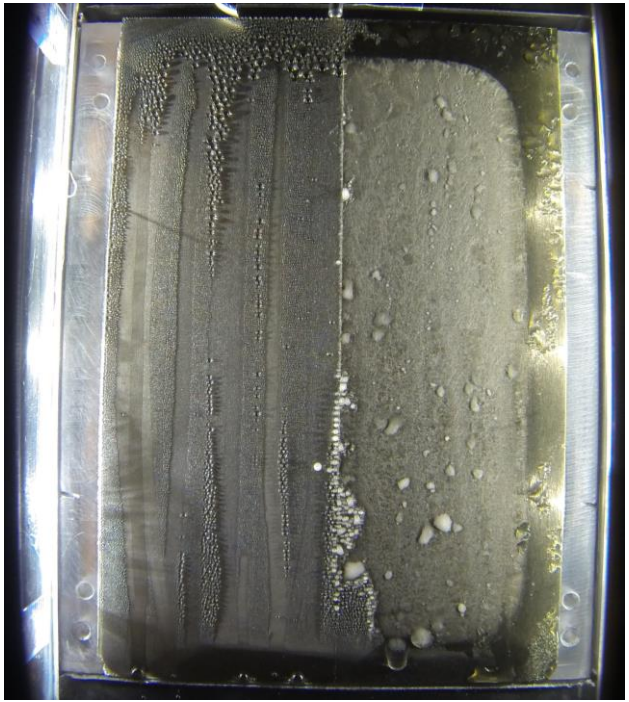


Solar-ice slurry system

- Source: solar with ice slurry as intermediate storage medium
- Heating with cooling as add-on feature

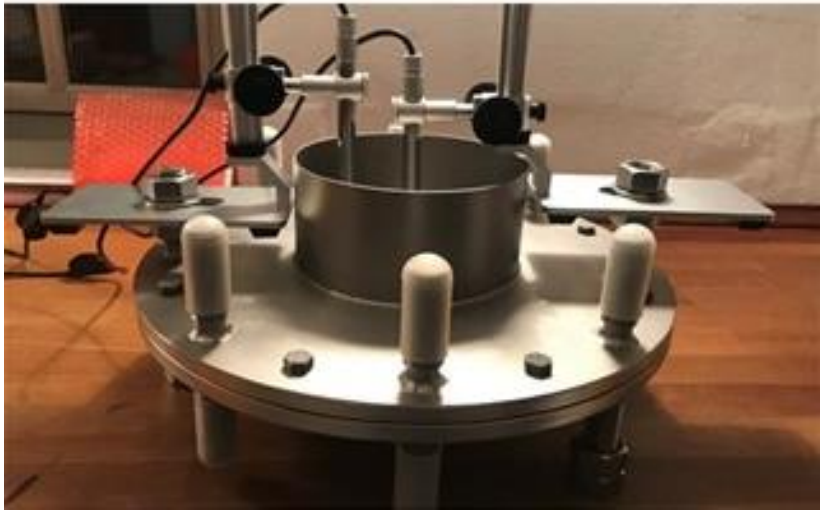


Icephobic coatings

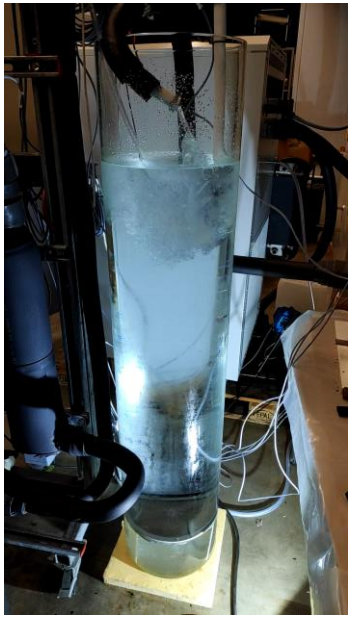


Icephobic coating from DTI

- Developments of anti-icing (icephobic) coatings for immersed applications with water flows
- Targets
  - Supercooling degree of 3-4 K

