MINUTES

3rd Expert Meeting
DRESDEN, MARCH 20-23, 2017

Campus TU Dresden, Dresden, Germany, 01069 Zellescher Weg 17, BZW-Building Room B107

ATTENDANCE

			Participants present in person:
1	Pawel Wargocki-(PW) Technical University of Denmark, Kgs. Lyngby, DK	15	Marc Abadie (MA) Université de La Rochelle, F
2	Carsten Rode (CAR) - Operating Agent (OA) Technical University of Denmark, Kgs. Lyngby, DK	16	Fitsum Tariku (FT) British Columbia Institute of Technology,CA
3	Manfred Plagmann-(MP) BRANZ,NZ	17	GUYOT Gaelle(GG) LOCIE, Université de Savoie,F
4	Henrik Knudsen (HK) Danish Building Research Institute, Aalborg University, Copenhagen, DK	18	Jelle Laverge(JL) Ghent University,BL
5	Jensen Zhang (JZ) Syracuse University, NY, USA	19	Nicole Poussineau(NP) Saint-Gobain,F
6	Jakub Kolarik (JK) Technical University of Denmark, Kgs. Lyngby, DK	20	Rojas-Kopeinig, Gabriel(RG) Universität Innsbruck, AS
7	Daria Zukowska-Tejsen(DZ) Technical University of Denmark, Kgs. Lyngby, DK	21	Ruisiuger Uloich(RU) TU Dresden, G
8	Schijndel, A.W.M. van(SA) TU Eindhoven, NL	22	Karel Frana(KF) TU Liberec, CZ
9	Menghao Quin (MQ) Technical University of Denmark, Kgs. Lyngby, DK	23	Jose Mercado(JM) IKEM-Berlin,G
10	John Grunewald (JG) TU Dresden, G	24	Esfandiar Burmandir(EB) University College London,UK
11	Amar Aganovic(AA) Norwegian University of Science and Technology	25	Risto Kosonen(RK) Aalto University,F
12	Guangyu Cao, (GC) Norwegian University of Science and Technology,N	26	Paul Kloseiko(PK) Tallinn University of Technology,ES
13	Andreas Nicolai(AN) TU Dresden, G	27	Hagar Elarga Technical University of Denmark, Kgs. Lyngby, DK
14	Dirk Weiss(DW) TU Dresden, G		

LIST OF ACRONYMS

AI	Action Item
ASAP	As Soon As Possible (in connection to AI)
BEPS	Building Energy Performance Simulation
ExCo	EBC Executive Committee
IAQ	Indoor Air Quality
OA	Operating Agent
RID	Research Item Description
ST	Subtask
STL	Subtask Leader

1. Start of the meeting and welcome

The meeting was started by CAR on March 21 at approx. 9:00. Participants introduced themselves during "tour de table".

2. Review of agenda

CAR briefly introduced the agenda (ATTACHMENT A) also he has mentioned that the main challenge is to link different available tools of simulations to reach a simplified model addressing heat, humidity and particles transfer. CAR also highlighted:

1-More results have to be analyzed and presented by participants in order to be prepared for the next ExCo meeting.

2-Upload the required documentation on the share folder.

3. Introduction to (hosting the meeting)

JG introduced TUD and his team and discussed about the days arrangement within the campus.

4. Discussion of ST 1 description

Marc Abadie presented the working progress regarding Subtask 1 from the 2nd Expert meeting in Syracuse (Sept. 2016). After a quick overview of the contents of this subtask, Marc Abadie informed about the reviewing process of Subtask 1 report. As it was planned after the IEA EBC ExCo meeting in Sydney (Nov. 2016), the report has been reviewed by two AIVC members (Max Sherman and Willem de Gids) for publication as a Contributing Report. In parallel, William Bahnfleth also reviewed the report. The main point that has been discussed during the meeting is the definition of "low-energy building", a concept that is different from country to country and that evolves with time according to the national (or supranational) standards. Two other advances have also been reported: the writing of a paper for a Special issue for EBC Annexes of Energy and Buildings (paper due: March 31st) and the participation to present the results of Subtask 1) to the AIVC 2017 Workshop on IAQ metrics (Brussels, 14-15 March 2017).

