D7.22

Project workshop at CLIMA 2016

[Report]

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Abstract: This document reports about the QUANTUM workshop organized during CLIMA 2016. Despite the project workplan mentions as a deliverable "D7.22 - Project workshop at CLIMA 2019", the due date for such deliverable (M24) would have made impossible to deliver the report on time (CLIMA 2019 will be in month 29). To overcome the mismatching dates, within the consortium it was agreed to change deliverable D7.22's title from CLIMA 2019 to CLIMA 2016. The outcomes of QUANTUM workshop at CLIMA 2016 were extensively promoted through QUANTUM and REHVA channels in 2016. The present deliverable further reports the workshop contents and outcomes.

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History of changes

CHAPTER NO.	DESCRIPTION OF CHANGE

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1 CLIMA 2016

CLIMA, the HVAC world congress, is REHVA's triennial flagship event, hosted on each occasion by one of REHVA's Member Associations.

In 2016 the Danish member DANVAK organised the event in cooperation with Aalborg University on 22–25 May 2016 in Aalborg, around the theme of "Building and HVAC systems performance in practice". The event was attended by around 875 experts from 49 Countries, attending the various activities organized offered.

The CLIMA 2016 format foresaw a wide offer of activities, to involve the whole spectrum of building experts in the REHVA network:

- **Keynote sessions** with eminent international recognized speakers
- **Scientific sessions** with presentations on recent research findings
- **Technical sessions** with short technical communication on practical applications
- **Workshops** on concurrent and future HVAC challenges
- **Industry forums** to discuss the major scientific questions and challenges in the industry
- **An exhibition for sponsors and industry** in conjunction with the congress
- **Technical Tours** to research laboratories and certified green buildings in the area
- **Student activities** (REHVA International and World Student Competitions)
- **Training courses** with leading experts before the congress
- Social Program

Coming to numbers, CLIMA was attended by around 875 researchers, experts and practitioners from 49 Countries. Over 700 technical and scientific papers were presented and 25 workshops organized.

1.1 CLIMA workshops

Among the long list of CLIMA 2016 activities, workshops specifically aimed at offering to building professionals occasions to enhance and update their technical knowledge, share their experiences and views, and reflect on the advancement of energy efficient HVAC technologies for buildings. These technical workshops offer the perfect platform for peer exchanges on current hot topics and the ideal place to present, discuss and disseminate project results.

In 2016, REHVA gave the floor to:

REHVA Supporters (Swegon; Eurovent Association; Eurovent Certita Certification; Grundfos; Belimo; ES-SO)

International cooperation partners (SHASE; CCHVAC; SAREK)

Representatives of European research projects (PROF/TRAC, QUANTUM, Cheap-GSHPs; QUALICHeCK)

Representatives of REHVA Task Forces, coordinated by the REHVA Technical and Research Committee.

Table 1 displays the full list of workshops organized during CLIMA 2016.

Code	Workshop	Organiser
WS 1	Understanding HVAC Operational Performance	Swegon
WS 2	NZEB design and construction: skill gaps and interdisciplinary training of professionals	PROF/TRAC
WS 3	Realizing (nearly) Zero Energy Hospital Buildings together	REHVA Task Force