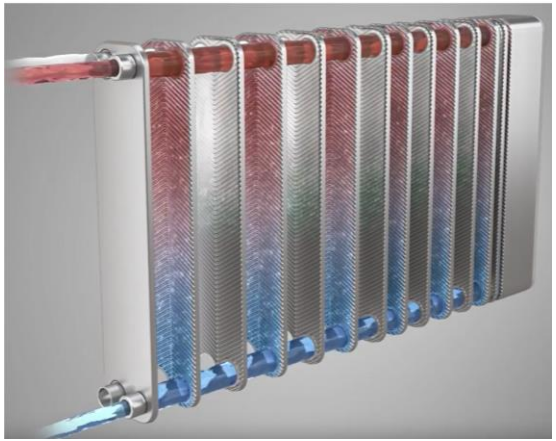


HX design: supercooler



Test rig for supercooler at SPF

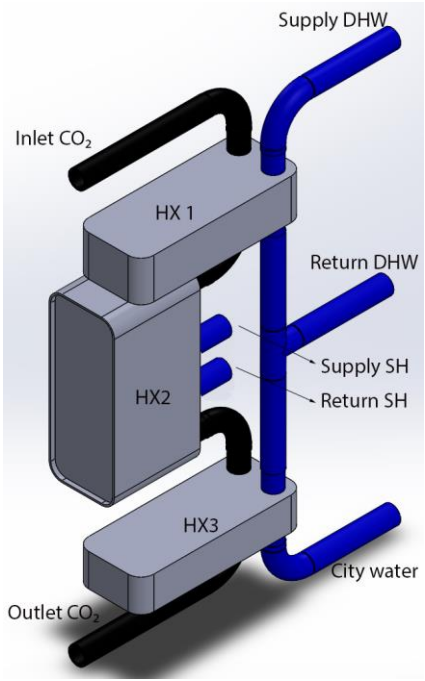
- An always free-of-ice evaporator used in the so-called slurry heat pump
- Water supercooled at -2 °C (liquid state) in the outlet of the supercooler
- 20 % higher efficiency compared to scraper type



HX design: tri-partite gas cooler

Test rig for tri-partite gas cooler at NTNU

- A compact gas cooler for CO_2 heat pumps
- Maximizing the use of the temperature glide in CO_2 gas cooler
- COP increase by 20 % when operated in simultaneous DHW and SH

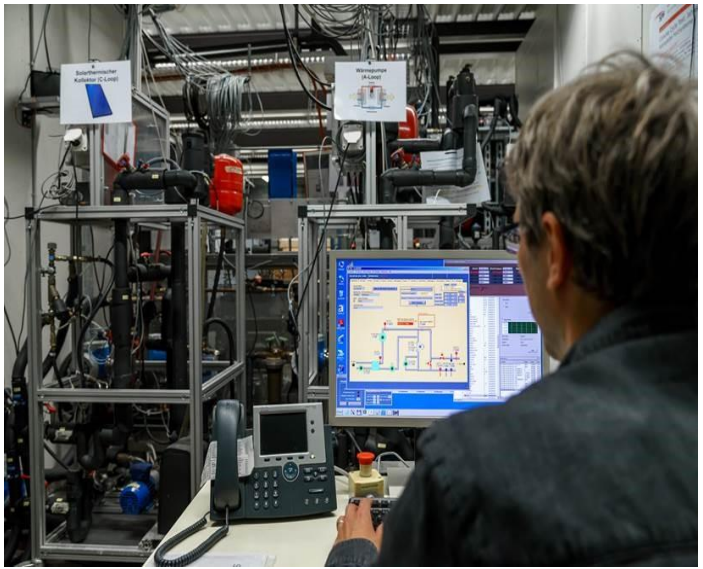


HX design: dual source/sink

Test rig for dual-source/sink HX at TECNALIA

- An evaporator/condenser able to use ground and air as heat sources
- Direct exchange between refrigerant and heat transfer fluids
- Targets
  - COP increase by 10 % when operated in dual mode for heating operation

Heat pumps development



Hardware-in-the-loop test rig at SPF

- 3 heat pumps developed
  - Propane-ice
    - supercooler
  - Propane-dual
    - dual-souce/sink HX
  - CO_2-ice
    - supercooler
    - tri-partite gas cooler

Advanced Energy Management System

- Manage whole system
- Heating, cooling and electricity
- Sensible, latent (ice) heat/cold and electrical storages
- Predictive control
- Self-detecting errors
- Targets
  - 15 % energy cost reduction

Technology acceptance

- Understanding and improving stakeholder's acceptance
- Analyse and identify the interest and needs of
  - end-users and installers
  - other identified key stakeholders
- Methods
  - Qualitative interviews with stakeholders (DE, CH, ES, NO)
  - Regional stakeholders workshops (DE, CH, ES, NO)
- Results : Guidelines and recommendations of stakeholder's acceptance

Thank you for your attention!

Contact

Dr. Daniel Carbonell, Project Coordinator

SPF Institute for Solar Technology

Eastern Switzerland University of Applied Sciences

Dani.Carbonell@ost.ch

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HEIM AG Heizsysteme

IREC Shaping Energy for a Sustainable Future

ALFA LAVAL

ILAG swiss quality coatings

Institut für sozial-ökologische Forschung

NTNU

DANISH TECHNOLOGICAL INSTITUTE

Hochschule Karlsruhe Technik und Wirtschaft UNIVERSITY OF APPLIED SCIENCES

REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

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