In the afternoon, Marc Abadie and Pawel Wargocki have worked on the comments made by the reviewers. In particular, regarding the definition of "low-energy building", it was decided to complete the text in two locations:

- In the introduction (description of Annex68): the original text has been completed with "*In some countries or regions, low-energy buildings are defined by the building codes or in relation to the energy standard. A building which can be classified as low-energy in one country may use more energy than a standard building from another neighboring country. Also, over time, standards have improved and what were low-energy standards some years ago may be standard today (Laustsen, 2008). In the present project, a building is considered as a low-energy building when it has a better energy performance than the typical new building following the minimum standards defined in building regulations at a given time and country.*"
- In the literature review regarding the selection of papers: "*The literature review has been limited to peer-reviewed articles and national research projects in the period from 2006 to 2016 i.e. studies performed in the last 10 years and period of time when the concept of low-energy buildings appears in Standards (implementation in 2006 of the European Directive 2002/91/EC (EPBD, 2003) by European countries; ENERGY STAR label defined by ASHRAE (2004) and IECC (2004)).*"

5. Discussion of ST 2 description

The Progress of ST2 has been presented by MQ, and JZ, it included three main aspects:

a- Literature Review and Database Development

- *A literature review on existing data of material emissions and sorption has been conducted, and a series set of databases have been identified including data from NRC's MEDBIAQ project, SU/MIT/Tsinghua's ASHRAE projects, U. of La Rochelle's PANDORA, IBR's and Tsinghua U's.*

b- Experimental

Two experiments are ongoing.

- *The first one is the combined effects of temperature and humidity on VOC emissions from different building materials. We will measure 6 VOCs, and for three different materials. It's a collaboration between NJU, Tsinghua and HKU. The data will also be used to validate the existing models as well as suggesting new models for the correlations between emission factors and environmental conditions.*
- *The second is the field measurement in P+ building in China to study the relationship between IAQ and different ventilation/ air cleaning strategies and building energy consumption. The tests started in March 2017, and will continue for one year. The test data will also be used to validate the models developed in Task 3, and provide a case study for Tasks 4 and 5.*
- *Additional small scale environmental chamber tests were conducted at Syracuse University to investigate the adsorption and desorption of VOCs and SVOCs on building materials and furnishing. The data will be combined with previous data to further evaluate and develop sink models.*

C- Modelling

- *A theoretical correlation between the emission rate and indoor temperature and relative humidity is derived.*

- *A procedure to estimate the model parameters of emission source models from the existing emission data accounting for the effect of temperature is under development.*
- *A procedure for the definition of reference buildings for estimating the pollution loads, IAQ and energy analysis for different countries/climates is proposed. An example is provided for detached house in Northeast region of U.S. including house specification, DesignBuilder/E+ simulation results for energy consumption, and IAQX simulation results for VOCs.*
- *A method and procedure of using a full-scale chamber to evaluate the effects of emission sources and sinks, ventilation and air cleaning on IAQ is developed. Two cases were defined with experimental data, one for a simple source (particle board), and the other with mock up for a room with vinyl floor, ceiling tiles, painted gypsum wallboards, and a desk. The test cases will also be used for the common exercises.*

Active contributors

- *DTU, Syracuse U., University of Texas Austin, California Department of Public Health, Nanjing U., Tsinghua U., Hong Kong U., University of Shanghai for S&T, Shenzhen IBR. (7 institutions) + La Rochelle U., TU Dresden*

6. Discussion of ST3 description

JG has started by an introduction of his view on the work programme of ST3 and mentioned that it should be focused on classification of available tools for CHAMPS modelling. There are many research oriented tools available. The main point is not to further develop tools, but to include all and develop classification methodology – a reference system. This means the collaborative model development towards a fully coupled CHAMPS modeling platform can be realized as envisaged d**uring the last meeting in Syracuse**: "The target of Subtask 3 is a review, gap analysis and categorization of existing models and standards. The task is to collect and develop validated reference cases by use of contemporary whole building analysis tools and methods to predict the hygrothermal conditions, absorption and transport of humidity and chemical substances, and energy consumption within buildings."

