**MINUTES OF MEETING**

**GROUND MED Meeting: WP 4**

**Besel (Madrid), November 10th 2009**

## Attendees

| | |
|---|---|
| Ana de la Cruz (AC) | BESEL |
| Angel López (AL) | BESEL |
| Anibal T. de Almeida (AA) | ISR |
| Björn Palm (BP) | KTH |
| Carla Montagud (CM) | UPV |
| Dimitrios Mendrinos (DM) | CRES |
| Donal Finn (DF) | UCD |
| Henk Witte (HW) | GROE |
| Jose María Sanchez (JMS) | BESEL |
| José Miguel Corberán (JMC) | UPV |
| Miguel Sierra (MS) | BESEL |

Minutes prepared by Ana De la Cruz, Besel.

## Agenda

The meeting commenced at 9.15 a.m., whereupon the following agenda was adopted:

| # | Time | Topic | Facilitator/Chair | Notes |
|---|---|---|---|---|
| | 08.30 – 09.00 | Arrival BESEL | - | - |
| 1 | 09.00 – 09.10 | Introduction<br>Agenda Adoption | Donal Finn | |
| 2 | 09.10 – 09.30 | WP 4 Overview.<br>T4.1, 4.2, 4.3 | Donal Finn | Brief summary of WP4.<br>Concise summary of the Valencia and Brussels meetings. |
| 3 | 09.30 – 10.00 | WP 4.4 | Miguel Sierra<br>Javier Mielgo | WP4 T4.4 Summary<br>BESEL DMS PROPOSAL Summary |
| 4 | 10.00 – 10.30 | WP 4.5 | Anibal de Almeida | WP4 T4.5 Summary |
| 5 | 10.30 – 10.45 | WP 7 | D. Mendrinos | WP7 T7.1 Summary |
| | | **BREAK (10.45-11.10)** | | |
| 6 | 11.10 – 12.05 | WP 4.4 | Donal Finn (Chair) | WP4 T4.4 Detailed discussion |
| 7 | 12.05 – 13.00 | WP 4.5 | Donal Finn (Chair) | WP4 T4.5 Detailed discussion |
| | | **LUNCH (13.00-14.00)** | | |
| 8 | 14.00 – 15.15 | WP 7<br>WP 6 & 8 | JM Corberan (Chair) | Presentation D. Mendrinos CRES<br>WP 6,7,8 Detailed discussion and their role viz-a-viz WP 4.4 & WP 4.5 |
| 9 | 15.15 – 16.00 | WP 4.1 | Donal Finn<br>Henk Witte | Deliverable 4.1 – Summary<br>Ground model presentation |
| 10 | 16.00 – 16.30 | Conclusions/AOB | Donal Finn | Summary of meeting and decisions |
| | 16.30 | Close | - | - |

## Minutes

### 1. Introduction

The main objective of the meeting was to discuss the role of the Data Management System (DMS), Data Acquisition System (DAQ) and Microprocessor (MP) in the GROUNDMED project and the responsibilities of each partner in the context of each of these systems. Because WP4 contributes significantly to each of WP6, WP7 and WP8 an overview of these work packages was also given, followed by an administrative and technical discussion on the various responsibilities and technical issues.

### 2. WP 4 Overview

DF summarised the objectives of WP 4, the decisions already made and the work carried out so far (see UCD1.ppt - attached). Comments and questions on this presentation were as follows:

- DF informed that the first draft of Del 4.1 (due for M10) is completed.
- DF reminded why TRNSYS will not be used for the building dynamic model: during the Valencia meeting it was concluded that using this detailed simulation package would not necessarily lead to optimum approach, both in terms of resources available and the technical outcome. Thus an approach based on developing a systems model from first principles that incorporates the ground loop, the heat pump and the building circuit has been developed.
- Deliverable 4.3 (Control algorithms) will be completed by October 2010. HW remarked that a critical issue to define is when to shift from cooling to heating mode. It is needed to decide the criteria that will lead to a shift from one to another.
- Demonstration buildings will incorporate 1 or 2 fixed speed compressors, not a multi compressor system.

