

GROUNDMED: Work Package 3
2nd meeting
11/12/2009

Università di Padova
Via Venezia 1, 35100 Padova, Italy
DIPARTIMENTO DI FISICA TECNICA

LIST OF PARTICIPANTS

Participants	Organization
Dimitrios Mendrinos	CRES
Christian Brenner	OCHSNER
Andrea Quercioli	HIREF
Alessandro Zerbetto	HIREF
Andrea Boaretto	HIREF
José Miguel Corberán	UPV
Bjorn Palm	KTH
Donal Finn	UCD
Alberto Salmistraro	ENEREN
Marcel Rosca	UOR
Peter Kralj	GEJZIR
Henk Witte	GROENH
Davide Del Col	UNIPD
Enrico Da Riva	UNIPD
Angelo Zarrella	UNIPD

Agenda

Thursday 10/12/09

h. 20.15 Dinner

Friday 11/12/09

h. 9.00 Start of meeting

Characteristics of heat pumps needed for each demo site (Hiref, UPV, UOR, Edrasis, Gejzir)

Preliminary heat pumps design by Hiref

Preliminary heat pumps design by Ochsner

Optimization of heat pump design

h. 10.45 Coffee break

Optimal characteristics of secondary circuit

Demo-Site Measurement Proposal - Specification of variables and sensors

Data Management System Requirements

Discussion

h. 13.15 Lunch

h. 14.30 Deliverable 3.1: Report on methods for improving heat pumps COP
Presentation
New parts

h. 15.30 Visit of the labs
Further discussion on D 3.1 among authors

h. 16.30 End of meeting

PRESENTATIONS

The following presentations have been made:

Definition of main characteristics of heat pumps for each demo-site (Hiref, UPV, UOR, Edrasis, Gejzir), *E. Da Riva*

Preliminary heat pumps design by Hiref, *A. Zerbetto*

Preliminary demo-site installation design by Eneren, *A. Salmistraro*

Preliminary heat pumps design by Ochsner, *C. Brenner*

Presentation of Gejzir demo-site, *P. Kralj*

Optimization study of heat pump design, *J.M. Corberan*

Influence of the volume and position of the tank on system operation, *J.M. Corberan*

Demo-Site Measurement Proposal - Specification of variables and sensors, *D. Finn*

Data Management System Requirements, *D. Mendrinós*

Brief presentation of Deliverable 3.1

Optimization of Borehole Heat Exchangers, *H. Witte*

MINUTES

A. DEFINITION OF PEAK LOADS AND DESIGN WATER TEMPERATURE LEVELS

The requested capacity and operating conditions of each heat pump were discussed and updated. The final values of design peak loads and water temperature levels for each demo site are reported in the following tables.

The reported temperatures refer to the worst condition; during normal operation more favourable temperature levels should be considered for heat pump operation depending on the control algorithm and the external temperature.

HIREF and GEJZIR demo-sites require sanitary hot water.

The EDRASIS building total loads are 300 kW during winter and 250 kW during summer; the heat pump is going to provide just a fraction of the total load.

Cooling for GEJZIR demo site will be needed around 3 days per month, while heating will be required during the whole winter season.

D.Mendrinós proposes “free cooling” to be used by demo-sites when possible.

	SURFACE	HEATING LOAD	COOLING LOAD	MANUFACTURER
HIREF	168 m ²	14.1 kW	14.4 kW	HIREF
UPV	250 m ²	18 kW	16 kW	HIREF
UOR	473 m ²	40 kW*	30 kW*	OCHSNER
EDRASIS	2000 m ² (total)	55 kW	55 kW	OCHSNER
GEJZIR	240 m ²	24 kW	10-19 kW	OCHSNER

*To be defined in January

		WATER TEMP. TO THE BUILDING (°C) AT THE END OF THE SEASON	WATER TEMP. FROM GROUND (°C) AT THE END OF THE SEASON
EDRASIS	WINTER	40	10
	SUMMER	10	30
UOR	WINTER	35	8
	SUMMER	15	25
GEJZIR	WINTER	45	8
	SUMMER	18	20
HIREF	WINTER	40	8
	SUMMER	10	30
UPV	WINTER	40	15
	SUMMER	10	26

B. PRELIMINARY DESIGN CONCEPTS

The preliminary design of Hiref and Ochsner heat pumps has been discussed. An optimization study of the Hiref heat pump has been presented by UPV. The following points need to be further analyzed.