JG has also clarified the Status of the Annex 68 / CHAMPS platform mentioning that during the last meeting in Syracuse, the Annex 68 consortium decided to initiate a collaborative model development towards a fully coupled CHAMPS modeling platform. This platform will be an open-source repository for numerical solvers and data being able to capture the most important physical processes of coupled heat, air, moisture and pollutant transfer in buildings. This platform will be the basis for a seamless continuation of the modeling and software development activities of the IEA EBC Annexes – especially it will build upon the achievements of the Annex 60, an effort on "New generation computational tools for building and community energy systems based on the Modelica and Functional Mockup Interface standards". The platform itself will be part of the German EnTool development financially supported by the German

Federal Ministry of Economics and Energy (BMWi). According to the targets and guidelines of the BMWi, a free open-source tools repository for public use will be developed. Since many software tools already exist, the focus is on review, gap analysis and categorization of the tool landscape. Quality insurance criteria are developed for inter-operability, data consistency and validation cases. The solvers on the platform will be able to capture transient heat, air and moisture processes in buildings with a strong focus on energy performance. An extension of the platform towards energy performance evaluation of quarters and cities is part of the strategic plan. The Annex 68 consortium works on extension of the EnTool platform towards fully coupled VOC emission / indoor air quality models. The Annex 68 members and their project partners will extend the developer's network on the VOC side. Part of this activity is the development of a training program for newcomers based on competences acquired by the pilot developers during the Annex 68. The TU Dresden will provide a training program in order to support proactive acquisition of the required programming technologies. This requires a stay in Dresden for at least 3 months. Afterwards, due limited time, any form of intensive correspondence to explain programming details, physics, algorithms etc. would have to be remain limited.

One of the accompanying activities of the EnTool platform is the further development of the GUI BIM-HVAC tool carried out by the TU Dresden in cooperation with their project partners. Workflow optimization is important from the user's point of view. The BIM-HVAC tool is an integrated modeling environment, which has capabilities to import BIM models and to trigger energy, airflow and daylight simulations. The BIM-HVAC tool includes professional post processing and reporting functionality and it will be capable to bridge to gap between research and planning practice. The further development of the BIM-HVAC tool is planned in the frame of the EnTool platform development.

Results from Annex 60 Co-Simulation work

AN in his presentation has summarized the achievements of TUD's work supported by the BMWi EnTool-CoSim project in the Annex 60, an effort on "New generation computational tools for building and community energy systems based on the Modelica and Functional Mockup Interface (FMI) standards".

The application of the FMI Co-Simulation technology to building energy performance simulation was discussed during the presentation, where detailed physical building models are coupled to Modelica-based HVAC component and plant models. The Annex60-based libraries AixLib, BuildingSystems, Buildings and Idias (Wetter et al., 2013; Wetter, 2009; Nytsch-Geusen et al., 2013; Sahlin et al., 2004) or the GreenBuilding library provide suitable components for modeling building systems.

The generation process of the building FMU from TUD's stand-alone building simulation program NANDRAD was discussed and internal algorithms for FMI version 2 capabilities were sketched out. Then, coupling scenarios were described and physical interface conventions were presented.

Usability was addressed by automatic generation of building-model specific adapters and wrappers. The building FMU and plant FMUs are then simulated together using different Co-Simulation master algorithms. Finally, based on simulation results and performance analysis the presentation was concluded with recommendations on suitable master algorithm options and specific features of suitable building FMUs. TUD's own software development MasterSim was introduced.

A typical CHAMPS usage scenario includes evaluation of different options regarding building envelope construction, HVAC systems and control strategies. Currently, available simulation tools, such as EnergyPlus, TRNSYS, IDA-ICE and NANDRAD are concepted as stand-alone tools. Modeling and simulation of integrated modern buildings requires flexible plant and equipment models, which are often case-specific.

However, modeling the entire building with sufficient physical detail in Modelica alone is not meaningful for several reasons:

- larger building complexes may involve many zones, constructions, facade elements, thermal storage members resulting in thousands of differential equations,
- Modelica code may become huge and may cause problems with the generic Modelica solvers, even symbolic analysis may be extremely slow,
- modeling the building in Modelica without suitable BIM-style data import or code generation will not be possible for realistic buildings, it is too time consuming and thus too expensive, and
- manual connection of many building components with corresponding equipment and control models may be extremely time-consuming and error-prone.