Code	Workshop	Organiser
WS 4	Beat Low Delta T Syndrome by use of the latest pump generation	GRUNDFOS
WS 5	Nearly Zero Energy Buildings (nZEB)	REHVA Task Force
WS 6	Building Commissioning: what's in it for me?	REHVA Task Force
WS 7	Energy efficient heat pumps, from "standard" to "seasonal performances"	Eurovent Certita Certification
WS 8	Inspections of ventilation and air conditioning systems	REHVA Task Force
WS 9	Greenhouse gas reduction in buildings & healthy building	SAREK
WS 10	BELIMO – Water Solutions – Energy Efficiency in modern buildings	BELIMO
WS 11	Policies, design guides and energy efficient HVAC solutions regarding nearly Zero Energy Buildings in EU and China	CCHVAC-REHVA
WS 12	Building and ductwork airtightness: what has changed in the past 5 years, what is likely to change in the next 5 years?	TightVent, AIVC, QUALICHeCK
WS 13	Dynamic Solar Shading in HVAC and Daylight Design	ES-SO, EQUA, SWEGON
WS 14	Zero Internal Heating / Cooling Load Air-Conditioning system	SHASE
WS 15	Perspectives for assessing ventilative cooling potential in Energy Performance regulations	venticool, IEA Annex 62, AIVC, QUALICHeCK
WS 16	How to make cheaper GSHPs in Europe/How to diffuse GSHP in Europe	Cheap-GSHPs
WS 17	Eurovent Innovation Hub – Adding value to your buildings: Efficient air curtain technologies made in Europe	Eurovent Association
WS 18	European Voluntary Certification Scheme: a tool linking environment and energy to market value	Sustainable Buildings Alliance
WS 19	Building Automation and Control Systems: continuous operational energy use optimization	REHVA-eu.bac Task Force
WS 20	How to improve the quality of the works and compliance of Energy Performance Certificates (EPC)?	QUALICHeCK
WS 21	Coupling HVAC + Refrigeration + Lighting systems in shopping centres: technology solutions and modelling approach	IIF-IIR and EURAC
WS 22	Agenda for Ventilation and Air Infiltration 2020 and beyond: knowledge gaps, research priorities and the need for innovation	AIVC
WS 23	Quality management for building performance: Closing the gap between design and operation	QUANTUM
WS 24	Energy Refurbishments	REHVA Task Force
WS 31	Advanced airflow distribution methods for reduction exposure to indoor pollution	SCANVAC

Table 1: CLIMA 2016 workshops

To further highlight the pivotal role that REHVA attributes to these workshops as a way to exchange ideas among building professionals, the contents of these workshops were object of REHVA Technical Report No.6, *Building and HVAC system performance in practice*[1].

[1] Girardi, C., Mariottini, F. (eds). (2016). *Building and HVAC system performance in practice - REHVA Workshops at CLIMA 2016, Aalborg, Denmark, 22-25 May 2016. REHVA Report No 6*. Brussels: REHVA.

2 QUANTUM WORKSHOP AT CLIMA 2016

In May 2016, when CLIMA 2016 was held, QUANTUM project was moving its first steps. To give a boost to the project activities and showcase QUANTUM goals to building professionals, the consortium decided to offer a workshop during CLIMA 2016. This "kick-off" workshop was organized on Tuesday 24 May, from 10:30 to 12:00, titled "Quality management for building performance: Closing the gap between design and operation". Table 2 displays the workshop agenda.

Time		Presentation	Speaker
10:30	1	From Design to Performance: Why quality must be the next step towards better building performance	**Stefan Plesser (IGS, synavision) – QUANTUM project coordinator**
		Discussion	
10:50	2	Energy Monitoring of Buildings: using energy data to obtain measurable energy efficiency	**Michele Liziero (Energy Team)**
		Discussion	
11:10	3	Energy is not enough: Evaluating indoor environmental qualities with the Comfortmeter	**Niels Delaere (Factor4)**
11:20		*Discussion*	
11:30	4	Design needs Testability: Active Functional Specifications close the loop between concept and operation	**Jan Mehnert (IGS, synavision)**
		Discussion	
11:50		Round-up	**Stefan Plesser (IGS, synavision) – QUANTUM project coordinator**

Table 2: QUANTUM workshop agenda

The outcomes of this workshop are published in REHVA Technical Report No 6 and in QUANTUM website and presentations and pictures are publicly available on REHVA website. In the following section, excerpts of the technical report summarizing the workshop contents are presented.

This workshop was also the occasion for the official set up of the REHVA-QUANTUM Task Force on Building Commissioning, currently ongoing. The joint efforts of REHVA and QUANTUM experts will result in a REHVA Guidebook on Building Commissioning, which will be presented at the next CLIMA Conference, in May 2019 in Bucharest.

2.1 WS 23: Quality management for building performance: Closing the gap between design and operation

2.1.1 Summary of the presentations

2.1.1.1 Presentation 1

"**Stefan Plesser** introduced the workshop topics with the presentation "From Design to Performance: Why quality must be the next step towards better building performance?"

The gap between predicted and actual energy performance is caused by different factors such as lack of quality, deficiency in technology, and lack of incentives. The European call EeB-07-2015 demanded new tools and methodologies to reduce this gap at the level of buildings and blocks of buildings, proposing that activities should focus on ICT at Readiness Level 5-7. Annex 34 of IEA Energy in Buildings and Community (EBC) Programme (Computer Aided Evaluation of HVAC System Performance) also stressed that, although quantitative performance metrics have been defined, "It is sometimes difficult to apply them, particularly in real buildings".