B.1. Variable speed compressor in Hiref heat pumps

According to the preliminary design of HIREF and UPV heat pumps, a variable speed scroll compressor (i.e. LG AR055VAD + inverter) is planned to be used. Simulations have been performed by UPV by means of the IMST-ART software and data by LG about the compressor. The performance with the VS compressor has been compared against the performance with a fixed speed scroll compressor (i.e. Copeland ZP72KCE-TDF). According to UPV results, the on/off configuration with the fixed speed compressor is expected to perform better.

A.Quercioli notices that the performance of a HP using a VS compressor cannot be fully analyzed by a steady state simulation. Benefits should arise during low heating/cooling loads as compared to on/off operation.

D.Mendrinós notices that having a variable speed compressor in the GroundMed project would provide interesting experimental data.

B.Palm suggests using an external inverter in order to make it possible to separate the compressor from the inverter and run the heat pump either with fixed-speed or variable-speed mode.

J.M.Corberán suggests using two compressors for the heat pump to be installed at the UPV demo site.

The choice of the compressor is an open problem to be studied by UPV, HIREF and UNIPD.

B.2. Water flow reversal for OCHSNER heat pumps

Ochsner will make three heat pumps using R-407C.

D.DelCol reminds that particular attention to the efficient use of R407C in reversible units is required, since R-407C refrigerant is a zeotropic mixture. In order to increase efficiency, flow reversal is suggested for both water and refrigerant loops in order to assure counter-current flow configuration in the heat exchangers during both heating and cooling operations.

D.Mendrinós also states that flow reversal is required both on the refrigerant side and water side.

C. DEMO SITE MEASUREMENTS AND DATA MANAGEMENT SYSTEM

Decisions by WP4 about the required demo-sites measurements and the data management system have been presented and discussed during the meeting.

Specification of variables to be measured and suggested sensors has been presented by D.Finn, while the proposed Data Management System has been presented by D.Mendrinós.

The list of compulsory measurements has been presented by D.Mendrinós.

The use of the same instrumentation for each demo-site is highly suggested (in particular regarding the data acquisition system and the electrical and thermal energy/power meters).

The sensors which should be inserted in the heat pump facility regard the following measurements:

1. Evaporator saturation pressure
2. Condenser saturation pressure
3. Refrigerant temperature at condenser outlet
4. Refrigerant temperature at evaporator outlet
5. Refrigerant temperature at compressor outlet

HIREF and OCHSNER agree to install the pressure transducers in their heat pumps.

D.Mendrinós notices that none of the above measurements is compulsory.

Instead, compressor power and compressor electricity consumption are compulsory measurements.

More details are reported in the Summary of WP4 Contribution to WP3 Padova Meeting.

An open problem regards the communication procedure for pressure and temperature sensors installed in the heat pump; it is not clear if those data can be transmitted through the heat pump control system.

D. DELIVERABLE 3.1

Some changes will be made to the first draft of Del. 3.1 by UNIPD, helped by KTH and UCD.

Two more sections will be added to the report: the first one regards the optimal brazed plate exchangers to be used in the heat pumps and will be written by UPV; the second one deals with the optimization of borehole heat exchangers and will be compiled by H.Witte (GROENH).

All these improvements must be completed by end of January 2010.



FP7 GROUND-MED PROJECT SUMMARY OF WP4 CONTRIBUTION TO WP3 PADOVA MEETING

Venue: University of Padova, Padova, Italy.

Meeting Date: Thursday and Friday, Dec 10th and 11th 2009.