For practical purposes, planners and engineers will not accept a procedure that involves creation of such complex models with current Modelica user interfaces, alone. The use of stand-alone simulation tools or Modelica-only based building modeling may not be a satisfying strategy. Instead, a hybrid approach appears meaningful:

- using existing building simulation software tailored to the building engineering user group, preferably Building Information Model (BIM) preprocessing software packages (DesignBuilder3, BIM-HVAC tool4, etc.) with database support, graphical representation of the building, and input error control with automatic generation of input data to building simulation engines (e.g. IDF-files for EnergyPlus, or nandrad-files for NANDRAD), and
- use of Modelica and suitable libraries by HVAC system planners to model building equipment (heater/chiller/ventilation systems) and required control strategies.

Linking both models in a coupled simulation will combine also the benefits of both modeling approaches.

The TUD's work of the last years, financially supported by the BMWi EnTool-CoSim project, was dedicated towards this goal. TUD succeeded to run coupled building energy performance simulations using the FMI standard and to implement the physical interface between plant and building FMU and the process of generating the building FMU itself.

For practical applications, overall simulation performance remains a crucial criterion. Considering the still long simulation times when applying Co-Simulation, further work is required with regard to finding suitable physical interfaces, choice of master algorithms and algorithmic parameters.

1. **Release of the Modelica Annex 60 library - Jun Cao, RWTH Aachen University**
2. **Introduction to ST3 common exercises (DIN EN ISO 13791) – Dirk Weiss, TU Dresden**

Seminars on tool training

The Annex meeting in Dresden has also included some seminars clarifying the overall approach of some tools such as Modelica, CHAMPS and IAQX. These seminars included:

- **The Introduction to modern Building Energy Performance simulation (AN):**
  - Basics of dynamic building energy simulation, requirements and fundamentals of modern dedicated solvers
  - Getting starting with dynamic simulation: single-zone models with THERAKLES and interactive variation studies.
  - Detailed HVAC/equipment models using Modelica: introduction into Modelica technology and Annex 60 libraries, Annex60/Eneff-BIM Toolchain from IFC to Modelica Simulation Models
  - Extension to multi-zone models: the need for pre-processing tools and tool chain automation
- **Introduction to IAQX and CHAMPS-BES for modeling the IAQ (JZ)**
  - IAQX and its applications to simulating the full-scale chamber test case, and the reference residential building case
  - CHAMPS-BES and its application to a dual-chamber test case, and plan for single-zone, 2-D simulation of the reference residential building case
- **Building Energy Performance simulation (DW)**
  - Introduction to BIM HVACTool: geometry import and modeling basics
  - Demonstration example and hands-on practice in setting up a simulation model
  - reports and simulation results
- **Hygrothermal simulation of envelope constructions, construction details, specialized equipment/systems with DELPHIN 6 (AN)**
  - Introduction in hygrothermal modeling: geometry, initial conditions, boundary conditions, sources/sinks and modeling parameters
  - Hands-on practice on some examples
  - Advanced topic: how to increase simulation efficiency by choosing suitable solver/numeric parameters

<u>Important notification</u>

EnTool strategy & implementation workshop

With the establishment of the German Research Network “Energy in Buildings and Neighborhoods” by the BMWi, officially founded on Oct-02-2014 in Berlin, the existing funding initiatives in the fields of renewable energies and energy efficiency in buildings and cities are bundled. At the same time, the TUD established the EnTool research initiative together with the RWTH Aachen University for a coordinated development of building energy performance simulation tools.

Since many software tools already exist, the focus of the EnTool research initiative is on review, gap analysis and categorization of the tool landscape. Quality insurance criteria are developed for inter-operability, data consistency and validation cases.

Invited representatives of the BMWi attended the EnTool strategy & implementation workshop. We provided space for discussion of many aspects of the strategic and technical implementation of the EnTool platform.

