



FP7-ENERGY-2013-1

Research and development of innovative solar thermal facades

FLUIDGLASS

Solar Thermal Glass Facades with Adjustable Transparency

Start date of Project: 01/09/2013
Duration: 48 months

Deliverable: D4.5

Energy concepts on district level for two cities (e.g. Munich and Limassol) for the use of low and medium thermal energy of buildings with fluidized glass façades

Due date of deliverable: 31/05/2016
Actual submission date: 29/10/2016

Responsible WP: WP4, CyRIC
Revision: v2.0

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (excluding the Commission Services)	

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DOCUMENT CONTROL

Document version	Date	Change
V1.0	20.10.2016	First version
V2.0	27.10.2016	Pc comments included

VALIDATION

Reviewers		Validation date
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DOCUMENT DATA

Keywords	District level, Anergy network,
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DISTRIBUTION LIST

Date	Issue	Recipients
29.10.2016	V2.0	All partners + PO

Executive Summary

A concept for a low temperature district heating network - district energy network (DAN) - with an office building with FLUIDGLASS façade, a seasonal storage and residential buildings has been developed. The components of the "FLUIDGLASS network" are modelled in TRNSYS and connected via "Building Controls Virtual Test Bed" (BCVTB) as a dynamic thermal district simulation. The FLUIDGLASS scenario (FG) has been simulated with varying numbers of residential buildings at the locations Munich (Germany) and Nicosia (Cyprus). As benchmark, three reference scenarios are simulated with the same building constellation and sites but with decentralized energy supply systems (heating and domestic hot water) without a connecting district heating network and seasonal storages. Reference scenario 1 (RS1) with air-water-heat pumps, reference scenario 2 (RS 2) with gas boilers and reference scenario 3 (RS3) with oil boilers. The potentially supplied residential buildings with a FLUIDGLASS network are identified and the results for primary energy demand and CO₂ equivalent for the four scenarios are calculated and compared.

Results at the location Munich:

- The solar collector gains of an office building with FLUIDGLASS façade are higher than the heating energy demand of the building. The gains can be transported via a DAN to other buildings (e.g. residential buildings) and a seasonal storage.
- The FLUIDGLASS scenario (FGS) can meaningfully supply one office building and nine residential buildings at the location Munich. More residential buildings would reduce the seasonal performance factor of the water-water-heat pumps too much (< 1.8).
- Comparing FGS with RS1, one office building and one residential building lead to the same primary energy demand. By increasing the numbers of residential buildings the RS1 is better than FGS.
- Comparing FGS with RS2 and RS3: one office building and up to nine residential buildings need less primary energy with FGS than RS2 or RS3. The primary energy savings are approximately 90 MWh/a with FGS compared to RS2 and RS3. The reduction of CO₂ emissions are approximately 7 t/a compared to RS2 and approximately 95 t/a compared to RS3.
- With only one residential building the potential for reductions are: approximately 47 MWh/a primary energy compared to RS 2 and RS3. Approximately 10 t CO₂ emissions per year compared to RS2 and approximately 15 t CO₂ emissions per year compared to RS3.

Results at the location Nicosia:

- The heating demand and the demand for domestic hot water are very low at the location Nicosia. Therefore approximately 1600 residential buildings could be supplied via a FLUIDGLASS network.
- The greatest share of energy demand in Nicosia is needed for cooling. Since the temperature level of the DAN is relatively low ($< 20^{\circ}\text{C}$) solar cooling is not possible with this environmental energy source. Therefore a FLUIDGLASS energy network is not advisable with the present knowledge, in particular taking into account the grey energy demand of the network.

Outlook:

- From the grey energy perspective, an earth probe storage should be considered as seasonal storage instead of a water storage tank.
- Other thermal energy sources should be additionally fed into the DAN.
- Having only FLUIDGLASS as renewable energy source, it probably would be more efficient to use the seasonal gains just for the FLUIDGLASS building with an earth probe storage.