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GROUND-MED: DEMO PROJECT BENEDIKT

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ABSTRACT

GROUND-MED project will demonstrate geothermal heat pump (GSHP) systems for heating and cooling of measured SPF>5,0 in 8 demonstration sites in South Europe. The SPF is determined by the heat pump unit and by its operating conditions imposed to the heat pump by the ground heat exchanger and the heating/cooling system of the building as well. GROUND-MED has the duration of 5 years. The consortium comprises 24 organizations, mainly from South Europe.

Demo project Benedikt is oriented to remodelling and restoration of a public building of the Municipal hall for an application of techniques and more innovative technologies that reduce the energy demand, and employ renewable energies. The main objective of the project is to achieve the generation of energy of high quality by geothermal energy source for heating and passive cooling by a large scale heat pump with vertical heat exchangers. Planned demonstration project of heat pump with vertical heat exchangers will be constructed in the Municipality hall, a public building encompassing 322 m^2 of heating area and having the heating power of about 30 kW and passive cooling of 25 kW.

1. INTODRUCTION

Ground source heat pumps (GSHP) exploit favourable heat transfer properties of water and the mild ground temperature, which remains almost constant throughout the year, independently of external weather conditions. Ground source heat pumps provide efficient heating, cooling and hot domestic water supply to the consumer. In cooling mode, they use 30 % less electricity than air source heat pumps of the latest technology. In heating mode, primary energy saving amounts to 60 % when electricity is generated by combined cycle natural gas power plants. As they are a reliable and environmental friendly technology, they can effectively aid European Union to fulfil its targets for renewable energy use and CO_2 emissions reduction.

Geothermal energy is becoming worldwide, and consequently in Europe, one of the most interesting sources of renewable energy for the future. Heating and cooling by ground coupled heat pumps is developed in the countries of Northern and Central Europe, although the corresponding market in South Europe is at early developing stages.

2. PROJECT CONCEPT

The project Advanced ground source heat pump systems for heating and cooling in Mediterranean climate (acronym: GROUND-MED) is carried on as a part of 7FP, Theme 5 (Energy), and started on January 1, 2009. The project joins 24 organizations from 13 countries. Its duration is 5 years.

GROUND-MED is a collaborative project which demonstrated innovating ground source heat pump solutions in 8 buildings in south part of European Union. Eight demonstration sites are dispersed in a wide geographic area (Portugal, Spain, South France, Italy, Slovenia, Romania and Greece), in order to maximize the project market impact. The global aim is to demonstrate integrated ground source heat pump systems of:

- Annual SPF for heating and cooling >5,0
- Payback time of <7 years with a system comparing natural gas boiler of 0,04 €/kWh
- High system durability expressed as at least 20 years of life span

It consists of 9 work packages:

1. Project management
2. Large capacity advanced GSHP prototypes and system components
3. Low/medium capacity advanced GSHP prototypes
4. Integrated system control
5. Integrated system engineering design
6. Integrated ground source heat pump demonstrations system
7. Demonstration, monitoring and fine tuning demo systems operation
8. Technology evaluation
9. Dissemination and training

3. DEMO PROJECT BENEDIKT

3.1 Benedikt place

The Benedikt place is situated in north-eastern Slovenia, at south-western margins of the Pannoninan basin (the Mura Basin), not far from the Austrian-Slovenian state boundary. The Municipality of Benedikt encompasses an area of 24 km^2 and has 2.244 inhabitants. In the Benedikt place half of the municipality inhabitants live. The Benedikt place's annual heat consumption amounts to 4 GWh, and is assured from diverse energy sources. Today, the biomass shear is 42 %, and it is used mainly in individual boilers.

In Maribor, an average annual temperatures amounted to **10,7** ºC and **11,7** ºC for the periods **1991 – 2000** and **2007,** respectively, and indicate an appreciable impact of the climate change**.** Extreme annual air temperature for the year **2008** (Radenci) amounted to **– 10 ºC** and **+ 34 ºC** in winter in summer, respectively. Average annual air Relative Humidity in **2006** (M. Sobota) was **78 %**.