QUANTUM consortium, formed by 14 partners, will provide a solution to these issues, developing pragmatic services and appropriate tools with high replication potential supporting Quality Management (QM) for building performance. "Quality" is measured by the degree of compliance with predefined standards and other recommendations (European Commission). By controlling the difference between the predefined requirements and the outcomes quality can be delivered. Within QUANTUM, the core mechanism is to "design for testability" by specifying transparent performance targets with cost effective testing methodologies.

Including QM to the construction sector means that quality control loops require development and integration that define a testing procedure to compare the target and measured value. Although it is difficult to define the target value (expectation), this is the only way to carry out a transparent and proper evaluation which will actually make the difference. Other aspects of QM are also important such as carrying on QM in an independent way, testing QM (and not only undertaking it), creating a constructive and positive spirit around QM and ensuring QM is enforced (even if that means stopping a production line and losing billions of Euros). Previous experiences showed the importance of being involved in a project from the beginning and to clarify what the purpose of QM is and what needs to be tested since there is usually a lack of interest and awareness about it.

The QUANTUM project aims to:

- Develop tools, services and business models support within the building life cycle (from design to operation);
- Implement QUANTUM tools to be representative of a set of typical European buildings;
- Prove cost effective across different applications.

Three ICT tools have already been developed by consortium partners and are almost ready

to be used:

- HPS/NG9 (by Energy Team, Italy). Cost effective, and easy to install, in-situ energy metering devices with online and on-site data analysis;
- Comfortmeter (by Factor4, Belgium). Completely web-based questionnaire for perceived user comfort;
- Performance Test Bench (by synavision, Germany). First tool for a digital specification and automated validation of Building Management Systems (BMS).

The companies will retain the ownership of the tools and sell them in order to guarantee technical support, training and to maintain high business interest in them."

2.1.1.2 Presentation 2

"Michele Liziero talked about using energy data to obtain measurable energy efficiency through energy monitoring of buildings. Two examples of applications of methods for identifying energy savings were described:

- Energy signature (scatter plot) of an office buildings according to the system power (e.g. for heating system, daily average heating gas power in kW) and external temperature (°C). By combining different variables, for different energy needs, it is possible to identify an incorrect set-up and potential energy savings;

- Carpet plot according to specific electric power [W/m²] and time (day and hour). A different visualisation of data which, for example, helps to identify the saving potential during weekends.

Energy Team also proposes and implements other methods to highlight the savings potential by applying advanced data visualisation.

An experience from Energy Team was shown, that demonstrated that more than 1000 euros of annual savings can be achieved just by spotting unexpected usage on a single air handling unit (e.g. during night).

Mr. Liziero described the main characteristics of NG-9 tool responsible for evaluating energy performance:

- Plug and play probes, from 1 to 2000 Amps;
- Power analyser, single-phase and three phase, other probes;
- Easy configurable, up to 160 measurements in 5 DIN modules;
- Very low power consumption;
- Possibility to integrate digital signals in the same tool (e.g. coming from temperature probes).

On the other hand, the Harvesting and Publishing System (HPS) will evaluate performances of Building Management Systems (BMS) by:

- web and local analysis: distributed intelligence without the need to install software;
- collecting and exporting a lot of local data, from proprietary systems or other systems;
- providing access locally via mobile or Wi-Fi hot spot, remotely via Internet;
- guaranteeing secure communication.

The tool will deliver an integrated solution for energy consumption monitoring on a web server platform, that will also be implementable in existing buildings. The audience raised an interesting area of debate concerning the correct balance between quality requirements (to be defined in advance) and affordable monitoring devices (e.g. probes). Mr. Liziero highlighted the difference between the cost of apparatus and the total cost of monitoring systems, including installation, configuration and maintenance costs. NG9 expressly addresses the total cost of energy monitoring and aims to reduce it considerably."

2.1.1.3 Presentation 3

"**Niels Delaere** illustrated the evaluation of indoor environmental quality, based on building users' answers, with the Comfortmeter. Factor 4 usually applies the Comfortmeter in Energy Performance Contracting and recommissioning projects, both before and after the project, in order to assure the quality and results. The tool currently covers 55 buildings and 120 additional building will be added in 2016 through the QUANTUM project with more planned before the end of the project.

Within QUANTUM project, Comfortmeter will:

- determine the comfort problems in a building;
- evaluate the potential impact of comfort conditions on the users;
- evaluate the impact of the users' comfort level on the building operation.