- The scope and limitations of the EnTool platform
- Stakeholders and their roles
- Requirements for tools, data & interfaces
- Standards and protocols for quality control
- Appropriate levels of detail: Practical usability vs. complexity
- BIM workflows & tool chains
- Support & knowledge transfer to practice
- The role of GUIs: Simplified, medium and expert modes
- Commercial approaches vs. open source
- Conclusions on EnTool strategy & implementation

As an outcome of the workshop, ST3 members have received a positive evaluation of our project proposal "SimQuality". The additionally mobilized resources from the SimQuality project are the total budget of the project which is around 2.7 Mio EUR and the expected contributions from the project partners. All six partners will contribute towards the targets of the modeling platform. The outputs of the previous "CoSim"-project and the BIM-HVACtool development are also valuable contributions which will deliver input to the Annex 68 ST3.

7. Discussion of ST4 description

JK, DZ and AA have clarified the Current status for ST4, and steps for the near future including the analysis of common exercise, workshop at AIVC conference in Sept. and A68 guidebook group). The main parameters were:

1. **Stakeholder Survey-ST4 common exercise - status and preliminary results** - DZ
2. **RoomVent Solutions - introduction to a research & development project** focused on innovative residential ventilation systems – JK.
3. **Indoor air quality and health symptoms in mechanically ventilated residential dwellings/low-rise buildings:** A review/analysis of existing information – AA.

Regarding activity 4.1, JK has presented status of the subtask work which is summarized in the following table:

Work to be conducted	Deadline	Involved	Status	Note
Part 1 - Update and compilation of ventilation requirements from building codes (reviews, reports, etc.)	Spring 2017	Jakub, Daria, Amar, Guangyu, Carmina	Ongoing	Paper for AIVC Sept. 2017; Amar, Guangyu, Jakub
Part1- Decide which A68 countries will participate; distribute template for lit. review; Skype meeting	V/2016	All ST4	Finished	
Part1 - "MS EXCEL Templates" Work on national contribution using the predefined structure for input; analysis of results on national level	IX/2016 -> ?	All ST4	Ongoing	Template filled out by DK, AU, UK & NOR, we need more
Part2-A68 participants declare their involvement and identify relevant stakeholders on national level; template for structured interview is finalized	VIII/2016	All A68	Finished	
Part2-Interviews conducted on national level (minimum 2 interviews / country)	XII/2016 -> II/2017 -> ?	All A68	Ongoing	New deadline probably V/2017
Part2-Analysis of results; inputs for Activity 4.2	XII/2016 -> ?	Daria, Esfandiar, Guangyu, Amar, Gabriel, Carmina	Ongoing ☺	New deadline probably XII/2017 AVIC paper V/2017
Part1+2-Preparation of peer reviewed paper	XII/2016 -> ?	Daria, Esfandiar, Guangyu, Amar, Gabriel, Carmina	Not started	New deadline probably XII/2017

JK at the beginning has clarified that ST4 suggests that all Annex participants involved in stakeholder survey (activity 4.1 - Part 2) should also perform a review of available guidance for ventilation designers in particular countries to provide a continuity between requirements - design guidance and the practice. JK also suggested that ST4 will distribute MS Excel to all participants involved in Part 2 and ask them for response.

Activity 4.1.

DZ has illustrated the overall approach of the Common exercise activity 4.1 - Part 2 which included in the Interview with important stakeholder that should be held with at least two of participated countries in annex 68. It is preferably to integrate more countries in order to have a more representative point of view. The interview template shall include minimum of three main questions to be asked plus hints for sub-questions. Work is ongoing and the progress is satisfactory. First analyses will be published in paper for AIVC conference in Nottingham (Sept. 2017). To start the process of data analysis, a group of ST4 members was created. The group involves JK, DZ, G, Esfandiar, GC, AA and Carmina (Henrik may join also, but he hasn't decided yet). It was agreed that the first analysis will be done on all surveys regardless the stakeholder type. Analysis will have two main questions: 1/ What is the state of the art - types of installed ventilation systems, requirements regarding ventilation rates etc. 2/ Barriers and challenges related to mechanical ventilation in dwellings. The group was divided in two sub groups focused on the mentioned questions. They should come with first results by 12. April.

Another discussed issue was Annex 68 workshop at AIVC conference in Nottingham. Suggested topic is "Ventilation in low energy residences-transition from requirements to practice". Contends should be presentation of activity 4.1 results. ST4 will work on the workshop preparation during spring 2017. Idea is that it should cover "Transition", present examples on cases from A68 countries (2 – 3 countries ?) and involve discussion/input from participants (Voting?, Stickers?, Questionnaire?).