3.2 Municipal Hall

The Municipal hall is located in the centre of the Benedikt place. It is used as an auditorium serving for performances, conferences, etc. A part of the building comprises offices and dressing-rooms.

Ground floor encompasses an area of 229,2 m^2, individual zones are shown in Table 1 and Fig. 1.

As the hall walls have a double-height, the first floor is appreciable smaller owing to the building architecture. It encompasses an area of 92,8 m^2 only; individual zones are shown in Table 2.

The thermal characteristics (U) of the building is follow: walls 0,938 W/m^2 K, ceiling 0,382 W/m^2 K and roof 0,189 W/m^2 K, windows 1,3 W/m^2 K and doors 2,0 W/m^2 K. The calculated looses amount to **23.170 W** for the entire building.

The existing heating system is classic with radiators and heating station of 24 kW which uses extra-light oil. Ventilation is installed, but cooling is not possible.

Table 1: Building zones ground floor

BUILDING ZONES	FLOOR(m2)	HEIGHT (m)
1 (Hall)	142	5,2
2	35,7	2,9
3	9,18	2,9
4	5,74	2,9
5	3,08	2,9
6	3,08	2,9
7	24,4	2,9
8	3,5	2,9
9	5,6	2,9
	229,2	

3.3 Proposed concept of air-conditioning using the heat pump system

The proposed system of air-conditioning preserves as much as possible of the existing concept. Owing to some mistrust of the owner, the Municipality of Benedikt wants to preserve the existing heat station using extra-light oil. For this reason, the heat pump will be installed and connected to the heating system in a parallel manner. It will be connected additionally to the ventilation system which will contribute to the existing heating capacity during heating seasons. The radiator capacity will be lower owing to a lower heating temperature. During summer periods, the ventilation system will be used for cooling.

Heat pump will be provided by the company OCHSNER. Golf Maxi series heat pump, model DMWW28, is foreseen. In terms of energy efficiency (SPF) the company OCHSNER will follow some requirements for technology improvement:

- The machine should comply with the Eurovent class A efficiency requirements
- The system SPF (including electricity at the circulating pumps) should exceed 5,5 in both heating and cooling modes (heating with 40°C water with 7°C water supply at the evaporator, and cooling with 7°C water).
- Water supply temperature range at the evaporator: minimum 5°C, operating maximum 15°C, absolute maximum 20-22°C for limited time (~30 min) during system start-up.
- Temperature difference at the evaporator: 3°C.
- Refrigerant used: R407C.
- The heat pump prototypes should operate in both heating and cooling mode.
- The refrigerant cycle will be optimized in terms of heat exchangers, compressor, expansion valve, etc. for both heating and cooling.
- COP should be maximized at partial load as well.
- The units will be reengineered for cooling.

As the energy source, a vertical ground heat exchanger or borehole heat exchanger (BHEs) will be constructed. PE double-U-tube of 4x32 mm diameter will be installed. A foreseen depth of BHEs is 120 – 150 m. Drill-holes will penetrate Tertiary sediments consisting of sandy-clayey silt. Temperature expected in the (BHT) drill-holes at maximum depths of 120 m and 150 m amounts to 24 °C and 27 °C respectively, owing to a high geothermal gradient in the Benedikt area. Both, local (Slovenian) and VDI 4640 standards will be followed.

Table 2: Building zones Ist Floor

BUILDING ZONES	FLOOR (m2)	HEIGHT (m)
2	46,4	2,8
3	46,4	2,8
	92,8	

3.4 State-of-the-Art

Until now, several meetings of the project participants were organized to set basic criteria for our activities. Elaboration of new project documentation and gathering of permissions for BHEs' construction is running. Slovenian legislation demands entire project documentation that equals to that as required for the wells of some 5000 m depth. For reconstruction of the existing heating system, no special permission of authorities is needed.