It is important to provide user comfort since their behaviour will contribute to the energy gap (e.g. by opening windows or increasing heat). Nevertheless, although technical requirements for indoor environmental quality are clear, user perception of comfort may vary considerably. Furthermore, the overall notion of comfort covers many aspects such as temperature, air, light, sound, control, office and building ergonomics and aesthetics.

The system creates an online survey covering all the above-mentioned topics related to comfort, in relation to the specific building zone. The system, while guaranteeing the anonymity of the answers, requires personal information concerning gender, age, productivity levels and the frequency of use of the different building zones. The cost of a survey covering about 200 respondents ranges from 1500 to 1800 euro, and it is generally submitted quarterly in order to take into account seasonal variations.

The output is a pdf report for the whole building and for each building zone which analyses the comfort aspect comparing the survey results with best practises, also providing an evaluation of the potential improvements for comfort and productivity.

There was a lot of interest from the audience about the relevance of the survey answers. While survey answers may be influenced by specific and temporary conditions, the survey instructions require participants to feedback on their normal perception of comfort. Currently the survey doesn't take into account the relative importance that each user assigns to each aspect although participants can provide a free text comment."

2.1.1.4 Presentation 4

"**Jan Mehnert** concluded the presentation session summarising how active functional specifications can close the loop between concept and operation of building automation controls. Most commercial buildings have a BMS (and every newly built commercial building will have one) thus data are generally available and can be used to exploit the saving potentials due to lack of operational quality in building services. However, while standards for performance tests are available in other sectors (e.g. standard plugin testing for cars), commissioning of building automation is usually done by visual examination related to the specific situation of each building.

Synavision fill this gap by providing a digital performance test bench to close the loop. An evaluation, in the form of a digital performance check, is performed after the implementation of active functional specifications (based on mathematically described rules) and is then compared with the BMS data. The results show the state of operation in the form of a chart (split by days and hours of operation) which allows system fault identification and optimisation of building performance.

The main features of Performance Test Bench are:

- Effectiveness: checks are part of the regular processes in the building sector;
- Transparency: all specifications and evaluations are comprehensible and documented;
- Speed: it takes less than four weeks from the start to deliver the report;
- Ease: engineers require less than four weeks' experience before applying the tool;
- Robustness: digitalization ensures scalability;
- Affordability: quality management for commissioning has a valid business model.

The process of extracting data from BMS aroused the curiosity of the participants who questioned the speakers about why measured data is not compared to set-points to detect operational faults. The authors stated that this approach would not detect faults which differ from designed values."

2.1.2 Workshop discussion's outcomes

"The workshop attracted mainly engineers but also other kinds of participants (e.g. manufacturers and installers) and, even before the discussion panels, there was an interesting

level of debate:

- Lack of specification of requirements (in particular owners' project requirements) and unfulfilled quality expectations. First it is important to define the specific needs and then it is possible to establish measurable targets;

- Importance of quality management (especially in facilities management). Without quality standards, commissioning usually results in bad outcomes;
- Timeframe of the quality management within QUANTUM. The goal of the consortium is to develop tools which address a specific part of the commissioning process (not only the whole life-cycle) which could be used by third-parties and turned into a business model;
- Role of the architect. This is very important although it may vary considerably, depending on their professional background and project organization.

The organisers collected feedback from 26 participants through an on-site poll:

- 50% of the participants answered that more than 30% of energy is wasted in buildings due to bad quality. However, this is not usually seen and understood by the building owners.
- 72% of the participants agreed that the combination of BMS with HVAC systems is mostly responsible for quality gaps.
- The audience expressed different opinions regarding which kind of professional is mostly responsible for quality gaps. In this regard, operation and management professionals (35%) were followed by engineer (23%). A similar result occurred regarding the comfort aspects that identified both engineers and operation management professionals (41% in both cases).
- There was no common agreement on which barrier is the most significant for quality management. Building owners (29%) were closely followed by lack of competence and ineffective business models (23% in both cases).
- All the attendees agreed that energy gap solutions need energy monitoring systems for continuous evaluation although a small percentage (28%) stated that it would also depend on the energy intensity.“

In general, positive impressions were gathered from this first QUANTUM event. “Attendees showed a lot of interest and agreed on the importance of quality management in building commissioning although they also highlighted many barriers and constraints regarding its practical application.“

3 LIST OF TABLES