WP4 Partners Present: Jose Miguel Corberan (JMC) UPV, Donal Finn (DF) NUID UCD, Henk Witte (HW) Groenholland, Dimitris Mendrinis (DM) CRES, Bjorn Palm (BP) KTH,

Minutes: Written by Donal Finn and Dimitris Mendrinis

Two presentations arising from WP4 were made at the WP3 Padova meeting as follows:

1. Demo-Site Measurement Proposal - Specification of Variables, Sensors & DAQ (D. Finn)
2. Data Management System Requirements (D. Mendrinis)

1. Demo-Site Measurement Proposal - Specification of Variables, Sensors & DAQ

1.1 Ranking of Measured Variables

Table 1 shows a 'wish-list' list of all variables that should be measured at each demonstration site. After discussion, it agreed that they should be divided into essential and desirable measurements. Essential measurements should be made at all demonstration sites. Desirable measurements are highly recommended for each demonstration site.

1.2. Sensors

It was recommended that a single recommendation be given for the electrical power meters and the thermal power meters be issued. In particular, BRUNATA HGS version 185 is recommended as thermal (heating and cooling) flow meter. ISR to advise re. electric power meter. Other sensors to be similarly advised, e.g. PT100 for temperature readings. All demonstration sites should use these meters as far as is practicable. ISR/WP4 to advise GROUND MED consortium on final sensor recommendation on/before the upcoming Athens Feb. meeting.

1.3. Data Acquisition System

It was agreed that the National Instruments proposal presented the best technical approach for the data acquisition requirements of the demonstration sites, subject to cost constraints. It was recommended that a minimum configuration for the data acquisition be issued based on the essential sensors in Table 1. This recommendation should include (i) the technical specification, (ii) the approximate cost to include DAQ systems and NI Lab View software. ISR/WP4 to advise GROUND MED consortium on final recommendation on/before the upcoming Athens Feb. meeting.

Category Sensor	Variable Description	Essential Measurement (Compulsory)	Desirable Measurement (Optional)
External			
PT100	Ambient Temperature	X	
	Solar Radiation		X
Indoor			
PT100	Troom (representative indoor temperature)	X	
	Temperature of other indoor spaces		X
Heat Pump			
	Pevap (evaporator pressure)		X
	Pcond (condenser pressure temp.)		X
	Tout cond (liquid subcooling temp.)		X
	Tout evap (evaporator superheat temp.)		X
	Tout comp (discharge temp.)		X
Power Meter	Compressor power, kW	X	
	Cumulative compressor electricity consumption, kWh	X	
Building Circuit			
Thermal (heating & cooling) Flow Meter	TIN CI (Temperature exiting the heat pump)	X	
	10 minute average Temperature exiting the heat pump		X
	TOUT CI (Temperature entering the heat pump)	X	
	10 minute average Temperature entering the heat pump		X
	Flow rate	X	
	Cumulative water volume	X	
	Operating hours	X	
	Thermal (heating-cooling) power to the building, kW	X	
Power meter fans	Cumulative heating supply to the building, kWh	X	
	Cumulative cooling supply to the building, kWh	X	
Power meter pump	Total power consumption of all fan coils (kW)	X	
	Cumulative electricity consumption in all fan-coils, kWh	X	
	Power of individual fan coils		X
	Total internal pump power, kW	X	
	Cumulative electricity consumption in internal pumps, kWh	X	
	Differential Pressure – Internal Circuit		X
	Absolute Pressure – Pump Discharge		X
Ground Circuit			
Thermal (heating & cooling) Flow Meter	TIN CE (Temperature exiting the heat pump)	X	
	10 minute average Temperature exiting the heat pump		X
	TOUT CE (Temperature entering the heat pump)	X	
	10 minute average Temperature entering the heat pump		X
	Flow rate	X	
	Operating hours	X	
	Cumulative water volume	X	

	Thermal (heating-cooling) power to the BHE, kW	X	
	Cumulative heating supply to the BHE, kWh	X	
	Cumulative cooling supply to the BHE, kWh	X	
Power meter pump	External pump power, kW	X	
	Cumulative electricity consumption in external pump, kWh	X	
	Differential Pressure – External Circuit		X
	Absolute Pressure – Pump Discharge		X

Table 1 Demonstration-site Measurements

1.4. Data Acquisition Site Implementation

The consensus from the meeting was that a common turn-key software program should be provided for each demonstration site. It was agreed that, if necessary, a training course could be undertaken by each demonstration site personnel (at ISR) if required. ISR to confirm.