### 3. Task 4.4 DMS summary

AL presented the DMS that will be developed to compile and store the demo-buildings performance data (see BESEL presentation - attached). The following comments were made:

- The frequency of the data collection depends on the DAQ and MP capacities. The DMS will have the capabilities to store data collected at very high frequencies, which could be beneficial for control and research studies. The DMS system will also be capable of storing data, which has been statistically processed, thereby making available interval averaged data for project assessment activities. JMC suggested that data should be measured every 15 seconds for system control and stored every minute. Once a day, measured data can be sent by FTP to the DMS. AA explained that the National Instruments DAQ equipment allow daily writing of all data to an external hard disk (6Mb estimated for each day).

- It was recommended that all data be collected and stored in the same format. Data will be sent to the DMS in .txt format by FTP, and then output files in Excel will be provided to WP 7 partners. The DMS will also able to manage the data and provide useful indicators (like SPF) which can later be used by the WP 7 and 8 partners. DM will send BESEL the requirements for the DMS.

- The DMS will be accessible through a link from the project website.

## 4. Task 4.5 summary

AA presented the MP control board and the sensors to be used to monitor the demonstration heat pumps and building performance (see ISR presentation attached). It was agreed that National Instruments equipment will be used in all demo-sites except UPV, which already has its own DAQ system. ISR recommended that a common DAQ software strategy be followed.

Comments on the proposed DAQ systems and associated sensors were as follows:

- HW proposed the use of a Thermal Energy Meter for measuring of heat pump evaporator or condenser load. Thermal meters give outputs in terms of kWh, volumetric flowrate and temperature differences. It will be considered.

- It was agreed that only cooling-heating related systems will be monitored within the building. The monitoring of other energy consumption (e.g., lighting) would be interesting so as to compare their relative contribution in relation to whole building consumption. However it was concluded that this would only be done if resources allowed.

- Fan coil electrical consumption should be measured jointly by a single power sensor. In the largest demonstration building (ISR-Coimbra) approximately 20 fan coils will be deployed.

- HW suggests installing a simple low-cost climatic station at each demonstration building. This option will be considered, if resources allow.

- It was agreed that demo-site partners should calibrate their sensors with the advice of WP 4 partners. For certain sensors (e.g., temperature), it may be adequate to obtain one certified sensor and then to calibrate the remaining sensors within the project.

- Each demonstration partner should install a specified National Instruments DAQ/Control system. A specification describing the sensor connections will be provided by ISR and if required ISR may be able to provide DAQ training at its facilities to the demonstration partners.

ISR will prepare a draft proposal outlining (i) the variables to be monitored at each demonstration site and (ii) the sensors to be used for measuring these variables. BESEL, GROENHOLLAND UCD and UPV to advise.

## 5. WP 7 summary

DM presented a summary of WP7, including: monitored variables, performance parameters, control parameters (see CRES presentation attached). This will influence the sensors to be utilised, the DAQ/Control system as well as the DMS definition within WP 4; moreover, as the acquisition of the sensors will be done within WP 7, therefore budget limitations have to be considered. Regarding this issue, AA estimated that the National Instruments DAQ/CONTROL units could cost approximately 4.000 €.

Main comment to the presentation was done by HW, who suggested considering the long lifetime of the system components in the calculation of the capital costs. This fact will make it more acceptable by the market.

## 6. WP 4 discussion

The main objective of this discussion was to clarify the responsibilities with respect to the DAQ, Control and DMS systems according to the Description of Work (Annex 1) document and to define some technical issues.