Activity 4.2

JK has presented two possible approaches: a) Top-down: ST4 defines "innovative design strategies" and A68 participants evaluate them in their particular national context b) Bottom up: strategies defined based on

national level and we analyze/compare them. During the consequent discussion it was decided to focus on a group of simulation case studies: Every participant defines the topic to look at (for example commissioning, room-based controls, etc.). Topics of interest will be gathered on a "list of open questions" – a document where all partners, who want to be involved specify their topics, main objectives as well as tools and data they may use to address the topic. Each partner will then work on his/her own topic and will discuss with ST3 and ST2 individually what help is needed to conduct the task.

JK will prepare the "list of open questions" template in Sharepoint.

Start of Activity 4.3 and 4.4 – it was decided that these will be addressed during the next expert meeting in Nottingham.

All presentations from the session can be seen in Sharepoint.

8. Discussion of ST5 description

As was decided at the last annex-meeting, 3 experiments are carried out as validation exercises for the ST2-3-4.

JL presented the first of these experiments:

- PASSYS test cell is used to carry on some simplified experimental investigation. Experimental measurements included global solar radiation intensities, inside/outside temperatures.
- Jensen proposed to use this results to validate the simplified one zone model which shall include thermal, IAQ , humidity analysis.
- Jelle has suggested that to repeat the experimental work in DTU (PASSYS test cell) and Carsten approved.

FK has presented the test facilities at his lab:

- 2 identical 1 room 'houses', heavily instrumented with T and RH sensors that are used for CFD validation.
- The group suggested that these might be a good alternative to the second experiment that is planned over the summer or an intermediate step between the first and second experiment
- Fitsum will coordinate with Jensen to see if some chemical analysis can be done in these labs or if samples can be sent to Syracuse
- Fitsum agreed to replace Treetechnisk as co-subtask leader in WP5

GG presented 2 french case studies included the observed IAQ database and more local case study. JL presented 3 consecutive Belgian case studies, one focusing on new low energy dwellings, one on low energy renovations and one on social housing/larger housing blocks

The group agrees that this is an interesting way to look at 'real building' and several have committed to present case studies at the next annex-meeting.

9. TO DO LIST:

ST2:

- *Continue the experiments and field measurements.*
- *Continue the modelling and validation of the models.*
- *Complete the validation of the procedure for determining the model parameters of mechanistic model for dry materials and the procedure for the definition of reference building with cases from other countries (China and Denmark?).*
- *Design 1-2 common exercises based on the "procedure" and "definition" mentioned above.*

ST3

ST4

- *Update and compilation of ventilation requirements from building codes*
- *"MS EXCEL Templates" Work on national contribution using the predefined structure for input; analysis of results on national level.*
- *Interviews conducted on national level (minimum 2 interviews / country).*
- *Analysis of results; inputs for Activity 4.2, conference paper for AIVC in Sept. 2017.*
- *Preparation of peer reviewed paper.*

ST5

- *Upload the description of the first experiment online so that modelling and validation could be initialized.*
- *Plan of the next experiments in the coming summer and winter seasons*
- *Disseminate the presentations and documentations of recently finished or ongoing case studies.*

10. General Conclusions

- *-Modelling teams will develop a simplified one zone model capable of predicting thermal, humidity and IAQ conditions for the first experiment.*
- *-By mid of April Carsten asked for a preliminary perspective of such a simplified model.*
- *- Each subtask should develop a Common Exercise to be submitted to all Annex participants by May 2017, such as to stimulate participants to obtain hands-on experience with the topics of the subtasks that can be presented at the next Expert meeting.*

- *- Free papers shall be encouraged to be submitted until the next expert meeting where they can presented. Free papers may be new work made with dedication to Annex 687, or it could be papers prepared in other research projects where the results have relevance for Annex 68.*

- *Papers and presentations should be uploaded to the Sharepoint.*

11. Next meetings

- *The next meeting is going to be held in Nottingham, UK, 11-13 September.*

Each ST group will prepare a plan for a two-hour activity related to its common exercised to be presented in Nottingham.

- *USST will host the Annex 68 expert meeting in Shanghai from March 28 to 30, 2018*

Picture: 1 Participants in the meeting at CSIC, Dresden