



Simulation of Unglazed Solar Thermal Integrated into Façade & Combined with Ultra Low Temperature District Heating

Speaker:

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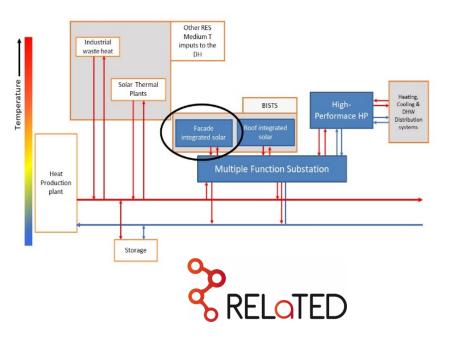
1. Introduction & Objectives

- What is presented?
 - Coupling algorithm for Unglazed Solar System & Ultra Low Temperature District Heating (DH)
 - Energetic & Economical assessment of the combined system
- Which are the main objectives of the study?
 - Present a control strategy for heat flows in the combined system
 - Demonstrate the economic viability of the presented system
 - Study the applicability for different districts



Introduction & Objectives

• 4th Generation District-Heating (4GDH)



- Ultra-Low Temperature (ULT) System (~45°C)
- Decentralized DH network
- Buildings acting as energy nodes
- Substations allow for bi-directional heat exchange
- Incorporation of low-grade heat sources
- Heat Pumps recover heat from cooling applications
- Decentralized, Building Integrated Solar Thermal

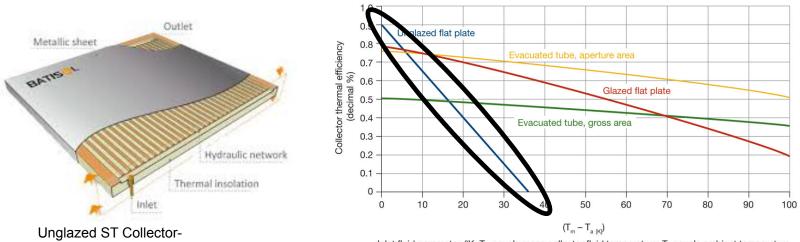


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Introduction & Objectives

- Façade Solar Thermal (ST) System
 - Performance equation $\eta \downarrow c$ $(t) = \eta \downarrow 0 a \downarrow 1 (T \downarrow m (t) T \downarrow a (t)) / G \downarrow T (t) a \downarrow 2 (T \downarrow m (t) T \downarrow a (t)) \uparrow 2 / C$



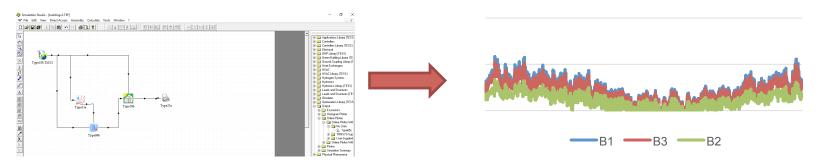
Batisol Project

Inlet fluid parameter, °K; T_m equals mean collector fluid temperature; T_a equals ambient temperature.



Methodology for calculations (Hourly basis)

- Heat Loads for different type of buildings (B1, B2 & B3) ← TRNSYS



- Solar Production simulations ← Rstudio (R software)



Reference: Solar engineering of thermal processes / John A. Duffie, William A. Beckman

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- Heat sink is avoided. Legionella issues are

Functioning Algorithm

Bidirectional heat flow

BS

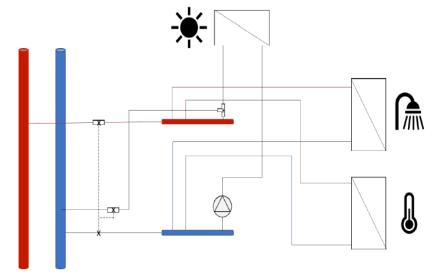
- From the DH to the building -
- From the building to the DH.
- In function of the solar heat exergy.
 - Heat injected to return line of the DH -

Introduction & Objectives

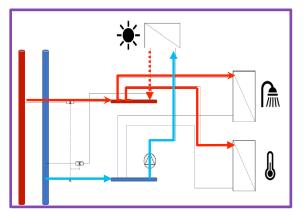
How do we couple ST & DH systems?

- Heat injected to supply line of the DH -
- avoided if there is no water storage for DHW



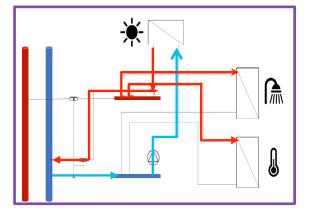


Coupling algorithm between ST & Heat-Load (Main)Mode 1Mode 2Mode 2Mode 3



Heat demand exceeds solar production

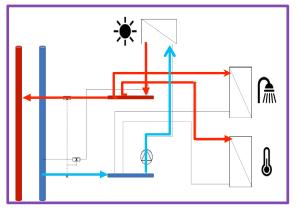
Heat supply comes from DH supply & ST



Solar production exceeds heat demand but not supply T



Excess heat is injected into return line of the DH



Solar production exceeds supply T of the DH

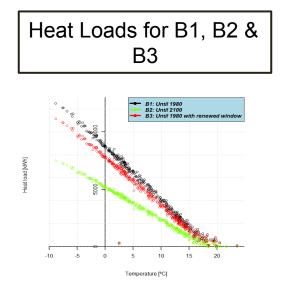
Excess heat is injected into the supply line of the DH



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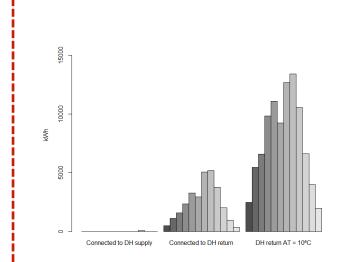
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Heat-Loads and Solar production



~ Linear dependency of outdoor temperature and the Space-Heating loads.

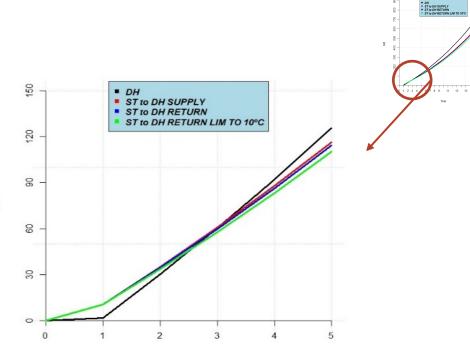
Solar heat production in function of output temperature



- Unglazed collectors don't perform in a correct way when high working temperatures (>45°C)
- Outdoor high temperatures reduce heat losses and improves efficiency.
- If ΔT is limited by varying the flow rate inside the pipelines of the solar collectors, obligying the ST system, production notably increases.



Economic assessment



Year

 $Demand\downarrow DH = Deman$ $d\downarrow building / BSF[-]$

Economic metrics:

 $ROI = dNPV = \sum_{i=1}^{T} T$ ROI = dNPV / Q i / (1+r) i - 1/0 $I \neq 0$

ROI Values	Supply	Return	Return AT = 10 ℃			
BSF = 0%	1.21	2.35	2.88			
BSF = 50%	1.19	2.10	2.34			



Discussion & Conclusions

- 4GDH system enable a high efficiency way of distributing heat to high density areas, enabling reduced heat losses and incorporation of renewable low grade sources (such as unglazed ST).
- Unglazed solar system needs alternative energy sources (by now).
- Limited ΔT increase energy production by 200%
- Payback times for incorporation of ST rounds 3 years.



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http://www.relatedproject.eu/







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Questions and Comments

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