The following distribution of responsibilities was agreed for DAQ (Table 1) and Control (Table 4.2):

| Task | Partners | WP |
|---|---|---|
| Preliminary Design | BESEL, ISR | 4.4, 4.5 |
| Detailed Specification | BESEL, ISR | 4.4, 4.5 |
| Site Implementation | 8 Demo Site Partners CRES, BESEL, UNIPD, ENEREN CIAT, HIREF, OCHSNER | 6.2, 6.3 |
| Site Commissioning | 8 Demo Site Partners CIAT, HIREF, OCHSNER CRES, BESEL, UCD, UNIPD | 7.1 |
| Site Data Collection & Analysis | 8 Demo Site Partners CRES, BESEL, UNIPD, CETIAT | 8 |
| Data Management & Display | BESEL | 4.4 |

Table 1: Distribution of responsibilities on the DAQ system

| Task | Partners | WP |
|---|---|---|
| Preliminary Design | UCD, UPV, KTH, GH | 4.1 4.2 4.3 |

| | | |
|---|---|---|
| Detailed<br><br>Specification | UCD, UPV, KTH, GH, ISR | 4.3<br><br>4.5 |
| Site Implementation<br><br>Site Commissioning | 8 Demo Site Partners<br>CRES, BESEL, UNIPD, ENEREN<br>CIAT, HIREF, OCHSNER | 6.5 |
| Control Algorithm Evaluation | 8 Demo Site Partners<br>CIAT, HIREF, OCHSNER<br>CRES, ISR, BESEL, UCD, UNIPD | 7.2 |

Table 2: Distribution of responsibilities on the control system

The following conclusions from the discussions were adopted:

- A similar control system for all demo buildings will be developed. This can be further optimised for some sites (2 or 3 out of the 8), where more detailed research could be carried out. JMC noted that the various heat pump components of each site will be considerably different (e.g., fixed or multispeed compressors, etc), therefore the adoption of a standard control system could reduce system efficiency.

- The control of the heat pump system should if possible be integrated with the building control system.

- Each heat pump will have its own integrated control system, which will have to be linked to the National Instruments controller.

- A common range of variables will be measured at each demo-site. They are as follows:

1. Temperature (water inlet/outlet temperatures for both secondary circuits, outside air temperature, manual thermostat in each space, air temperatures in representative rooms could also be considered).

   JMC noted that individual temperature measurement of each building space would be expensive, but some could be selected.

2. Pressure (differential pressure internal / external circuit and total pressure).

   Low-cost differential pressure sensors could be used for this task. Various suppliers were suggested by ISR and UCD.

   In addition, the inclusion of 2 pressure (evaporator and condenser saturation pressures) and 2 temperature sensors (condenser sub-cooling and evaporator superheat) will be requested to the HP manufacturers.

3. Fluid flow (in internal / external circuits). Low-cost magnetic flow meters were recommended by UPV.

4. Power consumption (compressor, internal circuit pump external circuit pump, fan coil units).

5. Solar radiation. It can be measured with an affordable American sensor found by ISR.

**7. Ground model presentation**

HW presented a mathematical model for ground source heat exchangers that is being developed in-house by Groenholland (see GROE presentation attached).

Main comments to the presentation were the following:

- UPV suggests that the model should consider what happens if the heat pump switches off.

- The main problem is to develop a borehole model, but it is recommended by DM and JMC not to develop this model within this project. Nevertheless if it is possible to develop it with the resources available, that will be helpful as results will be of higher quality.

**8. AOB**

CM presented a free software called Universal Translator, which could be useful to analyse all project data coming from demonstration. It was considered to be interesting, and DM will study it in more detail.

## Action plan

| Action | Responsibility | Deadline |
|---|---|---|
| Demo-Site Measurement Proposal/Template<br>Specification of variables to be measured and sensors to be used at each demo-site | ISR/BESEL | 30.11.2009 |
| Proposal Review 1 (informal meeting) | Padova Meeting | 10.12.2009 |
| Proposal Review 2 (email review) | ALL WP4 partners | 15.01.2010 |
| Circulation to 8 Demonstration site partners | ISR/BESEL | 31.01.2010 |
| Athens GROUNDMED Meeting (presentation) | ISR/BESEL | 25.02.2010 |
| DMS Requirements<br>Data processing, filtering, statistical treatment<br>Calculation of COP, SPF, etc. | CRES | 30.11.2009 |
| Proposal Review 1 (informal meeting) | Padova Meeting | 10.12.2009 |
| Proposal Review 2 (email review) | ALL WP4 partners | 15.01.2010 |
| Athens GROUNDMED Meeting (presentation) | BESEL/CRES | 25.02.2010 |