2. Data Management System

2.1 Requirements

The data management system should read the above values every minute and store them in one Excel file per day (1440 rows with data). The DMS should calculate average or read cumulative values at the end of every day of selected parameters according to the Table 2 below, and store them in one Excel summary file appended every day (total 730 rows of data for 2 years monitoring).

Category	Variable Description	Daily average	Last reading of the day
External			
PT100	Ambient Temperature	X	
	Solar Radiation	X	
Indoor			
PT100	Troom (representative indoor Temperature)	X	
Heat Pump			
	Cumulative compressor electricity consumption		X
Building Circuit			
Thermal (heating & cooling) Flow Meter	TIN CI (Temperature exiting the heat pump)	X	
	TOUT CI (Temperature entering the heat pump)	X	
	Cumulative heating supply to the building, kWh		X
	Cumulative cooling supply to the building, kWh		X
	Cumulative electricity consumption in all Fan-Coils, kWh		X
	Cumulative electricity consumption in internal Pumps, kWh		X
Ground Circuit			
Thermal (heating & cooling) Flow Meter	TIN CE (Temperature exiting the heat pump)	X	
	TOUT CE (Temperature entering the heat pump)	X	
	Cumulative heating supply to the BHE, kWh		X
	Cumulative cooling supply to the BHE, kWh		X
	Cumulative electricity consumption in external Pump, kWh		X

Table 2 Daily summary values stored by DMS



The DMS should also calculate daily average COP and SPF values and store them in the above Excel file, as follows:

- SPF1 = cumulative heating + cooling energy supply divided with the cumulative compressor electricity consumption.
- SPF2 = cumulative heating + cooling energy supply divided with the cumulative compressor + external pump electricity consumption.
- SPF3 = cumulative heating + cooling energy supply divided with the cumulative compressor + external pump + internal pumps electricity consumption.
- SPF4 = cumulative heating + cooling energy supply divided with the cumulative compressor + external pump + internal pumps + all fancoils electricity consumption.

Average daily COPs will be calculated as above using the daily energy supply and electricity consumption instead. The daily energy value equals the difference of the daily cumulative value minus the cumulative value of the previous day.

That way, by using heat (thermal) meters we avoid the need for complex statistical analysis.

2.2 Real Time Web Display

The following parameters should be displayed at the web site and updated automatically every 10 minutes. All other data will be confidential but available for download by project partners.

	Category	Variable Description
Heat Pump	Power meter	Compressor power
		Cumulative compressor electricity consumption
Building Circuit	Thermal (heating & cooling) Flow Meter	10 minute average Temperature exiting the heat pump
		10 minute average Temperature entering the heat pump
		Thermal (heating-cooling) Power to the building, kW
		Cumulative heating supply to the building, kWh
		Cumulative cooling supply to the building, kWh
	Power meter	Total Power in all Fan Coils
		Cumulative electricity consumption in all Fan-Coils, kWh
	Power meter	Total Pumps Power, kW
Cumulative electricity consumption in Pumps, kWh		
Ground Circuit	Thermal (heating & cooling) Flow Meter	10 minute average Temperature exiting the heat pump
		10 minute average Temperature entering the heat pump
		Thermal (heating-cooling) Power to the BHE, kW
		Cumulative heating supply to the BHE, kWh
		Cumulative cooling supply to the BHE, kWh
	Power meter	Pump Power, kW
		Cumulative electricity consumption in Pump, kWh

Table 3 Real time web display data